DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R2–ES–2012–0035; 4500030113]

RIN 1018–AY22

Endangered and Threatened Wildlife and Plants; Determination of Endangered Species Status for the Austin Blind Salamander and Threatened Species Status for the Jollyville Plateau Salamander Throughout Their Ranges

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), determine endangered species status for the Austin blind salamander (*Eurycea waterlooensis*) and threatened species status for Jollyville Plateau salamander (*Eurycea tonkawae*) under the Endangered Species Act of 1973 (Act), as amended. The effect of this regulation is to conserve these salamander species and their habitats under the Act. This final rule implements the Federal protections provided by the Act for these species.

DATES: This rule becomes effective September 19, 2013.

ADDRESSES: This final rule is available on the Internet at *http://www.regulations.gov* and *http://www.fws.gov/southwest/es/AustinTexas/*. Comments and materials received, as well as supporting documentation used in preparing this final rule is available for public inspection, by appointment, during normal business hours, at U.S. Fish and Wildlife Service, Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

FOR FURTHER INFORMATION CONTACT: Adam Zerrenner, Field Supervisor, U.S. Fish and Wildlife Service, Austin Ecological Services Field Office, 10711 Burnet Rd., Suite 200, Austin, TX 78758; by telephone 512–490–0057; or by facsimile 512–490–0974. Persons who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Executive Summary

Why we need to publish a rule. Under the Act, a species may warrant protection through listing if it is endangered or threatened throughout all or a significant portion of its range. Listing a species as an endangered or threatened species can only be completed by issuing a rule.

This rule lists the Austin blind salamander as an endangered species and the Jollyville Plateau salamander as a threatened species under the Act.

The basis for our action. Under the Act, we can determine that a species is an endangered or threatened species based on any of five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) Overutilization for commercial, recreational, scientific, or educational purposes; (C) Disease or predation; (D) The inadequacy of existing regulatory mechanisms; or (E) Other natural or manmade factors affecting its continued existence. We have determined that the Austin blind salamander is an endangered species and the Jollyville Plateau salamander is a threatened species under the Act due to threats faced by the species both now and in the foreseeable future from Factors A, D, and E.

Peer review and public comment. We sought comments from independent specialists to ensure that our designation is based on scientifically sound data, assumptions, and analyses. We invited these peer reviewers to comment on our listing proposal. We also considered all comments and information received during the comment period.

Background

Previous Federal Action

The Austin blind salamander was included in nine Candidate Notices of Review (67 FR 40657, June 13, 2002; 69 FR 24876, May 4, 2004; 70 FR 24870, May 11, 2005; 71 FR 53756, September 12, 2006; 72 FR 69034, December 6, 2007; 73 FR 75176, December 10, 2008; 74 FR 57804, November 9, 2009; 75 FR 69222, November 10, 2010; 76 FR 66370, October 26, 2011). The listing priority number has remained at 2 throughout the reviews, indicating that threats to the species were both imminent and high in impact. In addition, on May 11, 2004, the Service received a petition from the Center for Biological Diversity to list 225 species we previously had identified as candidates for listing in accordance with section 4 of the Act, including the Austin blind salamander.

The Jollyville Plateau salamander was petitioned to be listed as an endangered species on June 13, 2005, by Save Our Springs Alliance. Action on this petition was precluded by court orders and settlement agreements for other listing actions until 2006. On February 13, 2007, we published a 90-day petition finding (72 FR 6699) in which we concluded that the petition presented substantial information indicating that listing may be warranted. On December 13, 2007, we published the 12-month finding (72 FR 71040) on the Jollyville Plateau salamander, which concluded that listing was warranted, but precluded by higher priority actions. The Jollyville Plateau salamander was subsequently included in all of our annual Candidate Notices of Review (73 FR 75176, December 10, 2008; 74 FR 57804, November 9, 2009; 75 FR 69222, November 10, 2010; 76 FR 66370, October 26, 2011). Throughout the four reviews, the listing priority number has remained at 8, indicating that threats to the species were imminent, but moderate to low in impact. On September 30, 2010, the Jollyville Plateau salamander was petitioned to be emergency listed by Save Our Springs Alliance and Center for Biological Diversity. We issued a petition response letter to Save Our Springs Alliance and Center for Biological Diversity on December 1, 2011, which stated that emergency listing a species is not a petitionable action under the Administrative Procedure Act or the Act; therefore, we treat a petition requesting emergency listing solely as a petition to list a species under the Act.

On August 22, 2012, we published a proposed rule to list as endangered and designate critical habitat for the Austin blind salamander, Georgetown salamander (*Eurycea naufragia*), Jollyville Plateau salamander, and Salado salamander (*Eurycea chisholmensis*) (77 FR 50768). That proposal had a 60-day comment period, ending October 22, 2012. We held a public meeting and hearing in Round Rock, Texas, on September 5, 2012, and a second public meeting and hearing in Austin, Texas, on September 6, 2012. On January 25, 2013, we reopened the public comment period on the August 22, 2012, proposed listing and critical habitat designation; announced the availability of a draft economic analysis; and an amended required determinations section of the proposal (78 FR 9876).

Section 4(b)(6) of the Act and its implementing regulation, 50 CFR 424.17(a), requires that we take one of three actions within 1 year of a proposed listing: (1) Finalize the proposed listing; (2) withdraw the proposed listing; or (3) extend the final determination by not more than 6 months, if scientists knowledgeable about the species substantial disagreement regarding the sufficiency or accuracy of the available data relevant to the determination, for the purposes of soliciting additional data.

The public comments we have received indicate substantial disagreement regarding the sufficiency or accuracy of the available data that is relevant to our determination of the proposed listing of the Georgetown and Salado salamanders. Therefore, in consideration of these disagreements, we are publishing a 6-month extension of final determination for the Georgetown and Salado salamanders elsewhere in today's **Federal Register**. With this 6-month extension, we will make a final determination on the proposed rule for the Georgetown and Salado salamanders no later than February 22, 2014.

On the other hand, more research has been conducted, and, therefore, more is known about the life history, population trends, and threats to the Austin blind and Jollyville Plateau salamanders. Although there may be some disagreement among scientists knowledgeable about the Austin blind and Jollyville Plateau salamanders, the disagreement is not substantial enough to extend the final determination for these species. Therefore, this rule constitutes our final determination to list the Austin blind and Jollyville Plateau salamanders as an endangered and threatened species, respectively.

Species Information

Taxonomy

The Austin blind and Jollyville Plateau salamanders are neotenic (do not transform into a terrestrial form) members of the family Plethodontidae. Plethodontid salamanders comprise the largest family of salamanders within the Order Caudata, and are characterized by an absence of lungs (Petranka 1998, pp. 157–158). The Jollyville Plateau salamander has very similar external morphology. Because of this, the Jollyville Plateau salamander was previously believed to be the same species as the Georgetown and Salado salamanders; however, molecular evidence strongly supports that there is a high level of divergence between the three groups (Chippindale *et al.* 2000, pp. 15–16). Based on our review of these differences, and taking into account the view expressed in peer reviews by taxonomists, we believe that the currently available evidence is sufficient for recognizing these salamanders as separate species.

Morphological Characteristics

As neotenic salamanders, they retain external feathery gills and inhabit aquatic habitats (springs, spring-runs, wet caves, and groundwater) throughout their lives (Chippindale *et al.* 2000, p. 1). In other words, the Austin blind and Jollyville Plateau salamanders are aquatic and respire through gills and permeable skin (Duellman and Trueb 1986, p. 217). Also, adult salamanders of these species are about 2 inches (in) (5 centimeters (cm)) long (Chippindale *et al.* 2000, pp. 32–42; Hillis *et al.* 2001, p. 268).

Habitat

Each species inhabits water of high quality with a narrow range of conditions (for example, temperature, pH, and alkalinity) maintained by groundwater from various sources. Both the Austin blind and Jollyville Plateau salamanders depend on water in sufficient quantity and quality to meet their life-history requirements for survival, growth, and reproduction. Much of this water is sourced from the Edwards Aquifer, which is a karst aquifer characterized by open chambers such as caves, fractures, and other cavities that were formed either directly or indirectly by dissolution of subsurface rock formations. Water for the salamanders is provided by infiltration of surface water through the soil or recharge features (caves, faults, fractures, sinkholes, or other open cavities) into the Edwards Aquifer, which discharges from springs as groundwater (Schram 1995, p. 91). In addition, some Jollyville Plateau salamander populations rely on water from other sources. For instance, springs, such as Rieblin Spring, may discharge from the Walnut formation, and some, such as Pit Spring, may discharge from the Glen Rose formation (part of the Trinity Aquifer) (Johns 2012, COA, pers. comm.; Johnson *et al.* 2012, pp. 1, 3, 46–53, 82). Other springs, such as Lanier Spring, appear to have alluvial aquifer sources (derived from water-bearing soil or sediments usually adjacent to streams) (Johns 2012, pers. comm.).

The Austin blind and Jollyville Plateau salamanders spend varying portions of their life within their surface habitats (the wetted top layer of substrate in or near spring openings and pools as well as spring runs) and subsurface habitats (within caves or other underground areas of the underlying groundwater source). Although surface and subsurface habitats are often discussed separately within this final rule, it is important to note the interconnectedness of these areas. Subsurface habitat does not necessarily refer to an expansive cave underground. Rather, it may be described as the rock matrix below the stream bed. As such, subsurface habitats are impacted by the same threats that impact surface habitat, as the two exist as a continuum (Bendik 2012, COA, pers. comm.).

Salamanders move an unknown depth into interstitial spaces (empty voids between rocks) within the spring or streambed substrate that provide foraging habitat and protection from predators and drought conditions (Cole 1995, p. 24; Pierce and Wall 2011, pp. 16–17). They may also use deeper passages of the aquifer that connect to the spring opening (Dries 2011, COA, pers. comm.). This behavior makes it difficult to accurately estimate population sizes, as only salamanders on the surface can be regularly monitored. However, techniques have been developed for marking individual salamanders, which allows for better estimating population numbers using "mark and recapture" data analysis techniques. These techniques have been used by the City of Austin (COA) on the Jollyville Plateau salamander (Bendik *et al.* 2013, pp. 2–7).

Range

The habitat of the Austin blind salamander occurs in the Barton Springs Segment of the Edwards Aquifer, while the habitats of the three other species occur in the Northern Segment of the Edwards Aquifer (although some reside in spring locations with different groundwater sources, as explained above). The recharge and contributing zones of these segments of the Edwards Aquifer are found in portions of Travis, Williamson, Blanco, Bell, Burnet, Lampasas, Mills, Hays, Coryell, and Hamilton Counties, Texas (Jones 2003, p. 3; Mahler *et al.* 2006).

Diet

A stomach content analysis by the COA demonstrated that the Jollyville Plateau salamander preys on varying proportions of aquatic invertebrates, such as ostracods, copepods, mayfly larvae, fly larvae, snails, water mites, aquatic beetles, and stone fly larvae, depending on the location of the site (Bendik 2011b, pers. comm.). The feces of one wild-caught Austin blind salamander contained amphipods, ostracods, copepods, and plant material (Hillis *et al.* 2001, p. 273). Gillespie (2013, pp. 5–9) also found that the diet of the closely related Barton Springs salamanders consisted primarily of planarians or chironomids (flatworms or nonbiting midge flies) depending on which was more abundant and amphipods when planarians and chironomids were rare.

Predation

The Austin blind and Jollyville Plateau salamanders also share similar predators, which include centrarchid fish (carnivorous freshwater fish belonging to the sunfish family), crayfish (*Cambarus* sp.), and large aquatic insects (Pierce and Wall 2011, pp. 18–20; Bowles *et al.* 2006, p. 117; Cole 1995, p. 26).

Reproduction

The detection of juveniles in all seasons suggests that reproduction occur year-round (Bendik 2011a, p. 26; Hillis *et al.* 2001, p. 273). However, juvenile abundance of Jollyville Plateau salamanders typically increases in spring and summer, indicating that there may be relatively more reproduction occurring in winter and early spring compared to other seasons (Bowles *et al.* 2006, p. 116; Pierce 2012, pp. 10–11, 18, 20). Because eggs are very rarely found on the surface, these salamanders likely deposit their eggs underground for protection (O'Donnell *et al.* 2005, p. 18).

Population Connectivity

More study is needed to determine the nature and extent of the dispersal capabilities of the Austin blind and Jollyville Plateau salamanders. It has been suggested that they may be able to travel some distance through subsurface aquifer conduits. For example, it has been thought that Austin blind salamander can occur underground throughout the entire Barton Springs complex (Dries 2011, COA, pers. comm.). The spring habitats used by salamanders of the Barton Springs complex are not connected on the surface, so the Austin blind salamander population could extend a horizontal distance of at least 984 feet (ft) (300 meters (m)) underground, as this is the approximate distance between the farthest two outlets within the Barton Springs complex known to be occupied by the species. However, a mark-and-recapture study failed to document the movement of endangered Barton Springs salamanders (*Eurycea sosorum*) between any of the springs in the Barton Springs complex (Dries 2012, COA, pers. comm.). This could indicate that individual salamanders are not moving the distances between spring openings. Alternatively, this could mean that the study simply failed to capture the movement of salamanders. This study has only recently begun and is relatively small in scope.

Due to the similar life history of the Austin blind salamander to the other three *Eurycea* species considered here, it is plausible that populations of these species could also extend 984 ft (300 m) through subterranean habitat. However, subsurface movement is likely to be limited by the highly dissected nature of the aquifer system, where spring sites can be separated from other spring sites by large canyons or other physical barriers to movement. Surface movement is similarly inhibited by geologic, hydrologic, physical, and biological barriers (for example, predatory fish commonly found in impoundments along urbanized tributaries (Bendik 2012, COA, pers. comm.). Dye-trace studies have demonstrated that some Jollyville Plateau salamander sites located miles apart are connected hydrologically (Whitewater Cave and Hideaway Cave) (Hauwert and Warton 1997, pp. 12–13), but it remains unclear if salamanders are travelling between those sites. In conclusion, some data indicate that populations could be connected through subterranean water-filled spaces, although we are unaware of any information available on the frequency of movements and the actual nature of connectivity among populations.

Population Persistence

A population's persistence (ability to survive and avoid extirpation) is influenced by a population's demographic factors (such as survival and reproductive rates) as well as its environment. The population needs of the central Texas salamander species are the factors that provide for a high probability of population persistence over the long term at a given site (for example, low degree of threats and high survival and reproduction rates). We are unaware of detailed studies that describe all of the demographic factors that could affect the population persistence of the Austin blind and Jollyville Plateau salamanders; however, we have assessed their probability of persistence by evaluating environmental factors (threats to their surface habitats) and what we know about the number of salamanders that occur at each site.

To estimate the probability of persistence of each population involves considering the predictable responses of the population to various environmental factors (such as the amount of food available or the presence of a toxic substance), as well as the stochasticity. Stochasticity refers to the random, chance, or probabilistic nature of the demographic and environmental processes (Van Dyke 2008, pp. 217–218). Generally, the larger the population, the more likely it is to survive stochastic events in both demographic and environmental factors (Van Dyke 2008, p. 217). Conversely, the smaller the population, the higher are its chances of extirpation when experiencing this demographic and environmental stochasticity.

Rangewide Needs

We used the conservation principles of redundancy, representation, and resiliency (Shaffer and Stein 2000, pp. 307, 309–310) to better inform our view of what contributes to these species' probability of persistence and how best to conserve them. ''Resiliency'' is the ability of a species to persist through severe hardships or stochastic events (Tear *et al.* 2005, p. 841). ''Redundancy'' means a sufficient number of populations to provide a margin of safety to reduce the risk of losing a species or certain representation (variation) within a species, particularly from catastrophic or other events. ''Representation'' means conserving ''some of everything'' with regard to genetic and ecological diversity to allow for future adaptation and maintenance of evolutionary potential. Representation can be measured through the breadth of genetic diversity within and among populations and ecological diversity (also called environmental variation or diversity) occupied by populations across the species' range.

A variety of factors contribute to a species' resiliency. These can include how sensitive the species is to disturbances or stressors in its environment, how often they reproduce and how many young they have, how specific or narrow their habitat needs are. A species' resiliency can also be affected by the resiliency of individual populations and the number of populations and their distribution across the landscape. Protecting multiple populations and variation of a species across its range may contribute to its resiliency, especially if some populations or habitats are more susceptible or better adapted to certain threats than others (Service and NOAA 2011, p. 76994). The ability of individuals from populations to disperse and recolonize an area that has been extirpated may also influence their resiliency. As population size and habitat quality increase, the population's ability to persist through periodic hardships also increases.

A minimal level of redundancy is essential for long-term viability (Shaffer and Stein 2000, pp. 307, 309–310; Groves *et al.* 2002, p. 506). This provides a margin of safety for a species to withstand catastrophic events (Service and NOAA 2011, p. 76994) by decreasing the chance of any one event affecting the entire species.

Representation and the adaptive capabilities (Service and NOAA 2011, p. 76994) of each of the central Texas salamander species should also be conserved. Because a species' genetic makeup is shaped through natural selection by the environments it has experienced (Shaffer and Stein 2000, p. 308), populations should be protected in the array of different environments in which the salamanders occur (surface and subsurface) as a strategy to ensure genetic representation, adaptive capability, and conservation of the species.

To increase the probability of persistence of each species, populations of the Austin blind and Jollyville Plateau salamanders should be conserved in a manner that ensures their variation and representation. This result can be achieved by conserving salamander populations in a diversity of environments (throughout their ranges), including: (1) Both spring and cave locations, (2) habitats with groundwater sources from various aquifers and geologic formations, including the Edwards and Trinity Aquifers and the Edwards, Walnut, and Glen Rose formations, and (3) at sites with different hydrogeological characteristics, including sites where water flows come from artesian pressure, a perched aquifer, or resurgence through alluvial deposits (for example, artesian springs, Edwards and Edwards/Walnut headwater springs, and Bull Creek alluvial resurgence areas).

Information for Austin blind and Jollyville Plateau salamanders is discussed separately for each species in more detail below.

Austin Blind Salamander

The Austin blind salamander has a pronounced extension of the snout, no external eyes, and weakly developed tail fins. In general appearance and coloration, the Austin blind salamander is more similar to the Texas blind salamander (*Eurycea rathbuni*) that occurs in the Southern Segment of the Edwards Aquifer than its sympatric (occurring within the same range) species, the Barton Springs salamander. The Austin blind salamander has a reflective, lightly pigmented skin with a pearly white or lavender appearance (Hillis *et al.* 2001, p. 271). Before the Austin blind salamander was formally described, juvenile salamanders were sighted occasionally in Barton Springs, and thought to be a variation of the Barton Springs salamander. It was not until 2001 that enough specimens were available to formally describe these juveniles as a separate species using morphological and genetic characteristics (Hillis *et al.* 2001, p. 267). Given the reduced eye structure of the Austin blind salamander, and the fact that it is rarely seen at the water's surface (Hillis *et al.* 2001, p. 267), this salamander is thought to be more subterranean than the primarily surface-dwelling Barton Springs salamander.

The Austin blind salamander occurs in Barton Springs in Austin, Texas. These springs are fed by the Barton Springs Segment of the Edwards Aquifer. This segment covers roughly 155 square miles (mi) (401 square kilometers (km)) from southern Travis County to northern Hays County, Texas (Smith and Hunt 2004, p. 7). It has a storage capacity of more than 300,000 acre-feet of water. The contributing zone for the Barton Springs Segment of the Edwards Aquifer that supplies water to the salamander's spring habitat extends into Travis, Blanco, and Hays Counties, Texas (Ross 2011, p. 3). Under drought conditions, Barton Springs (particularly Sunken Garden/Old Mill Springs) also receives some recharge from the Blanco River (Johnson *et a*l. 2012, p. 82), whose waters originate from the Trinity Aquifer.

The Austin blind salamander is found in three of the four Barton Springs outlets in the COA's Zilker Park, Travis County, Texas: Parthenia (Main) Springs, Eliza Springs, and Sunken Garden (Old Mill or Zenobia) Springs where the Barton Springs salamander also occurs (Dries 2012, p. 4). Parthenia Springs provides water for the Barton Springs Pool, which is operated by the COA as a public swimming pool. These spring sites have been significantly modified for human use. The area around Parthenia Springs was impounded in the late 1920s to create Barton Springs Pool. Flows from Eliza and Sunken Garden Springs are also retained by concrete structures, forming small pools on either side of Barton Springs Pool (COA 1998, p. 6; Service 2005, pp. 1.6–25). The Austin blind salamander has not been observed at the fourth Barton Springs outlet, known as Upper Barton Springs (Hillis *et al.* 2001, p. 273; Dries 2012, p. 4). Upper Barton Springs flow only intermittently (and can cease flowing for weeks or months at a time) (Dries 2012, p. 4). We are unaware of any information that suggests Main, Eliza, or Sunken Garden Springs have ever stopped flowing.

From January 1998 to December 2000, there were only 17 documented observations of the Austin blind salamander. During this same timeframe, 1,518 Barton Springs salamander observations were made (Hillis *et al.* 2001, p. 273). The abundance of Austin blind salamanders increased slightly from 2002 to 2006, but fewer observations have been made in more recent years (2009 to 2010) (COA 2011a, pp. 51–52). In fact, during an 11-month period of drought conditions from 2008 to 2009, neither the Austin blind salamander nor the Barton Springs salamander was seen at all (Dries 2012, p. 17), despite almost monthly survey attempts (Dries 2012, p. 7). When they are observed, Austin blind salamanders occur in relatively low numbers (COA 2011a, pp. 51–52; Dries 2012, p. 4) within the surface habitat. Although the technology to mark salamanders for individual recognition has recently been developed (Bendik *et al.* 2013, p. 7), population estimates for this species have not been undertaken. However, population estimates are possible for aquifer-dwelling species using genetic techniques, and one such study is planned for the Austin blind salamander in the near future (Texas Parks and Wildlife Department (TPWD) 2011, p. 11).

Jollyville Plateau Salamander

Surface-dwelling populations of Jollyville Plateau salamanders have large, well-developed eyes; wide, yellowish heads; blunt, rounded snouts; dark greenish-brown bodies; and bright yellowish-orange tails (Chippindale *et al.* 2000, pp. 33–34). Some cave forms of Jollyville Plateau salamanders, which are also entirely aquatic, exhibit cave-associated morphologies, such as eye reduction, flattening of the head, and dullness or loss of color (Chippindale *et al.* 2000, p. 37). Genetic analysis suggests a taxonomic split within this species that appears to correspond to major geologic and topographic features of the region (Chippindale 2010, p. 2). Chippindale (2010, pp. 5, 8) concluded that the Jollyville Plateau salamander exhibits a strong genetic separation between two lineages within the species: A ''Plateau'' clade that occurs in the Bull Creek, Walnut Creek, Shoal Creek, Brushy Creek, South Brushy Creek, and southeastern Lake Travis drainages; and a ''peripheral'' clade that occurs in the Buttercup Creek and northern Lake Travis drainages (Chippindale 2010, pp. 5–8). The study also suggests this genetic separation may actually represent two species (Chippindale 2010, pp. 5, 8). However, a formal, peer-reviewed description of the two possible species has not been published. Because this split has not been recognized by the scientific community, we do not recognize a separation of the Jollyville Plateau salamander into two species.

The Jollyville Plateau salamander occurs in the Jollyville Plateau and Brushy Creek areas of the Edwards Plateau in northern Travis and southern Williamson Counties, Texas (Chippindale *et al.* 2000, pp. 35–36; Bowles *et al.* 2006, p. 112; Sweet 1982, p. 433). Upon classification as a species, Jollyville Plateau salamanders were known from Brushy Creek and, within the Jollyville Plateau, from Bull Creek, Cypress Creek, Long Hollow Creek, Shoal Creek, and Walnut Creek drainages (Chippindale *et al.* 2000, p. 36). Since it was described, the Jollyville Plateau salamander has also been documented within the Lake Creek drainage (O'Donnell *et al.* 2006, p. 1). Jollyville Plateau salamanders are known from 1 cave in the Cypress Creek drainage and 15 caves in the Buttercup Creek cave system in the Brushy Creek drainage (Chippindale *et al.* 2000, p. 49; Russell 1993, p. 21; Service 1999, p. 6; HNTB 2005, p. 60). There are 106 known surface sites for the Jollyville Plateau salamander.

The Jollyville Plateau salamander's spring-fed habitat is typically characterized by a depth of less than 1 ft (0.3 m) of cool, well oxygenated water (COA 2001, p. 128; Bowles *et al.* 2006, p. 118) supplied by the underlying Northern Segment of the Edwards Aquifer (Cole 1995, p. 33), the Trinity Aquifer (Johns 2012, COA, pers. comm.), or local alluvial sources (Johns 2012, COA, pers. comm.). The main aquifer that feeds this salamander's habitat is generally small, shallow, and localized (Chippindale *et al.* 2000; p. 36; Cole 1995, p. 26). Jollyville Plateau salamanders are typically found near springs or seep outflows and likely require constant temperatures (Sweet 1982, pp. 433–434; Bowles *et al.* 2006, p. 117). Salamander densities are higher in pools and riffles and in areas with rubble, cobble, or boulder substrates rather than on solid bedrock (COA 2001, p. 128; Bowles *et al.* 2006, pp. 114–116). Surface-dwelling Jollyville Plateau salamanders also occur in subsurface habitat within the underground aquifer (COA 2001, p. 65; Bowles *et al.* 2006, p. 118).

Some Jollyville Plateau salamander populations have likely experienced decreases in abundance in recent years. Survey data collected by COA staff indicate that four of the nine sites that were regularly monitored by the COA between December 1996 and January 2007 had statistically significant declines in salamander abundance over 10 years (O'Donnell *et al.* 2006, p. 4). The average number of salamanders counted at each of these 4 sites declined from 27 salamanders counted during surveys from 1996 to 1999 to 4 salamanders counted during surveys from 2004 to 2007. In 2007, monthly mark-recapture surveys were conducted in concert with surface counts at three sites in the Bull Creek watershed (Lanier Spring, Lower Rieblin, and Wheless Spring) over a 6- to 8-month period to obtain surface population size estimates and detection probabilities for each site (O'Donnell *et al.* 2008, p. 11). Using these estimation techniques, surface population estimates at Lanier Spring varied from 94 to 249, surface population estimates at the Lower Rieblin site varied from 78 to 126, and surface population estimates at Wheless Spring varied from 187 to 1,024 (O'Donnell *et al.* 2008, pp. 44–45). These numbers remained fairly consistent in more recent population estimates for the three sites (Bendik 2011a, p. 22). However, Bendik (2011a, pp. 5, 12–24, 26, 27) reported statistically significant declines in Jollyville Plateau salamander counts over a 13-year period (1996–2010) at six monitored sites with high impervious cover (18 to 46 percent) compared to two sites with lower (less than 1 percent) impervious cover. These results are consistent with Bowles *et al.* (2006, p. 111), who found lower densities of Jollyville Plateau salamanders at urbanized sites. Based on the best available information, these counts likely reflect changes in the salamander populations at these sites.

Summary of Comments and Recommendations

We requested comments from the public on the proposed designation of critical habitat for the Austin blind salamander and Jollyville Plateau salamanders during two comment periods. The first comment period associated with the publication of the proposed rule (77 FR 50768) opened on August 22, 2012, and closed on October 22, 2012, during which we held public meetings and hearings on September 5 and 6, 2012, in Round Rock and Austin, Texas, respectively. We reopened the comment period on the proposed listing rule from January 25, 2013, to March 11, 2013 (78 FR 5385). We also contacted appropriate Federal, State, and local agencies; scientific organizations; and other interested parties and invited them to comment on the proposed rule and draft economic analysis during these comment periods.

We received a total of approximately 416 comments during the open comment period for the proposed listing, proposed critical habitat, and associated documents. All substantive information provided during the comment periods has been incorporated directly into the final listing rule for the Austin blind and Jollyville Plateau salamanders and is addressed below. Comments from peer reviewers and State agencies are grouped separately below. Comments received are grouped into general issues specifically relating to the proposed listing for each salamander species. Beyond the comments addressed below, several commenters submitted additional reports and references for our consideration, which were reviewed and incorporated into this critical habitat final rule as appropriate.

Peer Review

In accordance with our peer review policy published on July 1, 1994 (59 FR 34270), we solicited expert opinions from 22 knowledgeable individuals with scientific expertise with the hydrology, taxonomy, and ecology that is important to these salamander species. The focus of the taxonomists was to review the proposed rule in light of an unpublished report by Forstner (2012) that questioned the taxonomic validity of the Austin blind, Georgetown, Jollyville Plateau, and Salado salamanders as separate species. We received responses from 13 of the peer reviewers.

During the first comment period we received public comments from SWCA Environmental Consultants (SWCA) and COA that contradicted each other. We also developed new information relative to the listing determination. For these reasons, we conducted a second peer review on: (1) Salamander demographics and (2) urban development and stream habitat. The peer reviewers were provided with the contradictory comments from SWCA and COA. During this second peer review, we solicited expert opinions from knowledgeable individuals with expertise in the two areas identified above, which included all of the peer reviewers from the first comment period except the taxonomists. We received responses from eight peer reviewers. The peer reviewers generally concurred with our methods and conclusions and provided additional information, clarifications, and suggestions to improve the final listing and critical habitat rule. Peer reviewer comments are addressed in the following summary and incorporated into the final rule as appropriate.

Peer Reviewer Comments

Taxonomy

(1) *Comment:* Most peer reviewers stated that the best available scientific information was used to develop the proposed rule and the Service's analysis of the available information was scientifically sound. Further, most reviewers stated that our assessment that the Austin blind, Georgetown, Jollyville Plateau, and Salado salamanders are four distinct species and our interpretation of literature addressing threats (including reduced habitat quality due to urbanization and increased impervious cover) to these species were well researched. However, some researchers suggested that further research would strengthen or refine our understanding of these salamanders. For example, one reviewer stated that the Jollyville Plateau salamander was supported by ''weak but suggestive evidence,'' and, therefore, it needed more study. Another reviewer thought there was evidence of missing descendants in the group that included the Jollyville Plateau salamander in the enzyme analysis presented in the original species descriptions (Chippindale *et al.* 2000).

Our Response: Peer reviewers' comments indicate that we used the best available science, and we correctly interpreted that science as recognizing the Austin blind, Georgetown, Jollyville Plateau, and Salado salamanders as four separate species. In the final listing rule, we continue to recognize the Austin blind and Jollyville Plateau salamanders as distinct and valid species. However, we acknowledge that the understanding of the taxonomy of these salamander species can be strengthened by further research.

(2) *Comment:* Forstner (2012, pp. 3–4) used the size of geographic distributions as part of his argument for the existence of fewer species of *Eurycea* in Texas than are currently recognized. Several peer reviewers commented that they saw no reason for viewing the large number of *Eurycea* species with small distributions in Texas as problematic when compared to the larger distributions of *Eurycea* species outside of Texas. They stated that larger numbers and smaller distributions of Texas *Eurycea* species are to be expected given the isolated spring environments that they inhabit within an arid landscape. Salamander species with very small ranges are common in several families and are usually restricted to island, mountain, or cave habitats.

Our Response: See our response to comment 1.

(3) *Comment:* Forstner (2012, pp. 15–16) used results from Harlan and Zigler (2009), indicating that levels of genetic variation within the eastern species *E. lucifuga* are similar to those among six currently recognized species of Texas *Eurycea,* as part of his argument that there are fewer species in Texas than currently recognized. Several peer reviewers said that these sorts of comparisons can be very misleading in that they fail to take into consideration differences in the ages, effective population sizes, or population structure of the units being compared. The delimitation of species should be based on patterns of genetic variation that bear on the separation (or lack thereof) of gene pools rather than on the magnitude of genetic differences, which can vary widely within and between species.

Our Response: See our response to comment 1.

(4) *Comment:* Several peer reviewers stated that the taxonomic tree presented in Forstner (2012, pp. 20, 26) is difficult to evaluate because of the following reasons: (1) no locality information is given for the specimens; (2) it disagrees with all trees in other studies (which seem to be largely congruent with one another), including that in Forstner and McHenry (2010, pp. 13–16) with regard to monophyly (more than one member of a group sharing the same ancestor) of several of the currently recognized species; and (3) the tree is only a gene tree, presenting sequence data on a single gene, which provides little or no new information on species relationships of populations.

Our Response: See our response to comment 1.

(5) *Comment:* Peer reviewers generally stated that Forstner (2012, pp. 13–14) incorrectly dismisses morphological data that have been used to recognize some of the Texas *Eurycea* species on the basis that it is prone to convergence (acquisition of the same biological trait in unrelated lineages) and, therefore, misleading. The peer reviewers commented that it is true that similarities in characters associated with cave-dwelling salamanders can be misleading when suggesting that the species possessing those characters are closely related. However, this in no way indicates that the reverse is true; that is, indicating differences in characters is not misleading in identifying separate species.

Our Response: See our response to comment 1.

Impervious Cover

(6) *Comment:* The 10 percent impervious cover threshold may not be protective of salamander habitat based on a study by Coles *et al.* (2012, pp. 4–5), which found a loss of sensitive species due to urbanization and that there was no evidence of a resistance threshold to invertebrates that the salamanders preyed upon. A vast amount of literature indicates that 1 to 2 percent impervious cover can cause habitat degradation, and, therefore, the 10 percent threshold for impervious cover will not be protective of these species.

Our Response: We recognize that low levels of impervious cover in a watershed may have impacts on aquatic life, and we have incorporated results of these studies into the final listing rule. However, we are aware of only one peer-reviewed study that examined watershed impervious cover effects on salamanders in central Texas, and this study found impacts on salamander density in watersheds with over 10 percent impervious cover (Bowles *et al.* 2006, pp. 113, 117–118). Because this impervious cover study was done locally, we are using 10 percent as a guideline to categorize watersheds that are impacted in terms of salamander density.

(7) *Comment:* While the Service's impervious cover analysis assessed impacts on stream flows and surface habitat, it neglected to address impacts over the entire recharge zone of the contributing aquifers on spring flows in salamander habitat. Also, the surface watersheds analyzed in the proposed rule are irrelevant because these salamanders live in cave streams and spring flows that receive groundwater. Without information on the groundwater recharge areas, the rule should be clear that the surface watersheds are only an approximation of what is impacting the subsurface drainage basins.

Our Response: We acknowledge that the impervious cover analysis is limited to impacts on the surface watershed. Because the specific groundwater recharge areas of individual springs are unknown, we cannot accurately assess the current or future impacts on these areas. However, we recognize subsurface flows as another avenue for contaminants to reach the salamander sites, and we tried to make this clearer in the final rule.

(8) *Comment:* Several of the watersheds analyzed for impervious cover in the proposed rule were overestimated. The sub-basins in these larger watersheds need to be analyzed for impervious cover impacts.

Our Response: We have refined our impervious cover analysis in this final listing rule to clarify the surface watersheds of individual spring sites. Our final impervious cover report containing this refined analysis is available on the Internet at *http://www.regulations.gov* under Docket No. FWS–R2–ES–2012–0035 and at *http://www.fws.gov/southwest/es/AustinTexas/*.

Threats

(9) *Comment:* One peer reviewer stated that the threat to these species from over collection for scientific purposes may be understated.

Our Response: We have reevaluated the potential threat of overutilization for scientific purposes and have incorporated a discussion of this under Factor B ''*Overutilization for Commercial, Recreational, Scientific, or Educational Purposes.''* We recognize that removing individuals from small, localized populations in the wild without any proposed plans or regulations to restrict these activities could increase the population's vulnerability of extinction and decrease its resiliency and ability to withstand stochastic events. However, we do not consider overutilization from collecting salamanders in the wild to be a threat by itself, but it may cause significant population declines, and could negatively impact the species in combination with other threats.

Salamander Demographics

(10) *Comment:* Several peer reviewers agreed that COA's salamander survey data were generally collected and analyzed appropriately and that the results are consistent with the literature on aquatic species' responses to urbanizing watersheds. Three reviewers had some suggestions on how the data analysis could be improved, but they also state that COA's analysis is the best scientific data available, and alternative methods of analysis would not likely change the conclusions.

Our Response: Because the peer reviewers examined COA's salamander demographic data, as well as SWCA's analysis of the COA's data, and generally agreed that the COA's data was the best information available, we continue to rely upon this data set in the final listing rule.

(11) *Comment:* Two peer reviewers pointed out that SWCA's water samples were collected during a period of very low rainfall and, therefore, under represent the contribution of water influenced by urban land cover. The single sampling of water and sediment at the eight sites referenced in the SWCA report do not compare in scope and magnitude to the extensive studies referenced from the COA. The numerous studies conducted (and referenced) within the known ranges of the Austin blind and Jollyville Plateau salamanders provide scientific support at the appropriate scale for recent and potential habitat degradation due to urbanization. One peer reviewer pointed out that if you sort the spring sites SWCA sampled into ''urbanized'' and ''rural'' categories, the urban sites generally have more degraded water quality than the rural sites, in terms of nitrate, nitrite, *E. coli* counts, and fecal coliform bacteria counts.

Our Response: We agree with the peer reviewers who stated that SWCA (2012, pp. 21–24) did not present convincing evidence that overall water quality at sites in Williamson County is good or that urbanization is not impacting the water quality at these sites. Water quality monitoring based on one or a few samples are not necessarily reflective of conditions at the site under all circumstances that the salamanders are exposed to over time. Based on this assessment, we continued to rely upon the best scientific evidence available that states water quality will decline as urbanization within the watershed increases.

(12) *Comment:* The SWCA report indicates that increasing conductivity is related to drought. (Note: Conductivity is a measure of the ability of water to carry an electrical current and can be used to approximate the concentration of dissolved inorganic solids in water that can alter the internal water balance in aquatic organisms, affecting the Austin blind and Jollyville Plateau salamanders' survival. Conductivity levels in the Edwards Aquifer are naturally low. As ion concentrations such as chlorides, sodium, sulfates, and nitrates rise, conductivity will increase. The stability of the measured ions makes conductivity an excellent monitoring tool for assessing the impacts of urbanization to overall water quality. High conductivity has been associated with declining salamander abundance.) While SWCA's report notes lack of rainfall as the dominant factor in increased conductivity, the confounding influence of decreases in infiltration and increases in sources of ions as factors associated with urbanization and changes in water quality in these areas is not addressed by SWCA. The shift to higher conductivity associated with increasing impervious surface is well documented in the COA references. Higher conductivity in urban streams is well documented and was a major finding of the U.S. Geological Survey (USGS) urban land use studies (Coles *et al.* 2012). Stream conductivity increased with increasing urban land cover in every metropolitan area studied. Conductivity is an excellent surrogate for tracking changes in water quality related to land use change associated with urbanization due to the conservative nature of the ions.

Our Response: While drought may result in increased conductivity, increased conductivity is also a reflection of increased urbanization. We incorporated information from the study by Coles *et al.* (2012) in the final listing rule, and we continued to include conductivity as a measure of water quality in the primary constituent elements for the Austin blind and Jollyville Plateau salamanders in the final critical habitat rule as published elsewhere in today's **Federal Register**.

(13) *Comment:* One peer reviewer stated that SWCA's criticisms of COA's linear regression analysis, general additive model, and population age structure were not relevant and unsupported. In addition, peer reviewers agreed that COA's mark-recapture estimates are robust and highly likely to be correct. Three peer reviewers agreed that SWCA misrepresented the findings of Luo (2010) and stated that this thesis does not invalidate the findings of COA.

Our Response: Because the peer reviewers examined COA's data, as well as SWCA's analysis of the COA's data, and generally agreed that the COA's data was the best information available, we continue to rely upon this data set in the final listing rule.

(14) *Comment:* One peer reviewer stated that the long-term data collected by the COA on the Jollyville Plateau salamander were simple counts that serve as indexes of relative population abundance, and not of absolute abundance. This data assumes that the probability of observing salamanders remains constant over time, season, and among different observers. This assumption is often violated, which results in unknown repercussions on the assessment of population trends. Therefore, the negative trend observed in several sites could be due to a real decrease in population absolute abundance, but could also be related to a decrease in capture probabilities over time (or due to an interaction between these two factors). Absolute population abundance and capture probabilities should be estimated in urban sites using the same methods implemented at rural sites by COA. However, even in the absence of clear evidence of local population declines of Jollyville Plateau salamanders, the proposed rule was correct in its assessment because there is objective evidence that stream alterations negatively impact the density

of *Eurycea* salamanders (Barrett *et al.* 2010).

Our Response: We recognize that the long-term survey data of Jollyville Plateau salamanders using simple counts may not give conclusive evidence on the true population status at each site. However, based on the threats and evidence from scientifically peer-reviewed literature, we believe the declines in counts seen at urban Jollyville Plateau salamander sites are likely representative of real declines in the population.

(15) *Comment:* One peer reviewer had similar comments on COA salamander counts and relating them to populations. They stated that the conclusion of a difference in salamander counts between sites with high and low levels of impervious cover is reasonable based on COA's data. However, this conclusion is not about salamander populations, but instead about the counts. The COA's capture-mark-recapture analyses provide strong evidence of both nondetection and substantial temporary emigration, findings consistent with other studies of salamanders in the same family as the Jollyville Plateau salamander. This evidence cautions against any sort of analysis that relies on raw count data to draw inferences about populations.

Our Response: See our response to previous comment.

(16) *Comment:* The SWCA (2012, pp. 70–76) argues that declines in salamander counts can be attributed to declines in rainfall during the survey period, and not watershed urbanization. However, one peer reviewer stated that SWCA provided no statistical analysis to validate this claim and misinterpreted the conclusions of Gillespie (2011) to support their argument. A second peer reviewer agrees that counts of salamanders are related to natural wet and dry cycles, but points out that COA has taken this effect into account in their analyses. Another peer reviewer points out that this argument contradicts SWCA's (2012) earlier claim that COA's salamander counts are unreliable data. If the data were unreliable, they probably would not correlate to environmental changes.

Our Response: Although rainfall is undoubtedly important to these strictly aquatic salamander species, the best scientific evidence suggests that rainfall is not the only factor driving salamander population fluctuations. In the final listing rule, we continue to rely upon this evidence as the best scientific and commercial information available, which suggests that urbanization is also a large factor influencing declines in salamander counts.

Regarding comments from SWCA on the assessment of threats, peer reviewers made the following comments:

(17) *Comment:* SWCA's (2012, pp. 84–85) summary understates what is known about the ecology of *Eurycea* species and makes too strong of a conclusion about the apparent ''coexistence with long-standing human development.'' Human development and urbanization is an incredibly recent stressor in the evolutionary history of the central Texas *Eurycea,* and SWCA's assertion that the *Eurycea* will be ''hardy and resilient'' to these new stressors is not substantiated with any evidence.

(18) *Comment:* SWCA (2012, p. 7) states that, ''Small population size and restricted distribution are not among the five listing criteria and do not of themselves constitute a reason for considering a species at risk of extinction.'' To the contrary, even though the salamanders may naturally occur in small isolated populations, small isolated populations and the inability to disperse between springs should be considered under listing criteria E as a natural factor affecting the species' continued existence. In direct contradiction, SWCA (2012, p. 81) later states that, ''limited dispersal ability (within a spring) may increase the species' vulnerability as salamanders may not move from one part of the spring run to another when localized habitat loss or degradation occurs.'' It is well known that small population size and restricted distributions make populations more susceptible to selection or extinction due to stochastic events. Small population size can also affect population density thresholds required for successful mating.

(19) *Comment:* SWCA (2012, p. v) contests that the Jollyville Plateau salamander is not in immediate danger of extinction because, ''over 60 of the 90-plus known Jollyville Plateau salamander sites are permanently protected within preserve areas. . . .'' This statement completely ignores the entire aquifer recharge zone, which is not included in critical habitat. Furthermore, analysis of the COA's monitoring and water quality datasets clearly demonstrate that, even within protected areas, there is deterioration of water quality and decrease in population size of salamanders.

(20) *Comment:* SWCA (2012, p. 11) criticizes the Service and the COA for not providing a ''direct cause and effect'' relationship between urbanization, nutrient levels and salamander populations. There is, in fact, a large amount of peer-reviewed literature on the effects of pollutants and deterioration of water quality on sensitive macroinvertebrate species as well as on aquatic amphibians. In the proposed rule, the Service cites just a small sampling of the available literature regarding the effects of pollutants on the physiology and indirect effects of urbanization on aquatic macroinvertebrates and amphibians. In almost all cases, there are synergistic and indirect negative effects on these species that may not have one single direct cause. There is no ecological requirement that any stressor (be it a predator, a pollutant, or a change in the invertebrate community) must be a direct effect to threaten the stability or long-term persistence of a population or species. Indirect effects can be just as important, especially when many are combined.

Our Response to Comments 17–20: We had SWCA's (2012) report peer reviewed. The peer reviewers generally agreed that we used the best information available in our proposed listing rule.

(21) *Comment:* One reviewer stated that, even though there is detectable gene flow between populations, it may be representative of subsurface connections in the past, rather than current population interchange. However, dispersal through the aquifer is possible even though there is currently no evidence that these species migrate. Further, they stated that there is no indication of a metapopulation structure where one population could recolonize another that had gone extinct.

Our Response: We acknowledge that more study is needed to determine the nature and extent of the dispersal capabilities of the Austin blind and Jollyville Plateau salamanders. It is plausible that populations of these species could extend through subterranean habitat. However, subsurface movement is likely to be limited by the highly dissected nature of the aquifer system, where spring sites can be separated from other spring sites by large canyons or other physical barriers to movement. Dye-trace studies have demonstrated that some Jollyville Plateau salamander sites located miles apart are connected hydrologically (Whitewater Cave and Hideaway Cave) (Hauwert and Warton 1997, pp. 12–13), but it remains unclear if salamanders are travelling between those sites. There is some indication that populations could be connected through subterranean water-filled spaces, although we are unaware of any information available on the frequency of movements and the actual nature of connectivity among populations.

Comments From States

Section 4(i) of the Act states, ''the Secretary shall submit to the State agency a written justification for his failure to adopt regulations consistent with the agency's comments or petition.'' Comments received from all State agencies and entities in Texas regarding the proposal to list the Austin blind and Jollyville Plateau salamanders are addressed below.

(22) *Comment:* Chippindale (2010) demonstrated that it is possible for Jollyville Plateau salamanders to move between sites in underground conduits. Close genetic affinities between populations in separate watersheds on either side of the RM 620 suggest that these populations may be connected hydrologically. Recent studies (Chippindale 2011 and 2012, in prep) indicate that gene flow among salamander populations follows groundwater flow routes in some cases and that genetic exchange occurs both horizontally and vertically within an aquifer segment.

Our Response: We agree that genetic evidence suggests subsurface hydrological connectivity exist between sites at some point in time, but we are unable to conclude if this connectivity occurred in the past or if it still occurs today without more hydrogeological studies or direct evidence of salamander migration from mark-recapture studies. Also, one of our peer reviewers stated that this genetic exchange is probably representative of subsurface connection in the past (see comment 21 above).

(23) *Comment:* Very little is known about Austin blind salamander, and COA has a plan in place to protect and improve habitat without listing.

Our Response: We agree that more study is needed on the ecology of the Austin blind salamander, but enough scientific and commercial data is available on the threats to this species to make a listing determination. We make our listing determinations based on the five listing factors, singly or in combination, as described in section 4(a)(1) of the Act. We recognize the conservation actions made by the COA in the final listing and critical habitat rules, but we determined that these actions are inadequate to protect the species from threats that are occurring from outside of the COA's jurisdiction (that is, the surface watershed and recharge area of Barton Springs).

(24) *Comment:* Regarding all central Texas salamanders, there was insufficient data to evaluate the long-term flow patterns of the springs and creeks, and the correlation of flow, water quality, habitat, ecology, and community response. Current research in Williamson County indicates that water and sediment quality remain good with no degradation, no elevated levels of toxins, and no harmful residues in known springs.

Our Response: We have reviewed the best available scientific and commercial information in making our final listing determination. We sought comments from independent peer reviewers to ensure that our designation is based on scientifically sound data, assumptions, and analysis. And the peer reviewers stated that our proposed rule was based on the best available scientific information. Additionally, recent research on water quality in Williamson County springs was considered in our listing rule. The peer reviewers agreed that these data did not present convincing evidence that overall water quality at salamander sites in Williamson County is good or that urbanization is not impacting the water quality at these sites (see Comment 19 above).

(25) *Comment:* The listing will have negative impacts to private development and public infrastructure.

Our Response: In accordance with the Act, we cannot make a listing determination based on economic impacts. Section 4(b)(2) of the Act states that the Secretary shall designate and make revisions to critical habitat on the basis of the best available scientific data after taking into consideration the economic impact, national security impact, and any other relevant impact of specifying any particular area as critical habitat. However, economic considerations are not taken into consideration as part of listing determinations.

(26) *Comment:* It was suggested that there are adequate regulations in Texas to protect the Austin blind and Jollyville Plateau salamanders, and their respective habitats. The overall programs to protect water quality—especially in the watersheds of the Edwards Aquifer region—are more robust and protective than suggested by the Service's descriptions of deficiencies. The Service overlooks the improvements in the State of Texas and local regulatory and incentive programs to protect the Edwards Aquifer and spring-dependent species over the last 20 years. Texas has extensive water quality management and protection programs that operate under State statutes and the Federal Clean Water Act. These programs include: Surface Water Quality Monitoring Program, Clean Rivers Program, Water Quality Standards, Texas Pollutant Discharge Elimination System (TPDES) Stormwater Permitting, Total Maximum Daily Load Program, Nonpoint Source Program, Edwards Aquifer Rules, and Local Ordinances and Rules (San Marcos Ordinance and COA Rules). Continuing efforts at the local, regional, and State level will provide a more focused and efficient approach for protecting these species than Federal listing.

Our Response: Section 4(b)(1)(A) of the Act requires us to take into account those efforts being made by a State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species, and we fully recognize the contributions of the State and local programs. We consider relevant Federal, State, and tribal laws and regulations when developing our threats analysis. Regulatory mechanisms may preclude the need for listing if we determine such mechanisms address the threats to the species such that listing is no longer warranted. However, the best available scientific and commercial data supports our determination that existing regulations and local ordinances are not adequate to remove all of the threats to the Austin blind and Jollyville Plateau salamanders. We have added further discussion of these regulations and ordinances to Factor D in the final listing rule.

(27) *Comment:* The requirement in the Edwards Rules for wastewater to be disposed of on the recharge zone by land application is an important and protective practice for aquifer recharge and a sustainable supply of groundwater. Permits for irrigation of wastewater are fully evaluated and conditioned to require suitable vegetation and sufficient acreage to protect water quality.

Our Response: Based on the best available science, wastewater disposal on the recharge zone by land application can contribute to water quality degradation in surface waters and the underground aquifer. Previous studies have demonstrated negative impacts to water quality (increases in nitrate levels) at Barton Springs (Mahler *et al.* 2011, pp. 29–35) and within streams (Ross 2011, pp. 11–21) that were likely associated with the land application of wastewater.

(28) *Comment:* A summary of surface water quality data for streams in the watersheds of the Austin blind and Jollyville Plateau salamanders was provided and a suggestion was made that sampling data indicated high-quality aquatic life will be maintained despite occasional instances where parameters exceeded criteria or screening levels.

Our Response: In reviewing the 2010 and 2012 Texas Water Quality Integrated Reports prepared by the Texas Commission on Environmental Quality (TCEQ), the Service identified 14 of 28 (50 percent) stream segments located within surface drainage areas occupied by the salamanders, which contained measured parameters within water samples that exceeded screening level criteria. These included ''screening level concerns'' for parameters such as nitrate, dissolved oxygen, impaired benthic communities, sediment toxicity, and bacteria. In addition, as required under Sections 303(d) and 304(a) of the Clean Water Act, 4 of 28 stream segments located within surface drainage areas occupied by the salamanders have been identified as impaired waters ''. . . for which effluent limitations are not stringent enough to implement water quality standards.'' Water quality data collected and summarized in TCEQ reports supports our concerns with water quality degradation within the surface drainage areas occupied by the salamanders. This information is discussed under *D. The Inadequacy of Existing Regulatory Mechanisms* in this final listing rule.

Public Comments

Existing Regulatory Mechanisms

(29) *Comment:* Many commenters expressed concern that the Service had not adequately addressed all of the existing regulatory mechanisms and programs that provided protection to the salamanders. In addition, many of the same commenters believed there were adequate Federal, State, and local regulatory mechanisms to protect the Austin blind and Jollyville Plateau salamanders and their aquatic habitats.

Our Response: Section 4(b)(1)(A) of the Act requires us to take into account those efforts being made by a State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species. Under *D. The Inadequacy of Existing Regulatory Mechanisms* in the final listing rule, we provide an analysis of the inadequacy of existing regulatory mechanisms. During the comment period, we sought out and were provided information on several local, State, and Federal regulatory mechanisms that we had not considered when developing the proposed rule. We have reviewed these mechanisms and have included them in our analysis under *D. The Inadequacy of Existing Regulatory Mechanisms* in the final listing rule. Our expanded analysis still concluded that existing regulations and local ordinances are not effective at removing the threats to the salamanders.

Protections

(30) *Comment:* The Service fails to consider existing local conservation measures and habitat conservation plans (HCPs) including the regional permit issued to the COA and Travis County, referred to as the Balcones Canyonlands Conservation Plan (BCCP), which benefits the salamanders. While the salamanders are not covered in most of these HCPs, some commenters believe that measures are in place to mitigate any imminent threats to the species. The Service overlooks permanent conservation actions undertaken by both public and private entities over the last two or more decades, including preservation of caves, which protects water quality through recharge, and the preservation of the original Water Treatment Plant 4 site as conservation land in perpetuity, which the COA is now managing as part of the Balcones Canyonlands Preserve. Additionally, Travis County conducts quarterly surveys at two permanent survey sites, and the COA monitors several spring sites, along with additional searches for new localities within the BCCP-managed properties. The HCPs and water quality protection standards are sufficient to prevent significant habitat degradation. Several commenters stated that the majority of Jollyville Plateau salamander sites were already protected by the Balcones Canyonlands Preserve.

Our Response: In the final listing rule, we included a section titled ''Conservation Efforts to Reduce Habitat Destruction, Modification, or Curtailment of Its Range'' that describes existing conservation measures including the regional permit issued to the COA and Travis County for the BCCP and the Williamson County Regional HCP. These conservation efforts and the manner in which they are helping to ameliorate threats to the species were considered in our final listing determination. The Service considered the amount and location of managed open space when analyzing impervious cover levels within each surface watershed (Service 2012, 2013). We also considered preserves when projecting how impervious cover levels within the surface watershed of each spring site would change in the future. These analyses included the benefits from open space as a result of several HCPs (including, but not limited to, the BCCP, Rockledge HCP, and Comanche Canyon HCP). Additional conservation lands considered, but not part of, an HCP, includes the Lower Colorado River Authority (LCRA), The Nature Conservancy of Texas, and Travis Audubon Society. While these conservation lands contribute to the protection of the surface and subsurface watersheds, other factors contribute to the decline of the salamander's habitat. Other factors include, but are not limited to: (1) Other areas within the surface watershed that have high levels of impervious cover, which increases the overall percentage of impervious cover within the watershed; (2) potential for groundwater pollution from areas outside of the surface watershed; and (3) disturbance of the surface habitat of the spring sites themselves.

With regard to the BCCP specifically, we recognize that the BCCP system offers some water quality benefits to the Jollyville Plateau salamander in portions of the Bull Creek, Brushy Creek, Cypress Creek, and Long Hollow Creek drainages through preservation of open space (Service 1996, pp. 2–28–2–29). Despite the significant conservation measures being achieved by the BCCP and their partners, the potential for groundwater degradation still exists from outside these preserves. For example, eight of the nine COA monitoring sites occupied by the Jollyville Plateau salamander within the BCCP have experienced water quality degradation where pollution sources likely originated upstream and outside of the preserved tracts (O'Donnell *et al.* 2006, pp. 29, 34, 37, 49; COA 1999, pp. 6–11; Travis County 2007, p. 4).

(31) *Comment:* The proposed rule directly contradicts the Service's recent policy titled Expanding Incentives for Voluntary Conservation Actions Under the Act (77 FR 15352, March 15, 2012), which concerns the encouragement of voluntary conservation actions for non-listed species and is available at *http://www.gpo.gov/fdsys/pkg/FR-2012-03-15/pdf/2012-6221.pdf.*

Our Response: The commenter did not specify how the proposed rule contradicts the Service's recent policy pronouncements concerning the encouragement of voluntary conservation actions for nonlisted species. The recent policy pronouncements specifically state that voluntary conservation actions undertaken are unlikely to be sufficient to affect the need to list the species. However, if the species is listed and voluntary conservation actions are implemented, as outlined in policy pronouncements, the Service can provide assurances that if the conditions of a conservation agreement are met, the landowner will not be asked to do more, commit more resources, or be subject to further land use restrictions than agreed upon. We may also allow a prescribed level of incidental take by the landowner.

Listing Process and Policy

(32) *Comment:* The Service is pushing these listings because of the legal settlement and not basing its decision on science and the reality of the existing salamander populations.

Our Response: We are required by court-approved settlement agreements to remove Austin blind and Jollyville Plateau salamanders from the candidate list within a specified timeframe. To remove these salamanders from the candidate list means to propose them for listing as threatened or endangered or to prepare a not-warranted finding. The Act requires us to determine whether a species warrants listing based on our assessment of the five listing factors described in the Act using the best available scientific and commercial information. We already determined, prior to the court settlement agreement, that the Austin blind and Jollyville Plateau salamanders warranted listing under the Act, but were precluded by the necessity to commit limited funds and staff to complete higher priority species actions. The Austin blind and Jollyville Plateau salamanders have been included in our annual Candidate Notices of Review for multiple years, during which time scientific literature and data have and continue to indicate that these salamander species are detrimentally impacted by ongoing threats, and we continued to find that listing each species was warranted but precluded. While the settlement agreement has set a court-ordered timeline for rendering our final decision, our determination is still guided by the Act and its implementing regulations considering the five listing factors and using the best available scientific and commercial information.

(33) *Comment:* Commenters requested that the Service extend the comment period for another 45 days after the first comment period. The commenters were concerned about the length of the proposed listing, which is very dense and fills 88 pages in the **Federal Register** and that the public hearing was held only 2 weeks after the proposed rule was published. The commenter does not consider this enough time to read and digest how the Service is basing a listing decision that will have serious consequences for Williamson County. Furthermore, the 60-day comment period does not give the public enough time to submit written comments to such a large proposed rule.

Our Response: The initial comment period for the proposed listing and critical habitat designation consisted of 60 days, beginning August 22, 2012, and ending on October 22, 2012. We reopened the comment period for an additional 45 days, beginning on January 25, 2013, and ending on March 11, 2013. We consider the comment periods described above an adequate opportunity for both written and oral public comment.

(34) *Comment:* One commenter suggested recognition of two distinct population segments for Jollyville Plateau salamander.

Our Response: In making our listing determinations, we first decide whether a species is endangered or threatened throughout its entire range. Because we have already determined that the Jollyville Plateau salamander is warranted for listing throughout its entire range, we are not considering whether a distinct vertebrate population segment of the species meets the definition of an endangered or threatened species.

(35) *Comment:* One commenter expressed concern with the use of ''unpublished'' data in the proposed rule. It is important that the Service takes the necessary steps to ensure all data used in the listing and critical habitat designations are reliable, verifiable, and peer reviewed, as required by President Obama's 2009 directive for transparency and open government. In December of 2009, the Office of Management and Budget (OMB) issued clarification on the presentation and substance of data used by Federal agencies and required in its Information Quality Guidelines. Additionally under the OMB guidelines, all information disseminated by Federal agencies must meet the standard of ''objectivity.'' Additionally, relying on older studies instead of newer ones conflicts with the Information Quality Guidelines.

Our Response: Our use of unpublished information and data does not contravene the transparency and open government directive. Under the Act, we are obligated to use the best available scientific and commercial information, including results from surveys, reports by scientists and biological consultants, various models, and expert opinion from biologists with extensive experience studying the salamanders and their habitat, whether published or unpublished. One element of the transparency and open government directive encourages executive departments and agencies to make information about operations and decisions readily available to the public. Supporting documentation used to prepare the proposed and final rules is available for public inspection, by appointment, during normal business hours, at the U.S. Fish and Wildlife Service, Austin Ecological Services Field Office, 10711 Burnet Rd, Suite 200, Austin, Texas 78758.

Peer Review Process

(36) *Comment:* One commenter requested that the Service make the peer review process as transparent and objective as possible. The Service should make available the process and criteria used to identify peer reviewers. It is not appropriate for the Service to choose the peer review experts. For the peer review to be credible, the entire process including the selection of reviewers must be managed by an independent and objective party. We recommend that the peer review plan identify at least two peer reviewers per scientific discipline. Further, the peer reviewers should be identified.

Our Response: To ensure the quality and credibility of the scientific information we use to make decisions, we have implemented a formal peer review process. Through this peer review process, we followed the guidelines for Federal agencies spelled out in the Office of Management and Budget (OMB) ''Final Information Quality Bulletin for Peer Review,'' released December 16, 2004, and the Service's ''Information Quality Guidelines and Peer Review,'' revised June 2012. Part of the peer review process is to provide information online about how each peer review is to be conducted. Prior to publishing the proposed listing and critical habitat rule for the Austin blind and Jollyville Plateau salamanders, we posted a peer review plan on our Web site, which included information about the process and criteria used for selecting peer reviewers.

In regard to transparency, the OMB and Service's peer review guidelines mandate that we not conduct anonymous peer reviews. The guidelines state that we advise reviewers that their reviews, including their names and affiliations, and how we respond to their comments will be included in the official record for review, and, once all the reviews are completed, their reviews will be available to the public. We followed the policies and standards for conducting peer reviews as part of this rulemaking process.

(37) *Comment:* The results of the peer review process should be available to the public for review and comment well before the end of the public comment period on the listing decision. Will the

public have an opportunity to participate in the peer review process?

Response: As noted above, OMB and the Service's guidelines state that we make available to the public the peer reviewers information, reviews, and how we respond to their comments once all reviews are completed. The peer reviews are completed at the time the last public comment period closes, and our responses to their comments are completed at the time the final listing decision is published in the **Federal Register**. All peer review process information is available upon request at this time and will be made available from the U.S. Fish and Wildlife Service, Austin Ecological Services Field Office, 10711 Burnet Rd, Suite 200, Austin, Texas 78758.

(38) *Comment:* New information has been provided during the comment period. The final listing decision should be peer reviewed.

Response: During the second public comment period, we asked peer reviewers to comment on new and substantial information that we received during the first comment period. We did not receive any new information during the second comment period that we felt rose to the level of needing peer review. Furthermore, as part of our peer review process, we asked peer reviewers not to provide comments or recommendations on the listing decision. Peer reviewers were asked to comment specifically on the quality of information and analyses used or relied on in the reviewed documents. In addition, they were asked to identify oversights, omissions, and inconsistencies; provide advice on reasonableness of judgments made from the scientific evidence; ensure that scientific uncertainties are clearly identified and characterized and that potential implications of uncertainties for the technical conclusions drawn are clear; and provide advice on the overall strengths and limitations of the scientific data used in the document.

(39) *Comment:* One commenter requested a peer review of the Austin blind, Georgetown, Jollyville Plateau, and Salado salamanders' taxonomy and recommended that, to avoid any potential bias, peer reviewers not be from Texas or be authors or contributors of any works that the Service has or is relying upon to diagnose the Austin blind, Georgetown, Jollyville Plateau, and Salado salamanders as four distinct species. This commenter also provided a list of four recommended scientists for the peer review on taxonomy.

Our Response: We requested peer reviews of the central Texas salamander taxonomy from 11 scientific experts in this field. Because we considered the 4 recommended scientists to be qualified as independent experts, we included the 4 experts recommended by the commenter among the 11. Eight scientists responded to our request, and all eight scientists agreed with our recognition of four separate and distinct salamander species, as described in the *Species Information* section of the proposed and final listing rules. The commenter also provided an unpublished paper offering an alternative interpretation of the taxonomy of central Texas salamanders (Forstner 2012, entire), and that information was also provided to peer reviewers. We included two authors of the original species descriptions of the Austin blind, Georgetown, Jollyville Plateau, and Salado salamanders to give them an opportunity to respond to criticisms of their work and so that we could fully understand the taxonomic questions about these species.

(40) *Comment:* One commenter requested a revision to the peer review plan to clarify whether it is a review of non-influential information or influential information.

Our Response: We see no benefit from revising the peer review plan to clarify whether the review was of non-influential or influential information. The Service's ''Information Quality Guidelines and Peer Review,'' revised June 2012, defines influential information as information that we can reasonably determine that dissemination of the information will have or does have a clear and substantial impact on important policy or private sector decisions. Also, we are authorized to define influential in ways appropriate for us, given the nature and multiplicity of issues for which we are responsible. As a general rule, we consider an impact clear and substantial when a specific piece of information is a principle basis for our position.

(41) *Comment:* One commenter requested clarification on what type of peer review was intended. Was it a panel review or individual review? Did peer reviewers operate in isolation to generate individual reports or did they work collaboratively to generate a single peer review document.

Our Response: Peer reviews were requested individually. Each peer reviewer who responded generated independent comments.

(42) *Comment:* It does not seem appropriate to ask peer reviewers, who apparently do not have direct expertise on *Eurycea* or central Texas ecological systems, to provide advice on reasonableness of judgments made from generic statements or hyper-extrapolations from studies on other species. The peer review plan states that reviewers will have expertise in invertebrate ecology, conservation biology, or desert spring ecology. The disciplines of invertebrate ecology and desert spring ecology do not have any apparent relevance to the salamanders in question. The *Eurycea* are vertebrate species that spend nearly all of their life cycle underground. Central Texas is not a desert. The peer reviewers should have expertise in amphibian ecology and familiarity with how karst hydrogeology operates.

Our Response: The peer review plan stated that we sought out peer reviewers with expertise in invertebrate ecology or desert spring ecology, but this was an error. In the first comment period, we asked and received peer reviews from independent scientists with local and non-local expertise in amphibian ecology, amphibian taxonomy, and karst hydrology. In the second comment period, we sought out peer reviewers with local and non-local expertise in population ecology and watershed urbanization.

(43) *Comment:* The peer review plan appears to ask peer reviewers to consider only the scientific information reviewed by the Service. The plan should include the question of whether the scientific information reviewed constitutes the best available scientific and commercial data. The plan should be revised to clarify that the peer reviewers are not limited to the scientific information in the Service's administrative record.

Our Response: The peer review plan states that we may ask peer reviewers to identify oversights and omissions of information as well as to consider the information reviewed by the Service. When we sent out letters to peer reviewers asking for their review, we specifically asked them to identify any oversights, omissions, and inconsistencies with the information we presented in the proposed rule.

(44) *Comment:* The proposed peer review plan falls far short of the OMB Guidelines (2004 Office of Management and Budget promulgated its Final Information Quality Bulletin for Peer Review).

Our Response: This commenter failed to tell us how the plan falls short of the OMB Guidelines. We tried to adhere to the guidelines set forth for Federal agencies and in OMB's ''Final Information Quality Bulletin for Peer Review,'' released December 16, 2004, and the Service's ''Information Quality Guidelines and Peer Review,'' revised June 2012. While the draft peer review plan had some errors, we believe we satisfied the intent of the guidelines and that the errors did not affect the rigor of the actual peer review that occurred.

Salamander Populations

(45) *Comment:* Studies indicate that there are healthy populations of Jollyville Plateau salamanders in many locations, including highly developed areas such as State Highway 45 at RM 620 and along Spicewood Springs Road between Loop 1 and Mesa Drive.

Our Response: We are unaware of long-term monitoring studies that have demonstrated healthy populations of Jollyville Plateau salamanders over time in highly developed areas. Furthermore, the fact that some heavily urbanized areas still have salamanders in them does not indicate the probability of population stability. In the case of the Spicewood Spring site mentioned by the commenter, salamander monitoring by COA since 1996 has consistently found low numbers of salamanders (Bendik 2011a, pp. 14, 19–20).

(46) *Comment:* A recent study by SWCA proposes that the COA's data is inadequate to assess salamander population trends and is not representative of environmental and population control factors (such as seasonal rainfall and drought). The study also states that there is very little evidence linking increased urban development to declining water quality.

Our Response: We have reviewed the report by SWCA and COA's data and determined that it is reasonable to conclude that a link between increased urban development, declining water quality, and declining salamander populations exists for these species. Peer reviewers have also generally agreed with this assessment.

(47) *Comment:* Given the central Texas climate and the general geology and hydrology of the Edwards Limestone formation north of the Colorado River, the description ''surface-dwelling'' or ''surface residing'' overstates the extent and frequency that the Jollyville Plateau salamander utilizes surface water. The phrase ''surface dwelling population'' in the proposed rule appears to be based on two undisclosed and questionable assumptions pertaining to Jollyville Plateau salamander species: (1) There are a sufficient number of these salamanders that have surface water available to them for sufficient periods of times so that the group could be called a ''population;'' and (2) there are surface-dwelling Jollyville Plateau salamander populations that are distinct from subsurface dwelling Jollyville Plateau salamander populations. Neither assumption can be correct unless the surface area is within a spring-fed impoundment that maintains water for a significant portion of a year. The notion of Jollyville Plateau salamander being a ''surface dwelling *Eurycea''* most likely stems from an early description of the Barton Springs salamander adopted by the Service. Characterizing the Barton Springs salamander as ''predominately surface dwelling'' is highly questionable. The history of the Barton Springs Pool provides a tremendous amount of information regarding the life history of the Barton Springs salamander (and other Texas *Eurycea*), the relative importance of surface habitat areas, and the absolute necessity for underground habitat.

Our Response: In the proposed rule, we did not mean to imply or assume that ''surface-dwelling populations'' are restricted to surface habitat only. In fact, we made clear in the proposed rule that these populations need access to subsurface habitat. In addition, we also considered the morphology of these species in our description of their habitat use. The morphology of the Jollyville Plateau salamander serves as indicators of surface and subsurface habitat use. The Jollyville Plateau salamander's surface populations have large, well-developed eyes. In addition, the Jollyville Plateau salamanders have yellowish heads and dark greenish-brown bodies. Subterranean populations of this species have reduced eyes and dullness of color, indicating adaptation to subsurface habitat. In contrast, the Austin blind salamander has no external eyes and has lightly pigmented skin, indicating it is more subterranean than surface-dwelling.

Threats

(48) *Comment:* One commenter described an experiment at Barton Springs Pool in 1998 designed to measure the impacts on the Barton Springs salamander from lowering the water level during pool cleanings. At the time, the substrate of the beach area was described by the Service as ''basically silt and sediment with algae on top'' and ''like concrete.'' In other words, it was nothing like the habitat in the proposed rule, which emphasized the need for interstitial spaces (the space between the rocks) free from sediments. Despite this untraditional habitat, 23 Barton Springs salamanders were found in the beach area, and prey items such as amphipods were also found. Later, the COA removed the silt and algae substrate, restricting salamander habitat to the rocky substrate. The events of 1998 demonstrate that unobstructed interstitial space is not necessarily critical to impounded habitats. Constant water impoundments (Barton Springs Pool and Spring Lake in San Marcos) are a unique type of habitat (pond) for *Eurycea* distinct from ephemeral spring flow areas and underground areas. The San Marcos salamander uses aquatic vegetation as cover. It is noteworthy that Spring Lake has a significantly higher density of salamanders than does Barton Springs Pool. Threats the Service associates with sediment must be assessed differently for impounded areas compared to ephemeral spring flow areas.

Our Response: We recognize that these salamanders can use habitat types other than rocky substrate. Jollyville Plateau salamanders have been found under leaf litter, vegetation, and in open areas (Bowles *et al.* 2006, pp. 114–116). Pierce *et al.* (2010, p. 295) observed closely related Georgetown salamanders in open spaces and under sticks, leaf litter, and other structural cover. However, these peer-reviewed studies also came to the conclusion that salamanders are much more likely to be under rocks than other cover objects and that they select rocks with larger surface areas (Pierce *et al.* 2010, p. 296; Bowles *et al.* 2006, p. 118). These results are consistent with studies on other aquatic salamanders nationwide (Davic and Orr 1987; Parker 1991; Welsh and Ollivier 1998; Smith and Grossman 2003). Therefore, based on the best available information, we consider habitat containing substrates other than large rocks to be suboptimal habitat for the Austin blind and Jollyville Plateau salamanders. Regarding sediment, we explain the impacts that sedimentation has on salamanders in the proposed and final listing rules under Factor A. The assessment of this threat is based on a number of studies, which peer reviewers have agreed comprise the best available information. Impoundments promote sedimentation and generally suboptimal habitat for salamanders, as described under Factor A of the proposed and final listing rules. Despite the persistence of salamander species at impounded locations, these are not natural habitat types in which the species have evolved and would be unlikely to persist in perpetuity if restricted to sites like this.

(49) *Comment:* The Service appears reluctant to distinguish between what are normal, baseline physical conditions (climate, geology, and hydrology) found in central Texas and those factors outside of the norm that might actually threaten the survival of the Austin blind and Jollyville Plateau salamanders species. Cyclical droughts and regular flood events are part of the normal

central Texas climate and have been for thousands of years. The Service appears very tentative about accepting the obvious adaptive behaviors of the salamanders to survive floods and droughts.

Our Response: The final listing rule acknowledges that drought conditions are common to the region, and the ability to retreat underground may be an evolutionary adaptation to such natural conditions (Bendik 2011a, pp. 31–32). However, it is important to note that, although salamanders may survive a drought by retreating underground, this does not necessarily mean they are resilient to future worsening drought conditions in combination with other environmental stressors. For example, climate change, groundwater pumping, decreased water infiltration to the aquifer, potential increases in saline water encroachments in the aquifer, and increased competition for spaces and resources underground all may negatively affect their habitat (COA 2006, pp. 46–47; TPWD 2011, pp. 4–5; Bendik 2011a, p. 31; Miller *et al.* 2007; p. 74; Schueler 1991, p. 114). These factors may exacerbate drought conditions to the point where salamanders cannot survive. In addition, we recognize threats to surface habitat at a given site may not extirpate populations of these salamander species in the short term, but this type of habitat degradation may severely limit population growth and increase a population's overall risk of extirpation from cumulative impacts of other stressors occurring in the surface watershed of a spring.

(50) *Comment:* The Service cited two COA studies (COA 2001, p.15; COA 2010a, p. 16) within the proposed rule to support the finding of water quality degradation in the Bull Creek watershed. To the extent that the 2001 study is superseded by the 2010 study, the 2001 study should be excluded. The COA 2001 report (p. 16) states that ''Although this study found some evidence of a negative shift in the Bull Creek watershed, many COA watershed health measures, including the habitat quality index, the TCEQ aquatic life use score, the number of macroinvertebrate taxa, and the three diatom community metrics, all continue to indicate an overall healthy creek.'' The use of the 2010 study without providing a full disclosure or analysis of the overall findings of this study does not meet the objectivity standard of the Information Quality Guidelines.

Our Response: We cited the COA 2010 study twice in the proposed rule: once to state that sensitive macroinvertebrate species were lost in Bull Creek (77 FR 50778), and once to state that Tributary 5 of Bull Creek increased in conductivity, chloride, and sodium and decreased in invertebrate diversity from 1996 to 2008 (77 FR 50779). We do not believe that these statements were misleading or misrepresenting the results of the study. In addition, the COA 2010 report (p. 16) summarized their study by stating that ''currently Bull Creek ranks highest out of all sampled creeks in the COA; however, spatial differences between sites coupled with temporal shifts over the past decade indicate negative changes in the watershed, particularly in the headwater tributaries.'' This statement is followed by a list of water quality declines found in headwater tributaries 5 and 6. This is the area of Bull Creek where Jollyville Plateau salamander habitat is located.

Further, the Service has relied on other data to support the conclusion that water quality is degrading in the Bull Creek watershed. For example, O'Donnell *et al.* (2006, p. 45) state that despite the amount of preserve land in the watershed, ''the City of Austin has reported significant declines in Jollyville Plateau salamander abundance at one of their Jollyville Plateau salamander monitoring sites within Bull Creek even though our analysis found that 61 percent of the land within this watershed has 0 percent impervious cover.'' O'Donnell *et al.* (2006, p. 46) state, ''Poor water quality, as measured by high specific conductance and elevated levels of ion concentrations, is cited as one of the likely factors leading to statistically significant declines in salamander abundance at the COA's long-term monitoring sites.''

(51) *Comment:* The Service cites a 2005 COA study (Turner 2005a, p. 6) that reported ''significant changes over time'' for several chemical constituents (77 FR 50779). The proposed rule does not disclose the following finding from this study: ''No significant trends at the 0.05 level were found when the data from the last five years was eliminated.'' Also not disclosed were the study's author's admonition regarding the limitations of the study and statement that the study should not be used to predict future water quality concentrations. Finally, the proposed rule did not disclose the last sentence of this report: ''Significance and presence of trends is variable depending on flow conditions ('baseflow vs. stormflow, recharge vs. non-recharge').'' Such non-disclosures do not comport with the Information Quality Guidelines.

Our Response: We do not believe that our characterization of this study was misleading or misrepresenting the results of the study. The fact that significant trends were not found when the last 5 years of data (from 1995 through 1999) were excluded from the analysis supports our conclusion that recent urbanization in the surrounding areas was driving declines in water quality. The author states that their regression model should not be used to predict future water quality concentrations (Turner 2005, p. 6). We made no such predictions based on this model in the proposed rule. Regarding the last point made by the commenter, the proposed rule did in fact state that, ''The significance and presence of trends in other pollutants were variable depending on flow conditions (baseflow vs. stormflow, recharge vs. non-recharge) (Turner 2005a, p. 20)'' (see 77 FR 50779).

(52) *Comment:* The Tonkawa Springs and Great Oaks neighborhoods in Williamson County, Texas, had their water supply contaminated in 1995 after gasoline from a nearby gas station leaked into water wells for the two neighborhoods. These water wells had to be decommissioned and another water supplier found.

Our Response: We agree that leaking underground storage tanks and other sources of hazardous materials pose a threat to salamanders. The final listing rules cite this type of hazardous spill as a threat.

(53) *Comment:* One commenter contests the idea that land application irrigation from wastewater treatment plants increases pollutants in the aquifer.

Our Response: No citation is provided by the commenter to support this view; however, Ross (2011, pp. 11–18) reported that residential irrigation with wastewater effluent had led to excessive nutrient input into the recharge zone of the Barton Springs Segment of the Edwards Aquifer. Mahler *et al.* (2011, p. 35) also cites land application of treated wastewater as the likely source of excess nutrients, and possibly wastewater compounds, detected in tributaries recharging Barton Springs. This information has been updated in the final listing rule.

(54) *Comment:* City of Round Rock is extending its contract for the third time to build a fire station next to Krienke Spring in Jollyville Plateau salamander critical habitat Unit 1. No detention facilities have been proposed, and none appear possible because of topography without excavation into karst rock layer. The City of Round Rock had a geological assessment and geotechnical studies done as well as an engineering feasibility study, which includes logs of boring with lab test data, boring location

plan, and preliminary foundation and pavement design information. Copies were provided in the comment letter.

Our Response: The final listing rule cites population growth and urban development as a primary threat to salamanders. To achieve recovery of these salamander species, we will seek cooperative conservation efforts on private, State, and other lands.

(55) *Comment:* Through measuring water-borne stress hormones, researchers found that salamanders from urban sites had significantly higher corticosterone stress hormone levels than salamanders from rural sites. This finding serves as evidence that chronic stress can occur as development encroaches upon these spring habitats.

Our Response: We are aware that researchers are pursuing this relatively new approach to evaluate salamander health based on differences in stress hormones between salamanders from urban and nonurban sites. Stress levels that are elevated due to natural or unnatural (that is, anthropogenic) environmental stressors can affect an organism's ability to meet its life-history requirements, including adequate foraging, predator avoidance, and reproductive success. We encourage continued development of this and other nonlethal scientific methods to improve our understanding of salamander health and habitat quality.

(56) *Comment:* Information in the proposed rule does not discern whether water quality degradation is due to development or natural variation in flood and rainfall events. Fundamental differences in surface counts of salamanders between sites are due to a natural dynamic of an extended period of above-average rainfall followed by recent drought.

Our Response: We recognize that aquatic-dependent organisms such as the Austin blind and Jollyville Plateau salamanders will respond to local weather conditions; however, the best available science indicates that rainfall alone does not explain lower salamander densities at urban sites monitored by the COA. Furthermore, there is scientific consensus among numerous studies on the impacts of urbanization that conclude species diversity and abundance consistently declines with increasing levels of development, as described under Factor A in the final listing rule.

(57) *Comment:* Studies carried out by the Williamson County Conservation Foundation (WCCF) do not support the Service's assertions that habitat for the salamanders is threatened by declining water quality and quantity. New information from water quality studies performed within the past 3 months at Jollyville Plateau salamander sites indicate that aquifer water is remarkably clean and that water quality protection standards already in place throughout the county are working.

Our Response: The listing process requires the Service to consider both ongoing and future threats to the species. Williamson County has yet to experience the same level of population growth as Travis County, but is projected to have continued rapid growth in the foreseeable future. Therefore, it is not surprising that some areas where the Jollyville Plateau salamanders occur in Williamson County may exhibit good water quality. However, our peer reviewers concluded that the water quality data referenced by the commenter is not enough evidence to conclude that water quality at salamander sites in Williamson County is sufficient for the Jollyville Plateau salamander. The best available science indicates that water quality and species diversity consistently declines with increasing levels of urban development. Existing regulatory programs designed to protect water quality are often not adequate to preserve native ecosystem integrity. Although some springs support larger salamander populations compared to others, among the Jollyville Plateau salamander sites for which we have long-term monitoring data, there is a strong correlation between highly urbanized areas and lower salamander densities. According to COA, densities of Jollyville Plateau salamanders are an average of three times lower at urban sites compared to rural streams.

(58) *Comment:* Aerial photography in the Travis County soil survey indicates that the entire surface watershed of Indian Spring was built out as primarily single-family residential subdivisions before 1970 in the absence of any water quality regulations. Impervious cover levels in the watershed have remained above 40 percent for more than 40 years. Despite nearly 75 years of contiguous development and habitat modification to Indian Spring, the salamanders have persisted and appear to thrive.

Our Response: We were provided no references in support of the comment ''. . . Indian Spring . . . salamanders have persisted and appear to thrive.'' Our records indicate the status of the salamander population at Indian Springs is currently unknown. As stated in our response to comment 62 above, we are unaware of long-term monitoring studies that have demonstrated stable populations of Jollyville Plateau salamanders over time in highly developed areas. Furthermore, the fact that some heavily urbanized areas still have salamanders in them does not indicate the probability of population persistence over the long term.

Hydrology

(59) *Comment:* The Service homogenizes ecosystem characteristics across central Texas salamander species. The proposed rule often assumes that the ''surface habitat'' characteristics of the Barton Springs salamander and Austin blind salamander (year-round surface water in manmade impoundments) apply to the Jollyville Plateau salamanders, which live in very different geologic and hydrologic habitat. The Jollyville Plateau salamander lives in water contained within a ''perched'' zone of the Edwards Limestone formation that is relatively thin and does not retain or recharge much water when compared to the Barton Springs segment of the Edwards Aquifer. Many of the springs where Jollyville Plateau salamanders are found are more ephemeral due to the relatively small drainage basins and relatively quick discharge of surplus groundwater after a rainfall event. Surface water at several of the proposed creek headwater critical habitat units is generally short lived following a rain event. The persistence of Jollyville Plateau salamanders at these headwater locations demonstrates that this species is not as dependent on surface water as occupied impoundments suggest.

Our Response: The Service recognizes that the Austin blind salamander is more subterranean than the other three species of salamander. However, the Jollyville Plateau salamander spends large portions of its life in subterranean habitat. Further, the Jollyville Plateau salamander has cave-associated forms. The Austin blind and Jollyville Plateau salamander species are within the same genus, entirely aquatic throughout each portion of their life cycles, respire through gills, inhabit water of high quality with a narrow range of conditions, depend on water from the Edwards Aquifer, and have similar predators. The Barton Springs salamander shares these same similarities. Based on this information, the Service has determined that these species are suitable surrogates for each other.

Exactly how much these species depend on surface water is unclear, but the best available information suggests that the productivity of surface habitat is important for individual growth. For example, a recent study showed that Jollyville Plateau salamanders had negative growth in body length and tail width while using subsurface habitat during a drought and that growth did not become positive until surface flow returned (Bendik and Gluesenkamp 2012, pp. 3–4). In addition, the morphological variation found in these salamander populations may provide insight into how much time is spent in subsurface habitat compared to surface habitat.

(60) *Comment:* Another commenter stated that salamander use of surface habitat is entirely dependent on rainfall events large enough to generate sufficient spring and stream flow. Even after large rainfall events, stream flow decreases quickly and dissipates within days. As a result, the salamanders are predominately underground species because groundwater is far more abundant and sustainable.

Our Response: See our response to previous comment.

(61) *Comment:* Several commenters stated that there is insufficient data on long-term flow patterns of the springs and creek and on the correlation of flow, water quality, habitat, ecology, and community response to make a listing determination. Commenters propose that additional studies be conducted to evaluate hydrology and surface recharge area, and water quality.

Our Response: We agree that there is a need for more study on the hydrology of salamander sites, but there is enough data available on the threats to these species to make a listing determination. We make our listing determinations based on the five listing factors, singly or in combination, as described in section 4(a)(1) of the Act.

Pesticides

(62) *Comment:* Claims of pesticides posing a significant threat are unsubstantiated. The references cited in the proposed rule are in some cases misquoted, and others are refuted by more robust analysis. The water quality monitoring reports, as noted in the proposed rule, indicate that pesticides were found at levels below criteria set in the aquatic life protection section of the Texas Surface Water Quality Standards, and they were most often at sites with urban or partly urban watersheds. This information conflicts with the statement that the frequency and duration of exposure to harmful levels of pesticides have been largely unknown or undocumented.

Our Response: We recognize there are uncertainties about the degree to which different pesticides may be impacting water quality and salamander health across the range of the Austin blind and Jollyville Plateau salamanders, but the very nature of pesticides being designed to control unwanted organisms through toxicological mechanisms and their persistence in the environment makes them pose an inherent risk to nontarget species. Numerous studies have documented the presence of pesticides in water, particularly areas impacted by urbanization and agriculture, and there is ample evidence that full life-cycle and multigenerational exposures to dozens of chemicals, even at low concentrations, contribute to declines in the abundance and diversity of aquatic species. Few pesticides or their breakdown products have been tested for multigenerational effects to amphibians, and many do not have an applicable State or Federal water quality standard. For these reasons, we maintain that commercial and residential pesticide use contributes to habitat degradation and poses a threat to the Austin blind and Jollyville Plateau salamanders, as well as the aquatic organisms that comprise their diet.

(63) *Comment:* There were no detections of insecticides or fungicides in a USGS monitoring program that analyzed for 52 soluble pesticide residues in the Barton Springs aquifer from 2003 through 2005 (Maher *et al.* 2006). This same study found the highest atrazine concentrations detected was about 0.08 μg/L in a sample from Upper Spring, indicated as 40 times lower than levels of concern (Maher *et al.* 2006). The maximum value of 0.44 μg/L cited from older USGS monitoring data, though still lower than levels of concern, appears to be abnormally high and not representative of actual exposure. The body of evidence available strongly suggests that historical levels of pesticide residues in the aquifers inhabited by the Austin blind and Jollyville Plateau salamanders have always been low and are diminishing.

Our Response: We agree that levels of pesticides documented in Barton Springs and other surface water bodies of the Edwards Aquifer often occur at relatively low concentrations; nevertheless, we believe they are capable of negatively impacting habitat quality and salamander health. Barton Springs in particular is an artesian spring with high flows that would serve to dilute pollutants that are introduced to the system via storm events, irrigation runoff, or other non-point sources and may, therefore, not be representative of pesticide concentrations in springs throughout the range of the Austin blind and Jollyville Plateau salamanders. Furthermore, persistent compounds that bioaccumulate could enter aquatic systems at low levels, but nevertheless reach levels of concern in sediments and biological tissues over time. We agree that pesticide residues would be expected to be low historically in the aquifer, but we disagree that pesticides are decreasing. No citation was provided by the commenter to substantiate this claim. We believe that, with projected human population growth, the frequency and concentration of pesticides in the environment will increase in the future.

(64) *Comment:* The Service cites Rohr *et al.* (2003, p. 2,391) indicating that carbaryl causes mortalities and deformities in streamside salamanders (*Ambystoma barbouri*). However, Rohr *et al.* (2003, p. 2,391) actually found that larval survival was reduced by the highest concentrations of carbaryl tested (50 μg/L) over a 37-day exposure period. Rohr *et al.* (2003, p. 2,391) also found that embryo survival and growth was not affected, and hatching was not delayed in the 37 days of carbaryl exposure. In the same study, exposure to 400 μg/L of atrazine over 37 days (the highest dose tested) had no effect on larval or embryo survival, hatching, or growth. A Scientific Advisory Panel (SAP) of the Environmental Protection Agency (EPA) reviewed available information regarding atrazine effects on amphibians, including the Hayes (2002) study cited by the Service, and concluded that atrazine appeared to have no effect on clawed frog (*Xenopus laevis*) development at atrazine concentrations ranging from 0.01 to 100 μg/L. These studies do not support the Service's conclusions.

Our Response: We do not believe that our characterization of Rohr *et al.* (2003) misrepresented the results of the study. In their conclusions, Rohr *et al.* (2003, p. 2,391) state, ''Carbaryl caused significant larval mortality at the highest concentration and produced the greatest percent of malformed larvae, but did not significantly affect behavior relative to controls. Although atrazine did not induce significant mortality, it did seem to affect motor function.'' This study clearly demonstrates that these two pesticides can have an impact on amphibian biology and behavior. In addition, the EPA (2007, p. 9) also found that carbaryl is likely to adversely affect the Barton Springs salamander both directly and indirectly through reduction of prey.

Regarding the Hayes (2002) study, we acknowledge that an SAP of the EPA reviewed this information and concluded that atrazine concentrations less than 100 μg/L had no effects on clawed frogs in 2007. However, the 2012 SAP did reexamine the conclusions of the 2007 SAP using a meta-analysis of published studies along with additional studies on more species (EPA 2012, p. 35). The 2012 SAP expressed concern that some studies were discounted in the 2007 SAP analysis, including studies like Hayes (2002) that indicated that atrazine is linked to endocrine disruption in amphibians (EPA 2012, p. 35). In addition, the 2007 SAP noted that their results on clawed frogs are insufficient to make global conclusions about the effects of atrazine on all amphibian species (EPA 2012, p. 33). Accordingly, the 2012 SAP has recommended further testing on at least three amphibian species before a conclusion can be reached that atrazine has no effect on amphibians at concentrations less than 100 μg/L (EPA 2012, p. 33). Due to potential differences in species sensitivity, exposure scenarios that may include dozens of chemical stressors simultaneously, and multigenerational effects that are not fully understood, we continue to view pesticides in general, including carbaryl, atrazine, and many others to which aquatic organisms may be exposed, as a potential threat to water quality, salamander health, and the health of aquatic organisms that comprise the diet of salamanders.

Impervious Cover

(65) *Comment:* One commenter stated that, in the draft impervious cover analysis, the Service has provided no data to prove a cause and effect relationship between impervious cover and the status of surface salamander sites or the status of underground habitat.

Our Response: Peer reviewers agreed that we used the best available scientific information in regard to the link between urbanization, water quality, and salamander populations.

(66) *Comment:* On page 18 of the draft impervious cover analysis, the Service dismisses the role and effectiveness of water quality controls to mitigate the effects of impervious cover: ''. . . the effectiveness of storm water runoff measures, such as passive filtering systems, is largely unknown in terms of mitigating the effects of watershed-scale urbanization.'' The Service recognized the effectiveness of such storm water runoff measures in the final rule listing the Barton Springs salamander as endangered in 1997. Since 1997, the Service has separately concurred that the water quality controls imposed in the Edwards Aquifer area protect the Barton Springs salamander.

Our Response: Since 1997, water quality and Jollyville Plateau salamander counts have declined at several salamander sites, as described under Factor A in the final listing rule. This is in spite of water quality control measures implemented in the Edwards Aquifer area. Further discussion of these measures can be found under Factor D in this final listing rule.

(67) *Comment:* The springshed, as defined in the draft impervious cover analysis, is a misnomer because the so-called springsheds delineated in the study are not the contributing or recharge area for the studied springs. Calling a surface area that drains to a specific stretch of a creek a springshed is disingenuous and probably misleading to less informed readers.

Our Response: We acknowledge that the term springshed may be confusing to readers, and we have thus replaced this term with the descriptors ''surface drainage area of a spring'' or ''surface watershed of a spring'' throughout the final listing rule and impervious cover analysis document.

(68) *Comment:* Page 18 of the draft impervious cover analysis states, ''. . . clearly-delineated recharge areas that flow to specific springs have not been identified for any of these spring sites; therefore, we could not examine impervious cover levels on recharge areas to better understand how development in those areas may impact salamander habitat.'' This statement is not accurate with respect to the springs in which the Austin Blind salamander has been observed. Numerous studies, including several dye studies, have been conducted on the recharge area for these springs. Enclosed with this letter are seven studies that describe the ''springshed'' for these springs. Further, Barton Springs Pool is largely isolated from Barton Creek due to dams and bypass structures except during larger rainfall events when the creek tops the upstream dam. That the draft impervious cover analysis misses these obvious and widely known facts indicates a fundamental misunderstanding of how the Barton Springs segment of the Edwards Aquifer operates.

Our Response: We acknowledge that the recharge area for Barton Springs is much better studied compared to springs for other central Texas salamanders, and we have incorporated this information in the final impervious cover analysis. We are also aware of the upstream dam above Barton Springs. However, this dam does not isolate the springs from threats occurring within the surface watershed. We believe the surface watershed of Barton Springs does play a role in determining the overall habitat quality of this site. For example, development in the surface watershed may increase the frequency and severity of flood events that top the upstream dam. These floods contain contaminants and sediments that accumulate in Barton Springs (Geismar 2005, p. 2; COA 2007a, p. 4).

(69) *Comment:* During the first public comment period, many entities submitted comments and information directing the Service's attention to the actual data on water quality in the affected creeks and springs. Given the amount of water quality data available to the Service and the public, the Texas Salamander Coalition is concerned that the Service continues to ignore local data and instead focuses on impervious cover and impervious cover studies conducted in other parts of the country without regard to existing water quality regulations. Why use models, generic data, and concepts when actual data on the area of concern is readily available?

Our Response: The Service has examined and incorporated all water quality data submitted during the public comment periods. However, the vast majority of salamander sites are still lacking long-term monitoring data that are necessary to make conclusions on the status of the site's water quality. The impervious cover analysis allows us to quantify this specific threat for sites where information is lacking.

(70) *Comment:* Spicewood Springs, proposed critical habitat Unit 31 for the Jollyville Plateau salamander, was fully built out prior to 1995. No open space exists within Unit 31 aside from the narrow wooded area along an unnamed tributary. Impervious cover in Unit 31 exceeds 55 percent. Impervious cover within the Spicewood Springs surface watershed exceeds 50 percent. Development has almost certainly led to bank erosion, increased velocity, decreased water depths, fill from construction activities, and stream maintenance and stabilization. These modifications have altered the natural and traditional character of the tributary in which Spicewood Springs are located. Extensive, historic impervious cover in the watershed (55 percent) and the subsequent baseline water quality has not eliminated Jollyville Plateau salamander at the spring, documenting that the threat of the habitat degradation is absent in Unit 31. By the criteria in the proposed rule, the Jollyville Plateau salamander should no longer occupy Spicewood Springs because the impervious cover is greater than 15 percent and has been for 30 years. However, Jollyville Plateau salamanders have been found by the COA in 1996 after which most of the development in the area was complete. Further, recent water quality sampling by SWCA shows baseline levels of almost all contaminants. Any future added impervious cover is not likely to significantly reduce the current amount

of groundwater recharging. Groundwater depletion may also result from groundwater extraction. Review of the Texas Water Development Board data indicates no Edwards formation water wells are in the area.

Our Response: Numerous variables affect the extent to which any given spring may be impacted by surrounding land uses and human activities that occur both within the immediate watershed and in areas of groundwater recharge. Some springs may be more resistant or resilient to increased pollution loading due to high flow volume, extensive subsurface habitat, or other physical, chemical, or biological features that ameliorate the effects of environmental stressors. Impervious cover estimates are a useful tool to indicate the likelihood of injury to aquatic resources, but there are exceptions. However, the scientific literature overwhelmingly indicates a strong pattern of lower water quality and aquatic biodiversity in the presence of increasing levels of impervious cover.

Disease

(71) *Comment:* The Service concludes in the proposed rule that chytrid fungus is not a threat to any of the salamanders. The Service's justification for this conclusion is that they have no data to indicate whether impacts from this disease may increase or decrease in the future. There appears to be inconsistency in how the information regarding threats is used.

Our Response: Threats are assessed by their imminence and magnitude. Currently, we have no data to indicate that chytrid fungus is a significant threat to the species. The few studies that have looked for chytrid fungus in central Texas *Eurycea* found the fungus, but no associated pathology was found within several populations and among different salamander species.

(72) *Comment:* The statement about chytrid fungus having been documented on Austin blind salamanders in the wild is incorrect. Chytrid fungus has only been documented on captive Austin blind salamanders. The appropriate citation for this is Chamberlain 2011, COA, (pers. comm.), not O'Donnell *et al.* 2006, as cited in the proposed rule.

Our Response: This statement has been corrected in the final listing rule.

Climate Change

(73) *Comment:* Climate change has already increased the intensity and frequency of extreme rainfall events globally (numerous references) and in central Texas. This increase in rainfall extremes means more runoff possibly overwhelming the capacity of recharge features. This has implications for water storage. Implications are that the number of runoff events recharging the aquifer with a higher concentration of toxic pollutants than past events will be occurring more frequently, likely in an aquifer with a lower overall volume of water to dilute pollutants. Understanding high concentration toxicity needs to be evaluated in light of this.

Our Response: We agree that climate change will likely result in less frequent recharge, affecting both water quantity and quality of springs throughout the aquifer. We have added language in the final listing rule to further describe the threat of climate change and impacts to water quality.

(74) *Comment:* The section of the proposed rule addressing climate change fails to include any consideration or description of a baseline central Texas climate. The proposed rule describes flooding and drought as threats, but fails to provide any serious contextual analysis of the role of droughts and floods in the life history of the central Texas salamanders.

Our Response: The proposed and final listing rules discuss the threats of drought conditions and flooding, both in the context of naturally occurring weather patterns and as a result of anthropogenic activities.

(75) *Comment:* The flooding analysis is one of several examples in the proposed rule in which the Service cites events measured on micro-scales of time and area, and fails to comprehend the larger ecosystem at work. For example, the proposed rule describes one flood event causing ''erosion, scouring the streambed channel, the loss of large rocks, and creation of several deep pools.'' Scouring and depositing sediment are both normal results of the intense rainfall events in central Texas.

Our Response: While we agree that scouring and sediment deposition are normal hydrologic processes, when the frequency and intensity of these events is altered by climate change, urbanization, or other anthropogenic forces, the resulting impacts to ecosystems can be more detrimental than what would occur naturally.

Other Threats

(76) *Comment:* The risk of extinction is negatively or inversely correlated with population size. Also, small population size, in and of itself, can increase the risk of extinction due to demographic stochasticity, mutation accumulation, and genetic drift. The correlation between extinction risk and population size is not necessarily indirect (that is, due to an additional extrinsic factor such as environmental perturbation).

Our Response: Although we do not consider small population sizes to be a threat in and of itself to any of the Austin blind and Jollyville Plateau salamanders, we do believe that small population sizes make them more vulnerable to extinction from other existing or potential threats, such as major stochastic events.

Taxonomy

(77) *Comment:* The level of genetic divergence among the Jollyville Plateau, Georgetown, and Salado salamanders is not sufficiently large to justify recognition of three species. The DNA papers indicate a strong genetic relationship between individual salamanders found across the area. Such a strong relationship necessarily means that on an ecosystem-wide basis, the salamanders are exchanging genetic material on a regular basis. There is no evidence that any of these salamanders are unique species.

Our Response: The genetic relatedness of the Georgetown salamander, Jollyville Plateau salamander, and Salado salamanders is not disputed. The three species are included together on a main branch of the tree diagrams of mtDNA data (Chippindale *et al.* 2000, Figs. 4 and 6). The tree portraying relationships based on allozymes (genetic markers based on differences in proteins coded by genes) is concordant with the mtDNA trees (Chippindale *et al.* 2000, Fig. 5). These trees support the evolutionary relatedness of the three species, but not their identity as a single species. The lack of sharing of mtDNA haplotype markers, existence of unique allozyme alleles in each of the three species, and multiple morphological characters diagnostic of each of the three species are inconsistent with the assertion that they are exchanging genetic material on a regular basis. The Austin blind salamander is on an entirely different branch of the tree portraying genetic relationships among these species based on mtDNA and has diagnostic, morphological characters that distinguish it from other Texas salamanders (Hillis *et al.* 2001, p. 267). Based on our review of these differences, and taking into account the views expressed in peer reviews by expert taxonomists, we believe that the currently available evidence is sufficient for recognizing these salamanders as four separate species.

(78) *Comment:* A genetics professor commented that Forstner's report (2012) disputing the taxonomy of the Austin

blind, Georgetown, Jollyville Plateau, and Salado salamanders represents a highly flawed analysis that has not undergone peer review. It is not a true taxonomic analysis of the *Eurycea* complex and does not present any evidence that call into question the current taxonomy of the salamanders. Forstner's (2012) report is lacking key information regarding exact methodology and analysis. It is not entirely clear what resulting length of base pairs was used in the phylogenetic analysis and the extent to which the data set was supplemented with missing or ambiguous data. The amount of sequence data versus missing data is important for understanding and interpreting the subsequent analysis. It also appears as though Forstner included all individuals with available, unique sequence when, in fact, taxonomic sampling—that is, the number of individuals sampled within a particular taxon compared with other taxa—can also affect the accuracy of the resulting topology. The Forstner (2012) report only relies on mitochondrial DNA whereas the original taxonomic descriptions of these species relied on a combination of nuclear DNA, mitochondrial DNA, as well as morphology (Chippindale *et al.* 2000, Hillis *et al.* 2001). Forstner's (2012) report does not consider non-genetic factors such as ecology and morphology when evaluating taxonomic differences. Despite the limitations of a mitochondrial DNA-only analysis, Forstner's (2012) report actually contradicts an earlier report by the same author that also relied only on mtDNA.

Our Response: This comment supports the Service's and our peer reviewers' interpretation of the best available data (see Responses to Comments 1 through 5 above).

(79) *Comment:* Forstner (2012) argues that the level of genetic divergence among the three species of Texas *Eurycea* is not sufficiently large to justify recognition of three species. A genetics professor commented that this conclusion is overly simplistic. It is not clear that the populations currently called *Eurycea lucifuga* in reality represent a single species, as Forstner (2012) assumes. Almost all cases of new species in the United States for the last 20 years (*E. waterlooensis* is a rare exception) have resulted from DNA techniques used to identify new species that are cryptic, meaning their similarity obscured the genetic distinctiveness of the species. One could view the data on *Eurycea lucifuga* as supporting that cryptic species are also present. Moreover, Forstner's (2012) comparison was made to only one species, rather than to salamanders generally. Moreover, there is perhaps a problem with the Harlan and Zigler (2009) data. They sequenced 10 specimens of *E. lucifuga,* all from Franklin County, Tennessee; 9 of these show genetic distances between each other from 0.1 to 0.3 percent, which is very low. One specimen shows genetic distance to all other nine individuals from 1.7 to 1.9 percent, an order of magnitude higher. This single specimen is what causes the high level of genetic divergence to which Forstner compares the *Eurycea.* This discrepancy is extremely obvious in the Harlan and Zigler (2009) paper, but was not mentioned by Forstner (2012). A difference of an order of magnitude in 1 specimen of 10 is highly suspect, and, therefore, these data should not be used as a benchmark in comparing *Eurycea.*

The second argument in Forstner (2012) is that the phylogenetic tree does not group all individuals of a given species into the same cluster or lineage. Forstner's (2012) conclusions are overly simplistic. The failure of all sequences of *Eurycea tonkawae* to cluster closely with each other is due to the amount of missing data in some sequences. It is well known in the phylogenetics literature that analyzing sequences with very different data (in other words, large amounts of missing data) will produce incorrect results because of this artifact. As an aside, why is there missing data? The reason is that these data were produced roughly 5 years apart. The shorter sequences were made at a time when lengths of 350 bases for cytochrome b were standard because of the limitations of the technology. As improved and cheaper methods were available (about 5 to 6 years later), it became possible to collect sequences that were typically 1,000 to 1,100 bases long. It is important to remember that the data used to support the original description of the three northern species by Chippindale *et al.* (2000) were not only cytochrome b sequences, but also data from a different, but effective, analysis of other genes, as well as analysis of external characteristics. Forstner's (2012) assessment of the taxonomic status (species or not) of the three species of the northern group is not supported by the purported evidence that he presents (much of it unpublished).

Our Response: This comment supports the Service's and our peer reviewers' interpretation of the best available data (see Responses to Comments 1 through 5 above).

(80) *Comment:* Until the scientific community determines the appropriate systematic approach to identify the number of species, it seems imprudent to elevate the salamanders to endangered.

Our Response: The Service must base its listing determinations on the best available scientific and commercial information, and such information includes considerations of correct taxonomy. To ensure the appropriateness of our own analysis of the relevant taxonomic literature, we sought peer reviews from highly qualified taxonomists, particularly with specialization on salamander taxonomy, of our interpretation of the available taxonomic literature and unpublished reports. We believe that careful analysis and peer review is the best way to determine whether any particular taxonomic arrangement is likely to be generally accepted by experts in the field. The peer reviews that we received provide overall support, based on the available information, for the species that we accept as valid in the final listing rule.

Technical Information

(81) *Comment:* Clarify whether the distance given for the Austin blind salamander extending ''at least 984 feet (ft) (300 meters (m) underground'' is a vertical depth or horizontal distance.

Our Response: It is a horizontal distance. This has been clarified in the final listing rule.

(82) *Comment:* The Service made the following statement in the proposed rule: ''Therefore, the status of subsurface populations is largely unknown, making it difficult to assess the effects of threats on the subsurface populations and their habitat.'' In fact, the difficulty of assessing threats for subsurface populations depends upon the threats. One can more easily assess threats of chemical pollutants, for example, because subterranean populations will be affected similarly to surface ones because they inhabit the same or similar water.

Our Response: The statement above was meant to demonstrate the problems associated with not knowing how many salamanders exist in subsurface habitat rather than how threats are identified. We have removed the statement in the final listing rule to eliminate this confusion.

(83) *Comment:* In addition to the references cited in the proposed rule, Bowles *et al.* (2006) also documents evidence of reproduction throughout the year in Jollyville Plateau salamanders.

Our Response: We examined the published article by Bowles *et al.* (2006, pp. 114, 116, 118), and found that, while there were juvenile salamanders observed nearly year-round, there was also evidence of a seasonal reproduction pattern among their study's findings. We have included this information in the final listing rule.

(84) *Comment:* Geologists with the COA have extensively reviewed the possibility that a small test well caused the dewatering of Moss Gully Spring, as discussed in the proposed rule, and have been unable to substantiate that theory. In fact, the boring was drilled near the spring in 1985, and the spring was found to have significant flow and a robust Jollyville Plateau salamander population in the early 1990s. Reduction in flow and a smaller salamander population was observed at Moss Gully Spring around 2005 or 2006, but there had been no changes to the boring. Subsequent groundwater tracing also failed to delineate a definitive connection between the well and the spring.

Our Response: Given the existing uncertainty that dewatering at this site was caused by the 1985 test well, we have removed the discussion of Moss Gully Spring from the final listing rule.

(85) *Comment:* The discussion of the COA's Water Treatment Plant 4 project in the proposed rule could be misconstrued as posing a threat to the Jollyville Plateau salamander.

Our Response: We agree that construction and operation of the Jollyville Transmission Main tunnel, including associated vertical shafts, is unlikely to adversely affect the Jollyville Plateau salamander due to best management practices and environmental monitoring implemented by the COA. We have modified this discussion in the final listing rule to clarify our assessment.

Changes From Proposed Listing Rule

On August 22, 2012 (77 FR 50768), we published a proposed rule to list the Jollyville Plateau salamander as endangered. Based on additional information we received during the comment period on the proposed rule and after further analysis of the magnitude and imminence of threats to the species, we are listing the Jollyville Plateau salamander as a threatened species in this final rule. For more detailed information, please see *Listing Determination for the Jollyville Plateau Salamander* below.

Summary of Factors Affecting the Species

Section 4 of the Act and its implementing regulations (50 CFR 424) set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1) of the Act: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination. Each of these factors is discussed below.

A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Habitat modification, in the form of degraded water quality and quantity and disturbance of spring sites, is the primary threat to the Austin blind and Jollyville Plateau salamanders. Water quality degradation in salamander habitat has been cited as the top concern in several studies (Chippindale *et al.* 2000, pp. 36, 40, 43; Hillis *et al.* 2001, p. 267; Bowles *et al.* 2006, pp. 118–119; O'Donnell *et al.* 2006, pp. 45–50). These salamanders spend their entire life cycle in water. All of the species have evolved under natural aquifer conditions both underground and as the water discharges from natural spring outlets. Deviations from high water quality and quantity have detrimental effects on salamander ecology because the aquatic habitat can be rendered unsuitable for salamanders by changes in water chemistry and flow patterns. Substrate modification is also a major concern for the salamander species (COA 2001, pp. 101, 126; Geismar 2005, p. 2; O'Donnell *et al.* 2006, p. 34). Unobstructed interstitial space is a critical component to the surface habitat for the Austin blind and Jollyville Plateau salamanders, because it provides cover from predators and habitat for their macroinvertebrate prey items within surface sites. When the interstitial spaces become compacted or filled with fine sediment, the amount of available foraging habitat and protective cover for salamanders is reduced (Welsh and Ollivier 1998, p. 1,128).

Threats to the habitat of the Austin blind and Jollyville Plateau salamanders (including those that affect water quality, water quantity, or the physical habitat) may affect only the surface habitat, only the subsurface habitat, or both habitat types. For example, substrate modification degrades the surface springs and spring-runs, but does not impact the subsurface environment, while water quality degradation can impact both the surface and subsurface habitats, depending on whether the degrading elements are moving through groundwater or are running off the ground surface into a spring area (surface watershed). Our assessment of water quality threats from urbanization is largely focused on surface watersheds. Impacts to subsurface areas are also likely to occur from urbanization over recharge zones within the Edwards Aquifer region; however, these impacts are more difficult to assess given the limited information available on subsurface flows and drainage areas that feed into these subsurface flows to the springs and cave locations. These recharge areas are additional pathways for impacts to the Austin blind and Jollyville Plateau salamanders to occur that we are not able to precisely assess at each known salamander site. However, we can consider urbanization and various other sources of impacts to water quality and quantity over the larger recharge zone to the aquifer (as opposed to individual springs) to assess the potential for impacts at salamander sites.

The threats under Factor A will be presented in reference to stressors and sources. We consider a stressor to be a physical, chemical, or biological alteration that can induce an adverse response from an individual salamander. These alterations can act directly on an individual or act indirectly on an individual through impacts to resources the species requires for feeding, breeding, or sheltering. A source is the origin from which the stressor (or alteration) arises. The majority of the discussion below under Factor A focuses on evaluating the nature and extent of stressors and their sources related to urbanization, the primary source of water quality degradation, within the ranges of the Austin blind and Jollyville Plateau salamanders. Additionally, other stressors causing habitat destruction and modification, including water quantity degradation and physical disturbance to surface habitat, will be addressed.

Water Quality Degradation

Urbanization

Urbanization is the concentration of human populations into discrete areas, leading to transformation of land for residential, commercial, industrial, and transportation purposes. It is one of the most significant sources of water quality degradation that can affect the future survival of central Texas salamanders (Bowles *et al.* 2006, p. 119; Chippindale and Price 2005, pp. 196–197). Urban development leads to various stressors on spring systems, including increased frequency and magnitude of high flows in streams, increased sedimentation, increased contamination and toxicity, and changes in stream morphology and water chemistry (Coles *et al.* 2012, pp. 1–3, 24, 38, 50–51). Urbanization can also impact aquatic species by negatively affecting their invertebrate prey base (Coles *et al.* 2012, p. 4).

The ranges of the Austin blind and Jollyville Plateau salamanders reside within increasingly urbanized areas of Travis and Williamson Counties that are experiencing rapid human population growth. For example, the population of the COA grew from 251,808 people in 1970 to 656,562 people in 2000. By 2007, the population had grown to 735,088 people (COA 2007b, p. 1). This represents a 192 percent increase over the 37-year period. Population projections from the Texas State Data Center (2012, pp. 496–497) estimate that Travis County will increase in population from 1,024,266 in 2010, to 1,990,820 in 2050. This would be a 94 percent increase in the human population size over this 40-year period. The Texas State Data Center also estimates an increase in human population in Williamson County from 422,679 in 2010 to 2,015,294 in 2050, exceeding the size of Travis County. This would represent a 477 percent increase over a 40-year timeframe. All human population projections from the Texas State Data Center presented here are under a high growth scenario, which assumes that migration rates from 2000 to 2010 will continue through 2050 (Texas State Data Center and the Office of the State Demographer 2012, p. 9). By comparison, the national United States' population is expected to increase from 310,233,000 in 2010, to 439, 010,000 in 2050, which is about a 42 percent increase over the 40-year period (U.S. Census Bureau 2008, p. 1). Growing human populations increase demand for residential and commercial development, drinking water supply, wastewater disposal, flood control, and other municipal goods and services that alter the environment, often degrading salamander habitat by changing hydrologic regimes, and affecting the quantity and quality of water resources.

As development increases within the watersheds where the Austin blind and Jollyville Plateau salamanders occur, more opportunities exist for the detrimental effects of urbanization to impact salamander habitat. A comprehensive study by the USGS found that, across the United States, contaminants, habitat destruction, and increasing streamflow flashiness (rapid response of large increases of streamflow to storm events) resulting from urban development have been associated with the disruption of biological communities, particularly the loss of sensitive aquatic species (Coles *et al.* 2012, p. 1).

Several researchers have also examined the negative impact of urbanization on stream salamander habitat by making connections between salamander abundances and levels of development within the watershed. In 1972, Orser and Shure (p. 1,150) were among the first biologists to show a decrease in stream salamander density with increasing urban development. A similar relationship between salamanders and urbanization was found in North Carolina (Price *et al.* 2006, pp. 437–439; Price *et al.* 2012, p. 198), Maryland, and Virginia (Grant *et al.* 2009, pp. 1,372–1,375). Willson and Dorcas (2003, pp. 768–770) demonstrated the importance of examining disturbance within the entire watershed as opposed to areas just adjacent to the stream by showing that salamander abundance is most closely related to the amount and type of habitat within the entire watershed. In central Texas, Bowles *et al.* (2006, p. 117) found lower Jollyville Plateau salamander densities in tributaries with developed watersheds as compared to tributaries with undeveloped watersheds. Developed tributaries also had higher concentrations of chloride, magnesium, nitrate-nitrogen, potassium, sodium, and sulfate (Bowles *et al.* 2006, p. 117).

The impacts that result from urbanization can affect the physiology of individual salamanders. An unpublished study (Gabor 2012, Texas State University, pers. comm.) has demonstrated that Jollyville Plateau salamanders in disturbed habitats have greater stress levels than those in undisturbed habitats, as determined by measurements of water-borne stress hormones in disturbed (urbanized) and undisturbed streams (Gabor 2012, Texas State University, pers. comm.). Chronic stress can decrease survival of individuals and may lead to a decrease in reproduction. Both of these factors may partially account for the decrease in abundance of salamanders in streams within disturbed environments (Gabor 2012, Texas State University, pers. comm.).

Urbanization occurring within the watersheds of the Austin blind and Jollyville Plateau salamanders could cause irreversible declines or extirpation of salamander populations with continuous exposure over a relatively short time span. We consider this to be an ongoing threat of high impact for the Jollyville Plateau salamander that is expected to increase in the future as development within its range expands.

Impervious cover is another source of water quality degradation and is directly correlated with urbanization (Coles *et al.* 2012, p. 30). For this reason, impervious cover is often used as a surrogate for urbanization (Schueler *et al.* 2009, p. 309), even though it does not account for many sources of water quality degradation associated with urbanization, including human population density, fertilizer and pesticide use, septic tanks, and fuel storage and transport. Impervious cover is any surface material that prevents water from filtering into the soil, such as roads, rooftops, sidewalks, patios, paved surfaces, or compacted soil (Arnold and Gibbons 1996, p. 244). Once vegetation in a watershed is replaced with impervious cover, rainfall is converted to surface runoff instead of filtering through the ground (Schueler 1991, p. 114). Such urbanized development in a watershed may: (1) Alter the hydrology or movement of water through a watershed, (2) increase the inputs of contaminants to levels that greatly exceed those found naturally in streams, and (3) alter habitats in and near streams that provide living spaces for aquatic species (Coles *et al.* 2012, p. 38), such as the Austin blind and Jollyville Plateau salamanders. During periods of high precipitation levels, stormwater runoff in urban areas can enter recharge areas of the Edwards Aquifer and rapidly transport sediment, fertilizer nutrients, and toxic contaminants (such as pesticides, metals, and petroleum hydrocarbons) to salamander habitat.

Both nationally and locally, consistent relationships between impervious cover and water quality degradation through contaminant loading have been documented. In a study of contaminant input from various land use areas in Austin, stormwater runoff loads were found to increase with increasing impervious cover (COA 1990, pp. 12–14). This study also found that contaminant input rates of the more urbanized watersheds were higher than those of the small suburban watersheds. Soeur *et al.* (1995, p. 565) determined that stormwater contaminant loading positively correlated with development intensity in Austin. In a study of 38 small watersheds in the Austin area, several different contaminants were found to be positively correlated with impervious cover (5-day biochemical oxygen demand, chemical oxygen demand, ammonia, dissolved phosphorus, copper, lead, and zinc)

(COA 2006, p. 35). Using stream data from 1958 to 2007 at 24 Austin-area sites, some of which are located within watersheds occupied by Austin blind salamanders and Jollyville Plateau salamanders, Glick *et al.* (2009, p. 9) found that the COA's water quality index had a strong negative correlation with impervious cover. Veenhuis and Slade (1990, pp. 18–61) also reported mean concentrations of most water quality constituents, such as total suspended solids and other pollutants, are lower in undeveloped watersheds than those for urban watersheds.

Impervious cover has demonstrable impacts on biological communities within streams. Schueler (1994, p. 104) found that sites receiving runoff from high impervious cover drainage areas had sensitive aquatic macroinvertebrate species replaced by species more tolerant of pollution and hydrologic stress (high rate of changes in discharges over short periods of time). An analysis of nine regions across the United States found considerable losses of algal, invertebrate, and fish species in response to stressors brought about by urban development (Coles *et al.* 2012, p. 58). In an analysis of 43 North Carolina streams, Miller *et al.* (2007, pp. 78–79) found a strong negative relationship between impervious cover and the abundance of larval southern two-lined salamanders (*Eurycea cirrigera*). The COA cited five declining salamander populations from 1997 to 2006: Balcones District Park Spring, Tributary 3, Tributary 5, Tributary 6, and Spicewood Tributary (O'Donnell *et al.* 2006, p. 4). All of these populations occur within surface watersheds containing more than 10 percent impervious cover (Service 2013, pp. 9–11). Springs with relatively low amounts of impervious cover (6.77 and 0 percent for Franklin and Wheless Springs, respectively) in their surface drainage areas tend to have generally stable or increasing salamander populations (Bendik 2011a, pp. 18–19). Bendik (2011a, pp. 26–27) reported statistically significant declines in Jollyville Plateau salamander populations over a 13-year period at six monitored sites with high impervious cover (18 to 46 percent) compared to two sites with low impervious cover (less than 1 percent). These results are consistent with Bowles *et al.* (2006, p. 111), who found lower densities of Jollyville Plateau salamanders at urbanized sites compared to non-urbanized sites.

We recognize that the long-term survey data of Jollyville Plateau salamanders using simple counts may not give conclusive evidence on the long-term trend of the population at each site. However, based on the threats and evidence from the literature, the declines in counts seen at urban Jollyville Plateau salamander sites are likely real declines in the population. We expect downward trends in salamander populations to continue into the future as human population growth and urbanization drive further declines in habitat quality and quantity.

Impervious Cover Analysis

For this final rule, we calculated impervious cover within the watersheds occupied by the Austin blind and Jollyville Plateau salamanders. In this analysis, we delineated the surface areas that drain into spring sites and which of these sites may be experiencing habitat quality degradation as a result of impervious cover in the surface drainage area. However, we only examined surface drainage areas for each spring site for the Jollyville Plateau salamander because we did not know the recharge area for specific spring or cave sites. This information was available for the Austin blind salamander and the Barton Springs system. Another limitation of this analysis is that we did not account for riparian (stream edge) buffers or stormwater runoff control measures, both of which have the potential to mitigate some of the effects of impervious cover on streams (Schueler *et al.* 2009, pp. 312–313). Please see the Service's Refined Impervious Cover Analysis (Service 2013, pp. 2–7) for a description of the methods used to conduct this analysis. This analysis is most likely an underestimation of current impervious cover because small areas of impervious cover may have gone undetected at the resolution of our analysis and additional areas of impervious cover may have been added since 2006, which is the year the impervious-cover data for our analysis was generated. We compared our results with the results of similar analyses completed by SWCA and COA, and impervious-cover percentages at individual sites from both analyses were generally higher than our own (Service 2013, Appendix C).

Impervious Cover Categories

We examined studies that report ecological responses to watershed impervious- cover levels based on a variety of degradation measurements (Service 2013, Table 1, p. 4). Most studies examined biological responses to impervious cover (for example, aquatic invertebrate and fish diversity), but several studies measured chemical and physical responses as well (for example, water quality parameters and stream channel modification). The most commonly reported impervious cover level at which noticeable degradation to aquatic ecosystems begins to occur is approximately 10 percent, with more recent studies reporting levels of 10 percent and lower. Recent studies in the eastern United States have reported large declines in aquatic macroinvertebrates (the prey base of salamanders) at impervious-cover levels as low as 0.5 percent (King and Baker 2010, p. 1002; King *et al.* 2011, p. 1664). Bowles *et al.* (2006, pp. 113, 117–118) found lower Jollyville Plateau salamander densities in watersheds with more than 10 percent impervious cover. To our knowledge, this is the only peer-reviewed study that examined watershed impervious-cover effects on salamanders in our study area. This is also in agreement with the Center for Watershed Protection's impervious-cover model, which predicts that stream health begins to decline at 5 to 10 percent impervious cover in small watersheds (Schueler *et al.* 2009, pp. 309, 313). Their prediction is based on a meta-analysis of 35 recent research studies (Schueler *et al.* 2009, p. 310). However, a USGS investigation found immediate declines in aquatic invertebrate communities as soon as the percentage of developed land increased from background levels, including areas with less than 10 percent impervious cover (Coles *et al.* 2012, p. 64).

Various levels of impervious cover within watersheds have been cited as having detrimental effects to water quality and biological communities within streams (Schueler *et al.* 2009, pp. 312–313; Coles *et al.* 2012, p. 65). An impervious-cover model generated using data from relevant literature by Schueler *et al.* (2009, p. 313) indicates that stream degradation generally increases as impervious cover increases, and occurs at impervious cover of 5 to 10 percent. This model predicts that streams transition from an ''impacted'' status (clear signs of declining stream health) to a ''nonsupporting'' status (no longer support their designated uses in terms of hydrology, channel stability, habitat, water quality, or biological diversity) at impervious-cover levels from 20 to 25 percent. However, a recent national-scale investigation of the effects of urban development on stream ecosystems revealed that degradation of invertebrate communities can begin at the earliest levels of urban development (Coles *et al.* 2012, p. 64), thereby contradicting the resistance thresholds described by Schueler (1994, pp. 100–102). Therefore, the lack of a resistance threshold in biological responses indicates that no assumptions can be made with regard to a ''safe zone'' of impervious cover less than 10 percent (Coles *et al.* 2012, p. 64). In light of these studies, we created the following impervious cover categories:

- None: 0 percent impervious cover in the watershed
- Low: Greater than 0 percent to 10 percent impervious cover in the watershed
- Medium: Greater than 10 percent to 20 percent impervious cover in the watershed
- High: Greater than 20 percent impervious cover in the watershed

Sites in the Low category may still be experiencing impacts from urbanization, as cited in studies such as Coles *et al.* (2012, p. 64), King *et al.* (2011, p. 1664), and King and Baker (2010, p. 1002). In accordance with the findings of Bowles *et al.* (2006, pp. 113, 117–118), sites in the Medium category are likely experiencing impacts from urbanization that are negatively impacting salamander densities. Sites in the High category are so degraded that habitat recovery will either be impossible or very difficult (Schueler *et al.* 2009, pp. 310, 313).

Results of Our Impervious Cover Analysis

We estimated impervious cover percentages for each surface drainage area of a spring known to have at least one population of either an Austin blind or Jollyville Plateau salamander (cave locations were omitted). These estimates and maps of the surface drainage area of spring locations are provided in our refined impervious cover analysis (Service 2013, pp. 1–25). A total of 114 watersheds were analyzed, encompassing a total of 543,269 acres (ac) (219,854 hectares (ha)).

The Austin blind salamander had three watersheds delineated, one for each of the springs where the species is found. Eliza and Parthenia Springs had nearly identical large surface drainage areas, while the watershed of Sunken Garden (Old Mill) was found to be a much smaller area. Even though the level of impervious cover was Low in Eliza and Parthenia watersheds, most of the impervious cover occurs within 5 mi (8 km) of the springs.

We also calculated the impervious cover levels for the contributing and recharge zones of the Barton Springs Segment of the Edwards Aquifer. Unlike the known locations for the Jollyville Plateau salamander, the sources of subsurface water feeding the sites of Austin blind salamander (Barton Springs complex) are fairly well-delineated. Barton Springs is the principal discharge point for the Barton Springs Segment of the Edwards Aquifer, and recharge throughout most of the aquifer converges to this discharge point (Slade *et al.* 1986, p. 28; Johnson *et al.* 2012, p. 2). Most of the water recharging the Barton Springs Segment of the Edwards Aquifer was believed to be derived from percolation through six creeks that cross the recharge zone (Slade *et al.* 1986, pp. 43, 51), but more recent work shows that a significant amount of recharge occurs in the upland areas (Hauwert 2009, pp. 212–213). Approximately 75 percent of the Barton Springs Segment of the recharge zone has no impervious cover. Overall, the recharge zone of the Barton Springs Segment of the Edwards Aquifer has 6.9 percent impervious cover. The contributing zone of the Barton Springs Segment has 1.81 percent impervious cover overall.

For the Jollyville Plateau salamander, a total of 93 watersheds were delineated, representing 106 surface sites. The watersheds varied greatly in size, ranging from the 3-ac (1-ha) watershed of Cistern (Pipe) Spring to the 49,784-ac (20,147-ha) watershed of Brushy Creek Spring. Impervious cover also varied greatly among watersheds. Twelve watersheds had no impervious cover. Eighty-one of the 93 watersheds had some level of impervious cover, with 31 watersheds categorized as High, 26 as Medium, and 21 as Low. The highest level of impervious cover (48 percent) was found in the watershed of Troll Spring.

Based on our analysis of impervious-cover levels in land draining across the surface into salamander surface habitat (Service 2013, pp. 1–25), the Jollyville Plateau salamander had a high proportion of watersheds (47 of 93 analyzed) with medium and high levels of impervious cover. Conversely, the watersheds encompassing the Austin blind salamander were relatively low in impervious cover. No watersheds for the Austin blind salamander were classified as medium or high (that is, greater than 10 percent impervious cover). In addition, the recharge and contributing zones of the Barton Springs segment of the Edwards Aquifer were classified as low.

Although some watersheds in our analysis were classified as low, it is important to note that low levels of impervious cover (that is, less than 10 percent) may degrade salamander habitat. Recent studies in the eastern United States have reported large declines in aquatic macroinvertebrates (the prey base of salamanders) at impervious cover levels as low as 0.5 percent (King and Baker 2010, p. 1002; King *et al.* 2011, p. 1,664). Several authors have argued negative effects to stream ecosystems are seen at low levels of impervious cover and gradually increase as impervious cover increases (Booth *et al.* 2002, p. 838; Groffman *et al.* 2006, pp. 5–6; Schueler *et al.* 2009, p. 313; Coles *et al.* 2012, pp. 4, 64).

Although general percentages of impervious cover within a watershed are helpful in determining the general level of impervious cover within watersheds, it does not tell the complete story of how urbanization may be affecting salamanders or their habitat. Understanding how a salamander might be affected by water quality degradation within its habitat requires an examination of where the impervious cover occurs and what other threats to water quality (for example, non-point-source runoff, highways and other sources of hazardous materials, livestock and feral hogs, and gravel and limestone mining) are present within the watershed.

In addition, several studies have demonstrated that the spatial arrangement of impervious cover has impacts on aquatic ecosystems. An analysis of 42 watersheds in the State of Washington found that certain urban pattern variables, such as land use intensity, land cover composition, landscape configuration, and connectivity of the impervious area are important in predicting effects to aquatic ecosystems (Alberti *et al.* 2007, pp. 355–359). King *et al.* (2005, pp. 146–147) found that the closer developed land was to a stream in the Chesapeake Bay watershed, the larger the effect it had on stream macroinvertebrates. On a national scale, watersheds with development clustered in one large area (versus being interspersed throughout the watershed), and development located closer to streams had higher frequency of high-flow events (Steuer *et al.* 2010, pp. 47–48, 52). Based on these studies, it is likely that the way development is situated in the landscape of a surface drainage area of a salamander spring site plays a large role in how that development impacts salamander habitat.

One major limitation of this analysis is that we only examined surface drainage areas (watersheds) for each spring site for the Jollyville Plateau salamander. In addition to the surface habitat, this salamander uses the subsurface habitat. Moreover, the base flow of water discharging from the springs on the surface comes from groundwater sources, which are in turn replenished by recharge features on the surface. As Shade *et al.* (2008, pp. 3–4) points out, ''. . . little is known of how water recharges and flows through the subsurface in the Northern Segment of the Edwards Aquifer. Groundwater flow in karst is often not controlled by surface topography and crosses beneath surface water drainage boundaries, so the sources and movements of groundwater to springs and caves inhabited by the Jollyville Plateau salamander are poorly understood. Such information is critical to evaluating the degree to which Jollyville Plateau salamander sites can be protected from urbanization.'' So a recharge area for a spring may occur within the surface watershed, or it could occur many miles away in a completely different watershed. A site completely surrounded by development may still contain unexpectedly high water quality because that spring's base flow is coming from a distant recharge area that is free from impervious cover. While some dye tracer work has been done in the Northern Segment (Shade *et al.* 2008, p. 4), clearly delineated recharge areas that flow to specific springs in the Northern Segment have not been identified for any of these spring sites; therefore, we could not examine impervious-cover levels on recharge areas to better understand how development in those areas may impact salamander habitat.

Impervious cover by itself within the watersheds of the Austin blind and Jollyville Plateau salamanders could cause irreversible declines or extirpation of populations with continuous exposure to water quality degradation stressors over a relatively short timespan. Given the current levels of impervious cover within the surface watersheds for the Jollyville Plateau salamander, we consider this to be a threat of high impact for this species that is expected to increase in the future as development within its range expands. Although the impervious cover level for the Austin blind salamander remains relatively low at the present time, impacts from this threat could increase in the future as urbanization expands.

Hazardous Material Spills

The Edwards Aquifer is at risk from a variety of sources of contaminants and pollutants (Ross 2011, p. 4), including hazardous materials that have the potential to be spilled or leaked, resulting in contamination of both surface and groundwater resources (Service 2005, pp. 1.6–14–1.6–15). For example, a number of point-sources of pollutants exist within the Jollyville Plateau salamander's range. Utility structures such as storage tanks or pipelines (particularly gas and sewer lines) can accidentally discharge. Any activity that involves the extraction, storage, manufacture, or transport of potentially hazardous substances, such as fuels or chemicals, can contaminate water resources and cause harm to aquatic life. Spill events can involve a short release with immediate impacts, such as a collision that involves a tanker truck carrying gasoline. Alternatively, the release can be long term, involving the slow release of chemicals over time, such as a leaking underground storage tank.

A peer reviewer for the proposed rule provided information from the National Response Center's database of incidents of chemical and hazardous materials spills (*http://www.nrc.uscg.mil/foia.html*) from anthropogenic activities including, but not limited to, automobile or freight traffic accidents, intentional dumping, storage tanks, and industrial facilities. The number of incidents is likely to be an underestimate of the total number of incidents because not all incidents are discovered or reported. The database produced 450 records of spill events (145 that directly affected a body of water) in Travis County between 1990 and 2012 and 189 records of spill events (33 that directly affected a body of water) in Williamson County during the same time period. Spills that did not directly affect aquatic environments may have indirectly done so by contaminating soils or lands that drain to water bodies (Gillespie 2012, University of Texas, pers. comm.). The risk of this type of contamination is currently ongoing and expected to increase with increasing activities associated with urbanization in central Texas.

Hazardous material spills pose a significant threat to the Austin blind and Jollyville Plateau salamanders, and impacts from spills could increase substantially under drought conditions due to lower dilution and buffering capability of impacted water bodies. Spills under low flow conditions are predicted to have an impact at much smaller volumes (Turner and O'Donnell 2004, p. 26). For example, it is predicted that at low flows (10 cubic feet per second (cfs)) a spill of 360 gallons (1,362.7 liters) of gasoline 3 mi (4.8 km) from Barton Springs could be catastrophic for the Austin blind salamander population (Turner and O'Donnell 2004, p. 26).

A significant hazardous materials spill within stream drainages of the Austin blind salamander could have the potential to threaten its long-term survival and sustainability of multiple populations or possibly the entire species. Because the Austin blind salamander resides in only one spring system, a catastrophic spill in its surface and subsurface habitat could cause the extinction of this species in the wild. However, because the Jollyville Plateau salamander occurs in 106 surface and 16 cave populations over a broad range, the potential for a catastrophic hazardous materials spill to cause the extinction of this species in the wild is highly unlikely. Even so, a hazardous materials spill has the potential to cause localized Jollyville Plateau salamander populations to be extirpated. In combination with the other threats identified in this final rule, a catastrophic hazardous materials spill could contribute to the Jollyville Plateau salamanders' risk of extinction by reducing its overall probability of persistence. Furthermore, we consider hazardous material spills to be a potential significant threat to the Austin blind salamanders due to their limited distributions, the number of potential sources, and the amount of damage that could be done by a single event.

Underground Storage Tanks

The risk of hazardous material spills from underground storage tanks is widespread in Texas and is expected to increase as urbanization continues to occur. As of 1996, more than 6,000 leaking underground storage tanks in Texas had resulted in contaminated groundwater (Mace *et al.* 1997, p. 2). In 1993, approximately 6,000 gallons (22,712 liters) of gasoline leaked from an underground storage tank located near Krienke Springs in southern Williamson County, Texas, which is known to be occupied by the Jollyville Plateau salamander (Manning 1994, p. 1).

Leaking underground storage tanks have been documented as a problem within the Jollyville Plateau salamander's range (COA 2001, p. 16). The threat of water quality degradation from an underground storage tank could by itself cause irreversible declines or extirpation in local populations or significant declines in habitat quality of the Austin blind and Jollyville Plateau salamanders with only one exposure event. This is considered to be an ongoing threat of high impact to the Jollyville Plateau salamander. Although we are unaware of any information that indicates underground storage tanks have resulted in spills within the vicinity of Austin blind salamander sites, they are likely present within the watersheds that recharge Barton Springs given its urbanized environment. We expect this to become a more significant threat in the future as urbanization continues to expand.

Highways

The transport of hazardous materials is common on many highways, which are major transportation routes (Thompson *et al.* 2011, p. 1). Every year, thousands of tons of hazardous materials are transported over Texas highways (Thompson *et al.* 2011, p. 1). Transporters of hazardous materials (such as gasoline, cyclic hydrocarbons, fuel oils, and pesticides) carry volumes ranging from a few gallons up to 10,000 gallons (37,854 liters) or more of hazardous material (Thompson *et al.* 2011, p. 1). An accident involving hazardous materials can cause the release of a substantial volume of material over a very short period of time. As such, the capability of standard stormwater management structures (or best management practices) to trap and treat such releases might be overwhelmed (Thompson *et al.* 2011, p. 2).

Interstate Highway 35 crosses the watersheds that contribute groundwater to spring sites occupied by the Austin blind and Jollyville Plateau salamanders. A catastrophic spill could occur if a transport truck overturned and its contents entered the recharge zone of the Northern or Barton Springs Segments of the Edwards Aquifer. Transportation accidents involving hazardous materials spills at bridge crossings are of particular concern because recharge areas in creek beds can transport contaminants directly into the aquifer (Service 2005, pp. 1.6–14). The threat of water quality degradation from highways could by itself cause irreversible declines or extirpation in local populations or significant declines in habitat quality of the Austin blind and Jollyville Plateau salamanders with only one exposure event. We consider this to be an ongoing threat to the Austin blind and Jollyville Plateau salamanders.

Energy Pipelines

Energy pipelines are another source of potential hazardous material spills. They carry crude oil and refined products made from crude oil, such as gasoline, home heating oil, diesel fuel, and kerosene. Liquefied ethylene, propane, butane, and some petrochemicals are also transported through energy pipelines (U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration 2013, p. 1). Austin blind salamander habitat is at risk from hazardous material spills that could contaminate groundwater. There is potential for a catastrophic spill in the Barton Springs Segment of the Edwards Aquifer, due to the presence of the Longhorn pipeline (Turner and O'Donnell 2004, pp. 2–3). Although a number of mitigation measures were employed to reduce the risk of a leak or spill from the Longhorn pipeline, such a spill could enter the aquifer and result in the contamination of salamander habitat at Barton Springs (EPA 2000, pp. 9–29–9–30).

A contaminant spill could travel quickly through the aquifer to Barton Springs, where it could impact Austin blind salamander populations. Depending on water levels in the aquifer, groundwater flow rates through the Barton Springs Segment of the Edwards Aquifer can range from 0.6 mi (1 km) per day to over 4 mi (6 km) per day. The relatively rapid movement of groundwater under any flow conditions provides little time for mitigation efforts to reduce potential damage from a hazardous spill anywhere within the Barton Springs Segment of the Edwards Aquifer (Turner and O'Donnell 2004, pp. 11–13).

The threat of water quality degradation from energy pipelines could by itself cause irreversible declines, extirpation, or significant declines in habitat quality of the Austin blind salamander with only one exposure event. Because the Austin blind salamander is found only at one location and can be extirpated by one catastrophic energy pipeline leak, we consider this to be an ongoing threat of high impact that will likely continue in the future. However, we are unaware of any information that indicates energy pipelines are located within the range of the Jollyville Plateau salamander and, therefore, do not consider this to be a threat for this species at this time.

Water and Sewage Lines

Multiple municipality water lines also run through the surrounding areas of Barton Springs. A water line break could potentially flow directly into Barton Springs, exposing salamanders to chlorine concentrations that are potentially toxic (Herrington and Turner 2009, pp. 5, 6). Sewage spills are the most common type of spill within the Barton Springs watershed and represent a potential catastrophic threat (Turner and O'Donnell 2004, p. 27). Sewage spills often include contaminants such as nutrients, polycyclic aromatic hydrocarbons (PAHs), metals, pesticides, pharmaceuticals, and high levels of fecal coliform bacteria. Increased ammonia levels and reduced dissolved oxygen are the most likely impacts of a sewage spill that could cause rapid mortality of large numbers of salamanders (Turner and O'Donnell 2004, p. 27). Fecal coliform bacteria cause diseases in salamanders and their prey base (Turner and O'Donnell 2004, p. 27). Approximately 7,600 wastewater main pipelines totaling 349 mi (561.6 km) are present in the Barton Springs Segment of the Edwards Aquifer (Herrington *et al.* 2010, p. 16). In addition, there are 9,470 known septic facilities in the Barton Springs Segment as of 2010 (Herrington *et al.* 2010, p. 5), up from 4,806 septic systems in 1995 (COA 1995, pp. 3–13). In one COA survey of these septic systems, over 7 percent were identified as failing (no longer functioning properly, causing water from the septic tank to leak) (COA 1995, pp. 3–18).

Sewage spills from pipelines also have been documented in watersheds supporting Jollyville Plateau salamander populations (COA 2001, pp. 16, 21, 74). For example, in 2007, a sewage line overflowed an estimated 50,000 gallons (190,000 liters) of raw sewage into the Stillhouse Hollow drainage area of Bull Creek (COA 2007c, pp. 1–3). Because the location of the spill was a short distance downstream of currently known salamander locations, no salamanders were thought to be affected.

The threat of water quality degradation from water and sewage lines could by itself cause irreversible declines or extirpation in local populations or significant declines in habitat quality of the Austin blind and Jollyville Plateau salamanders with only one exposure event. We consider this to be an ongoing threat of high impact to the Austin blind and Jollyville Plateau salamanders that is likely to increase in the future as urbanization expands within the ranges of these species.

Swimming Pools

If water from swimming pools is drained into waterways or storm drains without dechlorination, impacts to *Eurycea* salamanders could occur (COA 2001, p. 130). This is due to the concentrations of chlorine commonly used in residential swimming pools, which far exceed the lethal concentrations observed in experiments with the San Marcos salamander (*Eurycea nana*) (COA 2001, p. 130). Saltwater pools have also grown in popularity and pose a similar risk to water quality, because saltwater can be harmful to freshwater organisms (Duellman and Trueb 1986, p. 165; Ingersoll *et al.* 1992, pp. 507–508; Bendik 2012, COA, pers. comm.). Residential swimming pools can be found throughout the watersheds of several Jollyville Plateau salamander sites and may pose a risk to the salamanders if discharged into the storm drain system or waterways.

Water quality degradation from swimming pools in combination with other impacts could contribute to significant declines in habitat quality. Although swimming pools occur throughout the range of the Jollyville Plateau salamander, using 2012 Google Earth aerial images we identified only two sites for this species (Krienke Spring and Long Hog Hollow Tributary) with swimming pools located within 50 m (164 ft). We did not identify any other swimming pools within 50 m (164 ft) of any other salamander site. Therefore, we do not consider this to be an ongoing threat to the Austin blind or Jollyville Plateau salamanders at this time.

Construction Activities

Short-term increases in pollutants, particularly sediments, can occur during construction in areas of new development. When vegetation is removed and rain falls on unprotected soils, large discharges of suspended sediments can erode from newly exposed areas resulting in increased sedimentation in downstream drainage channels (Schueler 1987, pp. 1–4; Turner 2003, p. 24; O'Donnell *et al.* 2005, p. 15). This increased sedimentation from construction activities has been linked to declines in Jollyville Plateau salamander counts at multiple sites (Turner 2003, p. 24; O'Donnell *et al.* 2006, p. 34).

Cave sites are also impacted by construction, as Testudo Tube Cave (Jollyville Plateau salamander habitat) showed an increase in nickel, calcium, nitrates, and nitrites after nearby road construction (Richter 2009, pp. 6–7). Barton Springs (Austin blind salamander habitat) is also under the threat of pollutant loading due to its proximity to construction activities and the spring's location at the downstream side of the watershed (COA 1997, p. 237). The COA (1995, pp. 3–11) estimated that construction-related sediment and in-channel erosion accounted for approximately 80 percent of the average annual sediment load in the Barton Springs watershed. In addition, the COA (1995, pp. 3–10) estimated that total suspended sediment loads have increased 270 percent over predevelopment loadings within the Barton Springs Segment of the Edwards Aquifer. Construction is intermittent and temporary, but it affects both surface and subsurface habitats. Therefore, we have determined that this threat is ongoing and will continue to affect the Austin blind and Jollyville Plateau salamanders and their habitats.

Also, the physical construction of pipelines, shafts, wells, and similar structures that penetrate the subsurface has the potential to negatively affect subsurface habitat for salamander species. It is known that these salamanders inhabit the subsurface environment and that water flows through the subsurface to the surface habitat. Tunneling for underground pipelines can destroy potential habitat by removing subsurface material, thereby destroying subsurface spaces/conduits in which salamanders can live, grow, forage, and reproduce. Additional material can become dislodged and result in increased sediment loading into the aquifer and associated spring systems. In addition, disruption of water flow to springs inhabited by salamanders can occur through the construction of tunnels and vertical shafts to access them. Because of the complexity of the aquifer and subsurface structure and because detailed maps of the underground conduits that feed springs in the Edwards Aquifer are not available, tunnels and shafts have the possibility of intercepting and severing those conduits (COA 2010b, p. 28). Affected springs could rapidly become dry and would not support salamander populations. The closer a shaft or tunnel location is to a spring, the more likely that the construction will impact a spring (COA 2010b, p. 28). Even small shafts pose a threat to nearby spring systems. We consider subsurface construction to be a threat to the surface and subsurface habitat of the Austin blind and Jollyville Plateau salamanders.

Examples of recent subsurface construction activities that had the potential to pose a threat to salamander surface and subsurface habitat are the Water Treatment Plant No. 4 pipeline and shaft construction and the Barton Springs Pool bypass tunnel repairs. In 2011, construction began on the Jollyville Transmission Main (JTM), a tunnel designed to transport treated drinking water from Water Treatment Plant No. 4 to the Jollyville Reservoir. The project also includes four working shafts along the tunnel route (COA 2010b, p. 1) that provide access points from the surface down to the tunnel. While this type of project has the potential to impact salamanders and their habitat, the COA took the salamanders into consideration and designed measures to avoid or minimize impacts. Because the tunnel is being constructed below the Edwards Aquifer and below the permeable portion of the Glen Rose formation (COA 2010b, p. 42; Toohey 2011, p. 1; COA 2011c, pp. 36, 46), the threat to the salamander from this particular tunnel is considered low.

Of the four Water Treatment Plant No. 4 shafts, only the one at the Four Points location appeared to be a potential threat to any Jollyville Plateau salamanders. However, construction on this shaft is now completed, and there have been no observed impacts to any springs or other downstream Jollyville Plateau habitat (COA 2012, pers. comm.). Within 1 mi (1.6 km) of the Four Points shaft location are 8 of 92 known Jollyville Plateau salamander sites. The closest locations (Spring 21 and Spring 24) are about 2,000 ft (610 m) or greater from the shaft. Best management practices designed to protect groundwater resources have been implemented into the design and construction of the Jollyville Transmission Main shafts. These practices include, but are not limited to: monitoring groundwater quality and spring flow, minimizing sediment discharges during construction, developing a groundwater impact contingency plan, locating working shafts in areas where the chance of encountering conduits to salamander springs is reduced, relocating the treatment plant from its original location near Jollyville Plateau salamander sites to within an area that has no known Jollyville Plateau salamander sites, dedicating 102 ac (41 ha) that was originally purchased for the Water Treatment Plant No. 4 project as conservation land in perpetuity as part of the Balcones Canyonlands Preserve system, creating contingency plans for unexpectedly high groundwater inflow to the shafts during their construction, and rerouting conduit flow paths around the shaft if encountered (COA 2010b, pp. 51–55).

In 2012, the COA began construction in Barton Springs Pool to repair and stabilize a bypass tunnel that allows both normal flow from Barton Creek and frequent small floods to bypass the swimming area to protect water quality within the pool. This project had the potential to affect both Barton Springs and Austin blind salamanders by directly injuring individuals found within the construction area, drying out areas of habitat during pool drawdowns, and subjecting them to potentially harmful chemicals and sediment (Service 2011, p. 27). However, the COA took the Barton Springs and Austin blind salamanders into careful consideration when planning this project and ultimately implemented a variety of protective measures to minimize threats to these species. Some of these measures included, but are not limited to: (1) Regular monitoring of water depth, water quality and temperature, discharge of the Barton Springs complex, and salamander habitat; (2) limiting drawdown to only 2 ft (0.6 m) under conditions of 40 cfs or greater; (3) daily surveying for salamanders to ensure none were present in an area where construction activities would be conducted; (4) relocating salamanders found during these surveys to undisturbed habitat areas; (5) carefully evaluating the types of materials used during construction and choosing those that were the least toxic to the aquatic ecosystem; and (6) using sediment and pollution control measures, such as silt fences, containment booms, and turbidity curtains (Service 2011, pp. 14–18). Because the COA implemented these protective measures, impacts to the Barton Springs and Austin blind salamanders were minimized.

The threat of water quality degradation from construction activities could by itself cause irreversible declines or extirpation in local populations or significant declines in habitat quality of the Austin blind and Jollyville Plateau salamanders with only one exposure event (if subsurface flows were interrupted or severed) or with repeated exposure over a relatively short timespan. From information available in our files and provided to us during the peer review and public comment period for the proposed rule, we found that all of the Austin blind salamander sites have been known to have had construction on their perimeters. Likewise, we are aware of physical habitat modification from construction activities at one of the known Jollyville Plateau surface sites. Therefore, we consider construction activities to be an ongoing threat of medium impact to the Austin blind salamander and low impact to Jollyville Plateau salamanders given their low exposure risk.

Quarries

Construction activities within rock quarries can permanently alter the geology and groundwater hydrology of the immediate area and adversely affect springs that are hydrologically connected to impacted sites (Ekmekci 1990, p. 4; van Beynan and Townsend 2005, p. 104; Humphreys 2011, p. 295). Limestone rock is an important raw material that is mined in quarries all over the world due to its popularity as a building material and its use in the manufacture of cement (Vermeulen and Whitten 1999, p. 1). The potential environmental impacts of quarries include destruction of springs or collapse of karst caverns, as well as impacts to water quality through siltation and sedimentation, and impacts to water quantity through water diversion, dewatering, and reduced flows (Ekmekci 1990, p. 4; van Beynan and Townsend 2005, p. 104). The mobilization of fine materials from quarries can lead to the occlusion of voids and the smothering of surface habitats for aquatic species downstream (Humphreys 2011, p. 295). Quarry activities can also generate pollution in the aquatic ecosystem through leaks or spills of waste materials from mining operations (such as petroleum products) (Humphreys 2011, p. 295). For example, in 2000, a spill of almost 3,000 gallons (11,356 liters) of diesel from an above-ground storage tank occurred on a limestone quarry in New Braunfels, Texas (about 4.5-mi (7.2 km) from Comal Springs in the Southern Segment of the Edwards Aquifer) (Ross *et al.* 2005, p. 14).

Quarrying of limestone is another activity that has considerable potential to negatively affect the physical environments where salamanders are known to occur. Quarrying and mineral extractions are known to cause the downstream mobilization of sediment (Humphreys 2011, p. 295), which can occlude the interstitial spaces that salamanders use for protective cover. Quarrying can alter landforms, reduce spring discharge, cause drawdown of the water table, produce sinkholes, and destroy caves (van Beynen and Townsend 2005, p. 104). As quarries continue to expand, the risk of impacting salamander habitat increases. One quarry occurs in one of the surface watersheds (Brushy Creek Spring) where Jollyville Plateau salamanders are known to occur. This assessment was based on examining Google Earth 2012 aerial photos of each site from the surface drainage basins (surface watersheds) of each surface site. There may be additional avenues of potential impacts to the springs or cave sites through subsurface drainage basins that were not documented through this analysis.

The threat of physical modification of surface habitat from quarrying by itself could cause irreversible declines in population sizes or habitat quality at any of the Austin blind or Jollyville Plateau salamander sites. It could also work in combination with other threats to contribute to significant declines of salamander populations or habitat quality. Currently quarries are located in the surface watersheds of 1 of the 106 assessed Jollyville Plateau salamander surface sites. Therefore, we consider this an ongoing threat of low impact given the low exposure risk to the Jollyville Plateau salamander that could increase in the future. Physical modification of surface habitat from quarries is not considered an ongoing threat to the Austin blind salamander at this time. The Austin blind salamander's range is located in downtown Austin, and there are no active limestone quarries within the species' range or in its surface watershed.

Contaminants and Pollutants

Contaminants and pollutants are stressors that can affect individual salamanders or their habitats or their prey. These stressors find their way into aquatic habitat through a variety of ways, including stormwater runoff, point (a single identifiable source) and non-point (coming from many diffuse sources) discharges, and hazardous material spills (Coles *et al.* 2012, p. 21). For example, sediments eroded from soil surfaces can concentrate and transport contaminants (Mahler and Lynch 1999, p. 165). The Austin blind and Jollyville Plateau salamanders and their prey species are directly exposed to sediment-borne contaminants present within the aquifer and discharging through the spring outlets. For example, in addition to sediment, trace metals such as arsenic, cadmium, copper, lead, nickel, and zinc were found in Barton Springs in the early 1990s (COA 1997, pp. 229, 231–232). Such contaminants associated with sediments are known to negatively affect survival and growth of an amphipod species, which are part of the prey base of the Austin blind and Jollyville Plateau salamanders (Ingersoll *et al.* 1996, pp. 607–608; Coles *et al.* 2012, p. 50). As a karst aquifer system, the Edwards Aquifer is more vulnerable to the effects of contamination due to: (1) A large number of conduits that offer no filtering capacity, (2) high groundwater flow velocities, and (3) the relatively short amount of time that water is inside the aquifer system (Ford and Williams 1989, pp. 518–519). These characteristics of the aquifer allow contaminants entering the watershed to enter and move through the aquifer more easily, thus reaching salamander habitat within spring sites more quickly than other types of aquifer systems. Various industrial and municipal activities result in the discharge of treated wastewater or unintentional release of industrial contaminants as point source pollution. Urban environments are host to a variety of human activities that generate many types of sources for contaminants and pollutants. These substances, especially when combined, often degrade nearby waterways and aquatic resources within the watershed (Coles *et al.* 2012, pp. 44–53).

Amphibians, especially their eggs and larvae (which are usually restricted to a small area within an aquatic environment), are sensitive to many different aquatic pollutants (Harfenist *et al.* 1989, pp. 4–57). Contaminants found in aquatic environments, even at sublethal concentrations, may interfere with a salamander's ability to develop, grow, or reproduce (Burton and Ingersoll 1994, pp. 120, 125). Central Texas salamanders are particularly vulnerable to contaminants, because they have evolved under very stable environmental conditions, remain aquatic throughout their entire life cycle, have highly permeable skin, have severely restricted ranges, and cannot escape contaminants in their environment (Turner and O'Donnell 2004, p. 5). In addition, macroinvertebrates, such as small freshwater crustaceans (amphipods and copepods), that aquatic salamanders feed on are especially sensitive to water pollution (Phipps *et al.* 1995, p. 282; Miller *et al.* 2007, p. 74; Coles *et al.* 2012, pp. 64–65). Studies in the Bull Creek watershed in Austin, Texas, found a loss of some sensitive macroinvertebrate species, potentially due to contaminants of nutrient enrichment and sediment accumulation (COA 2001, p. 15; COA 2010a, p. 16). Below, we discuss specific contaminants and pollutants that may be impacting the Austin blind and Jollyville Plateau salamanders.

Petroleum Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAHs) are a common form of aquatic contaminants in urbanized areas that could affect salamanders, their habitat, or their prey. This form of pollution can originate from petroleum products, such as oil or grease, or from atmospheric deposition as a byproduct of combustion (for example, vehicular combustion). These pollutants accumulate over time on impervious cover, contaminating water supplies through urban and highway runoff (Van Metre *et al.* 2000, p. 4,067; Albers 2003, pp. 345–346). The main source of PAH loading in Austin-area streams is parking lots with coal tar emulsion sealant, even though this type of lot only covers 1 to 2 percent of the watersheds (Mahler *et al.* 2005, p. 5,565). A recent analysis of the rate of wear on coal tar lots revealed that the sealcoat wears off relatively quickly and contributes more to PAH loading than previously thought (Scoggins *et al.* 2009, p. 4,914).

Petroleum and petroleum byproducts can adversely affect living organisms by causing direct toxic action, altering water chemistry, reducing light, and decreasing food availability (Albers 2003, p. 349). Exposure to PAHs at levels found within the Jollyville Plateau salamander's range can cause impaired reproduction, reduced growth and development, and tumors or cancer in species of amphibians, reptiles, and other organisms (Albers 2003, p. 354). Coal tar pavement sealant slowed hatching, growth, and development of a frog (*Xenopus laevis*) in a laboratory setting (Bryer *et al.* 2006, pp. 244–245). High concentrations of PAHs from coal tar sealant negatively affected the righting ability (amount of time needed to flip over after being placed on back) of adult eastern newts (*Notophthalmus viridescens*) and may have also damaged the newt's liver (Sparling *et al.* 2009, pp. 18–20). For juvenile spotted salamanders (*Ambystoma maculatum*), PAHs reduced growth in the lab (Sparling *et al.* 2009, p. 28). In a lab study using the same coal tar sealant once used by the COA, Bommarito *et al.* (2010, pp. 1,151–1,152) found that spotted salamanders displayed slower growth rates and diminished swimming ability when exposed to PAHs. These contaminants are also known to cause death, reduced survival, altered physiological function, inhibited reproduction, and changes in community composition of freshwater invertebrates (Albers 2003, p. 352). Due to their similar life histories, it is reasonable to assume that effects of PAHs on other species of amphibians, reptiles, and other organisms could also occur in Austin blind and Jollyville Plateau salamanders.

Limited sampling by the COA has detected PAHs at concentrations of concern at multiple sites within the range of the Jollyville Plateau salamander. Most notable were the levels of nine different PAH compounds at the Spicewood Springs site in the Shoal Creek drainage area, which were above concentrations known to adversely affect aquatic organisms (O'Donnell *et al.* 2005, pp. 16–17). The Spicewood Springs site is located within an area with greater than 30 percent impervious cover and down gradient from a commercial business that changes vehicle oil. This is also one of the sites where salamanders have shown declines in abundance (from an average of 12 individuals per visit in 1997 to an average of 2 individuals in 2005) during the COA's long-term monitoring studies (O'Donnell *et al.* 2006, p. 47). Another study found several PAH compounds in seven Austin-area streams, including Barton, Bull, and Walnut Creeks, downstream of coal tar sealant parking lots (Scoggins *et al.* 2007, p. 697). Sites with high concentrations of PAHs (located in Barton and Walnut Creeks) had fewer macroinvertebrate species and lower macroinvertebrate density (Scoggins *et al.* 2007, p. 700). This form of contamination has also been detected at Barton Springs, which is the Austin blind salamander's habitat (COA 1997, p. 10).

The threat of water quality degradation from PAH exposure could by itself cause irreversible declines or extirpation in local populations or significant declines in habitat quality of the Austin blind and Jollyville Plateau salamanders with continuous or repeated exposure. In some instances, exposure to PAH contamination could negatively impact a salamander population in combination with exposure to other sources of water quality degradation, resulting in significant habitat declines or other significant negative impacts (such as loss of invertebrate prey species). We consider this to be a threat of high impact to the Austin blind and Jollyville Plateau salamanders now and in the future as urbanization increases within these species' surface watersheds.

Pesticides

Pesticides (including herbicides and insecticides) are also associated with urban areas. Sources of pesticides include lawns, road rights-of-way, and managed turf areas, such as golf courses, parks, and ballfields. Pesticide application is also common in residential, recreational, and agricultural areas. Pesticides have the potential to leach into groundwater through the soil or be washed into streams by stormwater runoff.

Some of the most widely used pesticides in the United States—atrazine, carbaryl, diazinon, and simazine (Mahler and Van Metre 2000, p. 1)—were documented within the Austin blind salamander's habitat (Barton Springs Pool and Eliza Springs) in water samples taken at Barton Springs during and after a 2-day storm event (Mahler and Van Metre 2000, pp. 1, 6, 8). They were found at levels below criteria set in the aquatic life protection section of the Texas Surface Water Quality Standards (Mahler and Van Metre 2000, p. 4). In addition, elevated concentrations of organochlorine pesticides were found in Barton Springs sediments (Ingersoll *et al.* 2001, p. 7). A later water quality study at Barton Springs from 2003 to 2005 detected several pesticides (atrazine, simazine, prometon, and deethylatrazine) in low concentrations (Mahler *et al.* 2006, p. 63). The presence of these contaminants in Barton Springs indicates the vulnerability of salamander habitat to contamination.

Another study by the USGS detected insecticides (diazinon and malathion) and herbicides (atrazine, prometone, and simazine) in several Austin-area streams, most often at sites with urban and partly urban watersheds (Veenhuis and Slade 1990, pp. 45–47). Twenty-two of the 42 selected synthetic organic compounds analyzed in this study were detected more often and in larger concentrations at sites with more urban watersheds compared to undeveloped watersheds (Veenhuis and Slade 1990, p. 61). Other pesticides (dichlorodiphenyltrichloroethane, chlordane, hexachlorobenzene, and dieldrin) have been detected at multiple Jollyville Plateau salamander sites (COA 2001, p. 130).

While pesticides have been detected at Austin blind salamander and Jollyville Plateau salamander sites, we do not know the extent to which pesticides and other waterborne contaminants have affected salamander survival, development, and reproduction, or their prey. However, pesticides are known to impact amphibian species in a number of ways. For example, Reylea (2009, p. 370) demonstrated that diazinon reduces growth and development in larval amphibians. Another pesticide, carbaryl, causes mortality and deformities in larval streamside salamanders (*Ambystoma barbouri*) (Rohr *et al.* 2003, p. 2,391). The Environmental Protection Agency (EPA) (2007, p. 9) also found that carbaryl is likely to adversely affect the Barton Springs salamander both directly and indirectly through reduction of prey. Additionally, atrazine has been shown to impair sexual development in male amphibians (clawed frogs (*Xenopus laevis*)) at concentrations as low as 0.1 parts per billion (Hayes 2002, p. 5,477). Atrazine levels were found to be greater than 0.44 parts per billion after rainfall in Barton Springs Pool (Mahler and Van Mere 2000, pp. 4, 12).

We acknowledge that in 2007 a Scientific Advisory Panel (SAP) of the Environmental Protection Agency (EPA) reviewed the available information on atrazine effects on amphibians and concluded that atrazine concentrations less than 100 μg/L had no effects on clawed frogs. However, the 2012 SAP is currently reexamining the conclusions of the 2007 SAP using a meta-analysis of published studies along with additional studies on more species (EPA 2012, p. 35). The 2012 SAP expressed concern that some studies were discounted in the 2007 SAP analysis, including studies like Hayes (2002) that indicated that atrazine is linked to endocrine (hormone) disruption in amphibians (EPA 2012, p. 35). In addition, the 2007 SAP noted that their results on clawed frogs are insufficient to make global conclusions about the effects of atrazine on all amphibian species (EPA 2012, p. 33). Accordingly, the 2012 SAP has recommended further testing on at least three amphibian species before a conclusion can be reached that atrazine has no effect on amphibians at concentrations less than 100 μg/L (EPA 2012, p. 33). Due to potential differences in species sensitivity, exposure scenarios that may include dozens of chemical stressors simultaneously, and multigenerational effects that are not fully understood, we continue to view pesticides, including carbaryl, atrazine, and many others to which aquatic organisms may be exposed, as a potential threat to water quality, salamander health, and the health of aquatic organisms that comprise the diet of salamanders.

The threat of water quality degradation from pesticide exposure could by itself cause irreversible declines or extirpation in local populations or significant declines in habitat quality of the Austin blind and Jollyville Plateau salamanders with continuous or repeated exposure. In some instances, exposure to pesticide contamination could negatively impact a salamander population in combination with exposure to other sources of water quality degradation, resulting in significant habitat declines or other significant negative impacts (such as loss of invertebrate prey species). We consider this an ongoing threat of high impact for the Austin blind salamander because this species occurs only in one location. For the Jollyville Plateau salamanders, this is currently a threat of low impact that is likely to increase in the future.

Nutrients

Nutrient input (such as phosphorus and nitrogen) to watershed drainages, which often results in abnormally high organic growth in aquatic ecosystems, can originate from multiple sources, such as human and animal wastes, industrial pollutants, and fertilizers (from lawns, golf courses, or croplands) (Garner and Mahler 2007, p. 29). As the human population grows and subsequent urbanization occurs within the ranges of the Austin blind and Jollyville Plateau salamanders, they likely become more susceptible to the effects of excessive nutrients within their habitats because their exposure increases. To illustrate, an estimated 102,262 domestic dogs and cats (pet waste is a potential source of excessive nutrients) were known to occur within the Barton Springs Segment of the Edwards Aquifer in 2010 (Herrington *et al.* 2010, p. 15). Their distributions were correlated with human population density (Herrington *et al.* 2010, p. 15). Feral hogs have also been cited as a source of elevated bacteria, nitrates, and phosphorus in streams in the Austin area (Timmons *et al.* 2011, pp. 1–2). Finally, livestock grazing near streams can negatively affect stream systems by influencing nutrients, bacteria, and aquatic species diversity (COA 1995, pp. 3–62).

Various residential properties and golf courses are known to use fertilizers to maintain turf grass within watersheds where Jollyville Plateau salamander populations are known to occur (COA 2003, pp. 1–7). Analysis of water quality attributes conducted by the COA (1997, pp. 8–9) showed significant differences in nitrate, ammonia, total dissolved solids, total suspended solids, and turbidity concentrations between watersheds dominated by golf courses, residential land, and rural land. Golf course tributaries were found to have higher concentrations of these constituents than residential tributaries, and both golf course and residential tributaries had substantially higher concentrations for these five water quality attributes than rural tributaries (COA 1997, pp. 8–9).

Residential irrigation of wastewater effluent is another source leading to excessive nutrient input into the recharge and contributing zones of the Barton Springs Segment of the Edwards Aquifer (Ross 2011, pp. 11–18; Mahler *et al.* 2011, pp. 16–23). Wastewater effluent permits do not require treatment to remove metals, pharmaceutical chemicals, or the wide range of chemicals found in body care products, soaps, detergents, pesticides, or other cleaning products (Ross 2011, p. 6). These chemicals remaining in treated wastewater effluent can enter streams and the aquifer and alter water quality within salamander habitat. A USGS study found nitrate concentrations in Barton Springs and the five streams that provide most of its recharge much higher during 2008 to 2010 than before 2008 (Mahler *et al.* 2011, pp. 1–4). Additionally, nitrate levels in water samples collected between 2003 and 2010 from Barton Creek tributaries exceeded TCEQ screening levels and were identified as screening level concerns (TCEQ 2012b, p. 344). The rapid development over the Barton Springs contributing zone since 2000 was associated with an increase in the generation of wastewater (Mahler *et al.* 2011, p. 29). Septic systems and land-applied treated wastewater effluent are likely sources contributing nitrate to the recharging streams (Mahler *et al.* 2011, p. 29). As of November 2010, the permitted volume of irrigated flow in the contributing zone of the Barton Springs Segment of the Edwards Aquifer was 3,300,000 gallons (12,491 kiloliters) per day. About 95 percent of that volume was permitted during 2005 to 2010 (Mahler *et al.* 2011, p. 30).

Excessive nutrient input into aquatic systems can increase plant growth (including algae blooms), which pulls more oxygen out of the water when the dead plant matter decomposes, resulting in less oxygen being available in the water for salamanders to breathe (Schueler 1987, pp. 1.5–1.6; Ross 2011, p. 7). A reduction in dissolved oxygen concentrations could not only affect respiration in salamander species, but also lead to decreased metabolic functioning and growth in juveniles (Woods *et al.* 2010, p. 544), or death (Ross 2011, p. 6). Excessive plant material can also reduce stream velocities and increase sediment deposition (Ross 2011, p. 7). When the interstitial spaces become compacted or filled with fine sediment, the amount of available foraging habitat and protective cover is reduced (Welsh and Ollivier 1998, p. 1,128). Studies in the Bull Creek watershed found a loss of some sensitive macroinvertebrate species, potentially due to nutrient enrichment and sediment accumulation (COA 2001b, p. 15).

Increased nitrate levels have been known to affect amphibians by altering feeding activity and causing disequilibrium and physical abnormalities (Marco *et al.* 1999, p. 2,837). Poor water quality, particularly elevated nitrates, may also be a cause of morphological deformities in individual Jollyville Plateau salamanders. The COA has documented very high levels of nitrates (averaging over 6 milligrams per liter (mg L^{-1}) with some samples exceeding 10 mg L^{-1}) and high conductivity at two monitoring sites in the Stillhouse Hollow drainage area (O'Donnell *et al.* 2006, pp. 26, 37). Additionally, as reported in the 2012 Texas Integrated Report of Surface Water Quality, nitrate levels in water samples collected between 2003 and 2010 from Stillhouse Hollow, Barrow Preserve, and Spicewood stream segments exceeded TCEQ screening levels and were identified as screening level concerns (TCEQ 2012b, p. 38, 41). For comparison, nitrate levels in undeveloped Edwards Aquifer springs (watersheds without high levels of urbanization) are typically close to 1 mg L^{-1} (O'Donnell *et al.* 2006, p. 26). The source of the nitrates in Stillhouse Hollow is thought to be lawn fertilizers (Turner 2005b, p. 11). Salamanders observed at the Stillhouse Hollow monitoring sites have shown high incidences of deformities, such as curved spines, missing eyes, missing limbs or digits, and eye injuries (O'Donnell *et al.* 2006, p. 26). These deformities often result in the salamander's inability to feed, reproduce, or survive. The Stillhouse Hollow location was also cited as having the highest observation of dead salamanders (COA 2001, p. 88). Although no statistical correlations were found between the number of deformities and nitrate concentrations (O'Donnell *et al.* 2006, p. 26), environmental toxins are the suspected cause of salamander deformities (O'Donnell *et al.* 2006, p. 25). Nitrate toxicity studies have indicated that salamanders and other amphibians are sensitive to these pollutants (Marco *et al.* 1999, p. 2,837). Some studies have indicated that concentrations of nitrate between 1.0 and 3.6 mg/L can be toxic to aquatic organisms (Rouse 1999, p. 802; Camargo *et al.* 2005, p. 1,264; Hickey and Martin 2009, pp. ii, 17–18).

The threat of water quality degradation from excessive nutrient exposure could by itself cause irreversible declines or extirpation in local populations or significant declines in habitat quality of the Austin blind and Jollyville Plateau salamanders with continuous or repeated exposure. At least five surface watersheds of the known Jollyville Plateau salamander's surface sites contain golf courses that could be contributing to excessive nutrient loads. In some instances, exposure to excessive nutrient exposure could negatively impact a salamander population in combination with exposure to other sources of water quality degradation, resulting in significant habitat declines or other significant negative impacts (such as loss of morphological deformities). We consider this an ongoing threat of medium impact for the Austin blind salamander and low impact for the Jollyville Plateau salamanders that will likely increase in the future.

Changes in Water Chemistry

Conductivity

Conductivity is a measure of the ability of water to carry an electrical current and can be used to approximate the concentration of dissolved inorganic solids in water that can alter the internal water balance in aquatic organisms, affecting the Austin blind and Jollyville Plateau salamanders' survival. Conductivity levels in the Edwards Aquifer are naturally low, ranging from approximately 550 to 700 micro Siemens per centimeter (μS cm^{-1}) (derived from several conductivity measurements in two references: Turner 2005a, pp. 8–9; O'Donnell *et al.* 2006, p. 29). As ion concentrations such as chlorides, sodium, sulfates, and nitrates rise, conductivity will increase. These compounds are the chemical products, or byproducts, of many common pollutants that originate from urban environments (Menzer and Nelson 1980, p. 633), which are often transported to streams via stormwater runoff from impervious cover. This, combined with the stability of the measured ions, makes conductivity an excellent monitoring tool for assessing the impacts of urbanization to overall water quality. Measurements by the COA between 1997 and 2006 found that conductivity averaged between 550 and 650 μS cm^{-1} at rural springs with low or no development and averaged between 900 and 1000 μS cm^{-1} at monitoring sites in watersheds with urban development (O'Donnell *et al.* 2006, p. 37).

Conductivity can be influenced by weather. Rainfall serves to dilute ions and lower conductivity while drought has the opposite effect. The trends of increasing conductivity in urban watersheds were evident under baseflow conditions and during a period when precipitation was above average in all but 3 years, so drought was not a factor (NOAA 2013, pp. 1–7). The COA also monitored water quality as impervious cover increased in several subdivisions with known Jollyville Plateau salamander sites between 1996 and 2007. They found increasing ions (calcium, magnesium, and bicarbonate) and nitrates with increasing impervious cover at four Jollyville Plateau salamander sites and as a general trend during the course of the study from 1997 to 2006 (Herrington *et al.* 2007, pp. 13–14). These results indicate that developed watersheds can alter the water chemistry within salamander habitats.

High conductivity has been associated with declining salamander abundance. For example, three of the four sites with statistically significant declining Jollyville Plateau salamander counts from 1997 to 2006 are cited as having high conductivity readings (O'Donnell *et al.* 2006, p. 37). Similar correlations were shown in studies comparing developed and undeveloped sites from 1996 to 1998 (Bowles *et al.* 2006, pp. 117–118). This analysis found significantly lower numbers of salamanders and significantly higher measures of specific conductance at developed sites as compared to undeveloped sites (Bowles *et al.* 2006, pp. 117–118). Tributary 5 of Bull Creek has had an increase in conductivity, chloride, and sodium and a decrease in invertebrate diversity from 1996 to 2008 (COA 2010a, p. 16). Only one Jollyville Plateau salamander has been observed here from 2009 to 2010 in quarterly surveys (Bendik 2011a, p. 16). A separate analysis found that ions such as chloride and sulfate increased in Barton Creek despite the enactment of city-wide water quality control ordinances (Turner 2007, p. 7). Poor water quality, as measured by high specific conductance and elevated levels of ion concentrations, is cited as one of the likely factors leading to statistically significant declines in salamander counts at the COA's long-term monitoring sites (O'Donnell *et al.* 2006, p. 46).

The threat of water quality degradation from high conductivity could by itself cause irreversible declines or extirpation in local populations or significant declines in habitat quality of the Austin blind and Jollyville Plateau salamanders with continuous or repeated exposure. In some instances, exposure to high conductivity could negatively impact a salamander population in combination with exposure to other sources of water quality degradation, resulting in significant habitat declines. We consider this an ongoing threat of high impact for the Jollyville Plateau salamander that is likely to increase in the future. Although we are unaware of any information that indicates increased conductivity is occurring within the ranges of the Austin blind salamander, we expect this to become a significant threat in the future for this species as urbanization continues to expand within its surface watersheds.

Salinity

As groundwater levels decline, a decrease in hydrostatic pressure occurs and saline water is able to move into groundwater flow paths of the aquifer (Pavlicek *et al.* 1987, p. 2). Water quality in the Barton Springs Segment of the Edwards Aquifer has been degraded in the past due to saline water encroachment (Slade *et al.* 1986, p. 62). This water quality degradation occurred when Barton Springs discharge was less than 30 cfs (Slade *et al.* 1986, p. 64). An analysis of more recent data found similar declines in water quality as the flow of Barton Springs dropped into the 20 to 30 cfs range (Johns 2006, pp. 6–7). As mentioned earlier, reduced groundwater levels would also increase the concentration of pollutants in the aquifer. Flows at Barton Springs dropped below 17 cfs as recently as mid-November 2011 (Barton Springs/Edwards Aquifer Conservation District 2011, p. 1), and no Austin blind salamanders were observed during surveys at any of their three known locations during this time.

This saline water encroachment is detrimental to the freshwater biota in the springs and the aquifer, including the Austin blind and Jollyville Plateau salamanders and their prey. Most amphibian larvae cannot survive saline conditions (Duellman and Trueb 1986, p. 165). Ingersoll *et al.* (1992, pp. 507–508) found that increased salinity caused mortality in amphipods and some freshwater fish species. Saline conditions in the Edwards Aquifer could, therefore, pose a risk to the salamanders and their prey species.

The threat of water quality degradation from saline water encroachments could by itself cause irreversible declines or extirpation in local populations or significant declines in habitat quality of the Austin blind and Jollyville Plateau salamanders with continuous or repeated exposure. In some instances, exposure to saline conditions could negatively impact a salamander population in combination with exposure to other sources of water quality degradation, resulting in significant habitat declines or another significant negative impact (such as loss of prey species). We consider this an ongoing threat of high impact for the Austin blind salamander that will continue in the future. At this time, we are unaware of any information that indicates low saline water encroachment is occurring within the range of the Jollyville Plateau salamander.

Dissolved Oxygen

In an analysis performed by the COA (Turner 2005a, p. 6), significant changes over time were reported for several chemical constituents and physical parameters in Barton Springs Pool, which could be attributed to impacts from watershed urbanization. Conductivity, turbidity, sulfates, and total organic carbon increased over a 20- to 25-year time period while the concentration of dissolved oxygen decreased (Turner 2005a, pp. 8–17). A similar analysis by Herrington and Hiers (2010, p. 2) examined water quality at Barton Springs Pool and other Barton Springs outlets where Austin blind salamanders are found (Sunken Gardens and Eliza Springs) over a general period of the mid-1990s to the summer of 2009. Herrington and Hiers (2010, pp. 41–42) found that dissolved oxygen decreased over time in the Barton Springs Pool, while conductivity and nitrogen increased. However, this decline in water quality was not seen in Sunken Gardens Spring or Eliza Spring (Herrington 2010, p. 42).

Low dissolved oxygen can affect salamanders and other amphibians by reducing respiratory efficiency, metabolic energy, reproductive rate, and ultimately survival (Norris *et al.* 1963, p. 532; Hillman and Withers 1979, p. 2,104; Boutilier *et al.* 1992, pp. 81–82). The screening level for dissolved oxygen (5.0 mg/L) that is used by TCEQ for their analysis of water quality samples is similar to that recommended by the Service in 2006 to be protective of federally listed salamanders (White *et al.* 2006, p. 51). In 2012, the TCEQ reported that stream segments located within watersheds occupied by the Austin blind (Barton Spring pool) and Jollyville Plateau (Bull Creek) salamanders had depressed dissolved oxygen levels that were not meeting screening level criteria (TCEQ 2012b, pp. 35–36; 2012c, p. 733).

The threat of water quality degradation from low dissolved oxygen could by itself cause irreversible declines or extirpation in local populations or significant declines in habitat quality of the Austin blind and Jollyville Plateau salamanders with continuous or repeated exposure. In some instances, exposure to low dissolved oxygen could negatively impact a salamander population in combination with exposure to other sources of water quality degradation, resulting in significant habitat declines. We consider this an ongoing threat of high impact for the Austin blind salamander due to their limited range. However, we consider this to be a threat of low impact to the Jollyville Plateau salamanders given the low risk of exposure.

Water Quantity Degradation

Water quantity decreases and spring flow declines are considered threats to *Eurycea* salamanders (Corn *et al.* 2003, p. 36; Bowles *et al.* 2006, p. 111), because drying spring habitats can cause salamanders to be stranded, resulting in death of individuals (O'Donnell *et al.* 2006, p. 16). It is also known that prey availability for carnivores is low underground due to the lack of primary production (Hobbs and Culver 2009, p.

392). Therefore, relying entirely on subsurface habitat during dry conditions on the surface may negatively impact the salamanders' feeding abilities and slow individual and population growth, which can exacerbate the risk of extirpation in the face of other threats occurring at the site.

Urbanization

Increased urbanization in the watershed has been cited as one factor, particularly in combination with drought that causes declines in spring flows (COA 2006, pp. 46–47; TPWD 2011, pp. 4–5). This is partly due to reductions in baseflow due to impervious cover. Urbanization removes the ability of a watershed to allow slow filtration of water through soils following rain events. Instead rainfall runs off impervious surfaces and into stream channels at higher rates, increasing downstream ''flash'' flows and decreasing groundwater recharge and subsequent baseflows from springs (Miller *et al.* 2007, p. 74; Coles *et al.* 2012, pp. 2, 19). Urbanization can also impact water quantity by increasing groundwater pumping and altering the natural flow regime of streams. These stressors are discussed in more detail below.

Urbanization can also result in increased groundwater pumping, which has a direct impact on spring flows, particularly under drought conditions. Groundwater availability models demonstrate that 1 cfs of pumping will diminish Barton Springs flow by 1 cfs under drought-of-record (1950s drought) conditions (Smith and Hunt 2004, pp. 24, 36). Under the same conditions, these models suggest that present-day pumping rates will temporarily cease Barton Springs flow for at least a 4-month period under a repeat of drought-of-record conditions (Smith and Hunt 2004, pp. 24, 36).

From 1980 to 2000, groundwater pumping in the Northern Segment of the Edwards Aquifer nearly doubled (TWDB 2003, pp. 32–33). Total water use for Williamson County where the Jollyville Plateau salamander occurs was 82,382 acre feet (ac ft) in 2010, and is projected to increase to 109,368 ac ft by 2020, and to 234,936 ac ft by 2060, representing a 185 percent increase over the 50-year period (TWDB 2011, p. 78). Similarly, a 91 percent increase in total groundwater use over the same 50-year period is expected in Travis County (TWDB 2011, pp. 5, 72).

While the demand for water is expected to increase with human population growth, one prediction of future groundwater use in this area suggests a large drop in pumping as municipalities convert from groundwater to surface water supplies (TWDB 2003, p. 65). To meet the increasing water demand, the 2012 State Water Plan recommends more reliance on surface water, including existing and new reservoirs, rather than groundwater (TWDB 2012, p. 190). For example, one recommended project conveys water from Lake Travis to Williamson County (TWDB 2012, pp. 192–193). Another recommendation would augment the surface water of Lake Granger in Williamson County with groundwater from Burleson County and the Carrizo-Wilcox Aquifer (TWDB 2012, pp. 164, 192–193). However, it is unknown if this reduction in groundwater use will occur, and if it does, how that will affect spring flows for salamanders.

The COA found a negative correlation between urbanization and spring flows at Jollyville Plateau salamander sites (Turner 2003, p. 11). Field studies have also shown that a number of springs that support Jollyville Plateau salamanders have already gone dry periodically and that spring waters resurface following rain events (O'Donnell *et al.* 2006, pp. 46–47). Through a site-by-site assessment from information available in our files and provided during the peer review and public comment period for the proposed rule, we found that 51 out of the 106 Jollyville Plateau salamander surface sites have gone dry for some period of time. Because we lack flow data for some of the spring sites, it is possible that even more sites have gone dry for a period of time as well.

Flow is a major determining factor of physical habitat in streams, which in turn, is a major determining factor of aquatic species composition within streams (Bunn and Arthington 2002, p. 492). Various land-use practices, such as urbanization, conversion of forested or prairie habitat to agricultural lands, excessive wetland draining, and overgrazing can reduce water retention within watersheds by routing rainfall quickly downstream, increasing the size and frequency of flood events and reducing baseflow levels during dry periods (Poff *et al.* 1997, pp. 772–773). Over time, these practices can degrade in-channel habitat for aquatic species (Poff *et al.* 1997, p. 773).

Baseflow is defined as that portion of streamflow that originates from shallow, subsurface groundwater sources, which provide flow to streams in periods of little rainfall (Poff *et al.* 1997, p. 771). The land-use practices mentioned above can cause streamflow to shift from predominately baseflow, which is derived from natural filtration processes, to predominately stormwater runoff. With increasing stormwater runoff, the amount of baseflow available to sustain water supplies during drought cycles is diminished and the frequency and severity of flooding increases (Poff *et al.* 1997, p. 773). The increased quantity and velocity of runoff increases erosion and streambank destabilization, which in turn, leads to increased sediment loadings, channel widening, and detrimental changes in the morphology and aquatic ecology of the affected stream system (Hammer 1972, pp. 1,535–1,536, 1,540; Booth 1990, pp. 407–409, 412–414; Booth and Reinelt 1993, pp. 548–550; Schueler 1994, pp. 106–108; Pizzuto *et al.* 2000, p. 82; Center for Watershed Protection 2003, pp. 41–48; Coles *et al.* 2012, pp. 37–38).

Changes in flow regime can have a direct impact on salamander populations. For example, Barrett *et al.* (2010, pp. 2,002–2,003) observed that the density of aquatic southern two-lined salamanders (*Eurycea cirrigera*) declined more drastically in streams with urbanized watersheds compared to streams with forested or pastured watersheds. A statistical analysis indicated that this decline in urban streams was due to an increase in flooding frequency from stormwater runoff. Barrett *et al.* (2010, p. 2,003) also used artificial stream experiments to demonstrate that salamander larvae were flushed from sand-based sediments at significantly lower velocities, as compared to gravel, pebble, or cobble-based sediments. Sand-based substrates are common to urban streams due to high sedimentation rates (see ''Sedimentation'' section above). The combined effects of increased sand-based substrates due to high sedimentation rates and increased flow velocities from impervious cover result in effectively flushing salamander larvae from their habitat.

The Service has determined that impervious cover due to urbanization in the salamanders' watersheds causes streamflow to shift from predominately baseflow to predominately stormwater runoff. For example, an examination of 24 stream sites in the Austin area revealed that increasing impervious cover in the watersheds resulted in decreased base flow, increased high-flow events of shorter duration, and more rapid rises and falls of the stream flow (Glick *et al.* 2009, p. 9). Increases in impervious cover within the Walnut Creek watershed (Jollyville Plateau salamander habitat) have likely caused a shift to more rapid rises and falls of that stream flow (Herrington 2010, p. 11).

The threat of water quantity degradation from urbanization could by itself cause irreversible declines in population sizes or habitat quality for the Austin blind and Jollyville Plateau salamanders. Also, it could by itself cause irreversible declines or the extirpation of a salamander population at a site with continuous exposure. We consider this to be an ongoing threat of high impact for the Austin blind and Jollyville Plateau salamanders that is likely to increase in the future.

Drought

Drought conditions cause lowered groundwater tables and reduced spring flows. The Northern Segment of the Edwards Aquifer, which supplies water to the Jollyville Plateau salamander's habitat, is vulnerable to drought (Chippindale *et al.* 2000, p. 36). In particular, the portion of the Edwards Aquifer underlying the Jollyville Plateau is relatively shallow with a high elevation, thus being unlikely to sustain spring flows during periods of drought (Cole 1995, pp. 26–27). Drought has been cited as causing declines in spring flows within Jollyville Plateau and Austin blind salamander habitat (O'Donnell *et al.* 2006, pp. 46–47; Bendik 2011a, p. 31; Hunt *et al.* 2012, pp. 190, 195). A drought lasting from 2008 to 2009 was considered one of the worst droughts in central Texas history and caused numerous Jollyville Plateau salamander sites to go dry (Bendik 2011a, p. 31). An even more pronounced drought throughout Texas began in 2010, with the period from October 2010 through September 2011 being the driest 12-month period in Texas since rainfall records began (Hunt *et al.* 2012, p. 195). Rainfall in early 2012 lessened the intensity of drought conditions, but 2012 monthly summer temperatures continued to be higher than average (NOAA 2013, p. 6). Moderate to extreme drought conditions have continued into 2013 in the central Texas region (LCRA 2013, p. 1). Weather forecasts call for near to slightly less than normal rainfall across Texas through August, but not enough rain to break the drought is expected (LCRA 2013, p. 1).

Low flow conditions during drought also have negative impacts to the Austin blind salamander and its ecosystem in the Edwards Aquifer and at Barton Springs. The long-term average flow at the Barton Springs outlets is approximately 53 cfs (1.5 cubic meters per second) (COA 1998, p. 13; Smith and Hunt 2004, p. 10; Hunt *et al.* 2012, p. 194). The lowest flow recorded at Barton Springs was about 10 cfs (0.2 cubic meters per second) during a record, multiyear drought in the 1950s (COA 1998, p. 13). During the 2011 drought, 10-day average flows at Barton Springs reached 20 cfs (0.5 cubic meters per second) (Hunt *et al.* 2012, pp. 190, 195). Discharge at Barton Springs decreases as water levels in the Barton Springs Segment of the Edwards Aquifer drop. Decreased discharge is associated with increases in water temperature, decreases in spring flow velocity, and increases in sedimentation (COA 2011d, pp. 19, 24, 27).

The specific effects of low flow on central Texas salamanders can be inferred by examining studies on the Barton Springs salamander. Drought decreases spring flow and dissolved oxygen levels and increases temperature in Barton Springs (Turner 2004, p. 2; Turner 2009, p. 14). Low dissolved oxygen levels decrease reproduction in Barton Springs salamanders (Turner 2004, p. 6; 2009, p. 14). Turner (2009, p. 14) also found that Barton Springs salamander counts decline with decreasing discharge. The number of Barton Springs salamanders observed during surveys decreased during a prolonged drought from June 2008 through September 2009 (COA 2011d, pp. 19, 24, 27). The drought in 2011 also resulted in dissolved oxygen concentrations so low that COA used an aeration system to maintain oxygenated water in Eliza and Sunken Gardens Springs (Dries 2011, COA, pers. comm.). Drought also lowered water quality in Barton Springs due to saline water encroachments in the Barton Springs Segment of the Edwards Aquifer (Slade *et al.* 1986, p. 62; Johns 2006, p. 8).

The Austin blind and Jollyville Plateau salamanders may be able to persist through temporary surface habitat degradation because of their ability to retreat to subsurface habitat. Drought conditions are common to the region, and the ability to retreat underground may be an evolutionary adaptation to such natural conditions (Bendik 2011a, pp. 31–32). However, it is important to note that, although salamanders may survive a drought by retreating underground, this does not necessarily mean they are resilient to long-term drought conditions (particularly because sites may already be affected by other, significant stressors, such as water quality declines).

Drought may also affect surface habitats that are important for prey availability as well as individual and population growth. Therefore, sites with suitable surface flow and adequate prey availability are likely able to support larger population densities (Bendik 2012, COA, pers. comm.). Prey availability for carnivores, such as these salamanders, is low underground due to the lack of sunlight and primary production (Hobbs and Culver 2009, p. 392). Complete loss of surface habitat may lead to the extirpation of predominately subterranean populations that depend on surface flows for biomass input (Bendik 2012, COA, pers. comm.). In addition, length measurements taken during a COA mark-recapture study at Lanier Spring demonstrated that individual Jollyville Plateau salamanders exhibited negative growth (shrinkage) during a 10-month period of retreating to the subsurface from 2008 to 2009 (Bendik 2011b, COA, pers. comm.; Bendik and Gluesenkamp 2012, pp. 3–4). The authors of this study hypothesized that the negative growth could be the result of soft tissue contraction and/or bone loss, but more research is needed to determine the physical mechanism with which the shrinkage occurs (Bendik and Gluesenkamp 2012, p. 5). Although this shrinkage in body length was followed by positive growth when normal spring flow returned, the long-term consequences of catch-up growth are unknown for these salamanders (Bendik and Gluesenkamp 2012, pp. 4–5). Therefore, threats to surface habitat at a given site may not extirpate populations of these salamander species in the short term, but this type of habitat degradation may severely limit population growth and increase a population's overall risk of extirpation from other stressors occurring in the surface watershed.

The threat of water quantity degradation from drought by itself could cause irreversible declines in population sizes or habitat quality for the Austin blind and Jollyville Plateau salamanders. Also, it could negatively impact salamander populations in combination with other threats and contribute to significant declines in the size of the populations or habitat quality. For example, changes in water quantity will have direct impacts on the quality of that water, in terms of concentrations of contaminants and pollutants. Therefore, we consider this to be a threat of high impact for the Austin blind and Jollyville Plateau salamanders now and in the future.

Climate Change

The effects of climate change could potentially lead to detrimental impacts on aquifer-dependent species, especially coupled with other threats on water quality and quantity. Recharge, pumping, natural discharge, and saline intrusion of groundwater systems could all be affected by climate change (Mace and Wade 2008, p. 657). According to the Intergovernmental Panel on Climate Change (IPCC 2007, p. 1), ''warming of the climate system is unequivocal, as is now evident from observations of increases in global averages of air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.'' Localized projections suggest the southwestern United States may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007, p. 8), with warming increases in southwestern States greatest in the summer. The IPCC also predicts hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007, p. 8). Evidence of climate change has been observed in Texas, such as the record-setting drought of 2011, with extreme droughts becoming much more probable than they were 40 to 50 years ago (Rupp *et al.* 2012, pp. 1053–1054).

Climate change could compound the threat of decreased water quantity at salamander spring sites. An increased risk of drought could occur if evaporation exceeds precipitation levels in a particular region due to increased greenhouse gases in the atmosphere (CH2M HILL 2007, p. 18). The Edwards Aquifer is also predicted to experience additional stress from climate change that could lead to decreased recharge (Loáiciga *et al.* 2000, pp. 192–193). CH2M HILL (2007, pp. 22–23) identified possible effects of climate change on water resources within the Lower Colorado River Watershed (which contributes recharge to Barton Springs). A reduction of recharge to aquifers and a greater likelihood for more extreme droughts, such as the droughts of 2008 to 2009 and 2011 mentioned above, were identified as potential impacts to water resources (CH2M HILL 2007, p. 23).

Furthermore, climate change could affect rainfall and ambient temperatures, which are factors that may limit salamander populations. Different ambient temperatures in the season that rainfall occurs can influence spring water temperature if aquifers have fast transmission of rainfall to springs (Martin and Dean 1999, p. 238). Gillespie (2011, p. 24) found that reproductive success and juvenile survivorship in the Barton Springs salamander, which occurs at the three spring sites where the Austin blind salamander is known to occur, may be significantly influenced by fluctuations in mean monthly water temperature. This study also found that groundwater temperature is influenced by the season in which rainfall events occur over the recharge zone of the aquifer. When recharging rainfall events occur in winter when ambient temperature is low, mean monthly water temperature at Barton Springs and Eliza Spring can drop as low as 65.5 °F (18.6 °C) and remain below the annual average temperature of 70.1 °F (21.2 °C) for several months (Gillespie 2011, p. 24).

The threat of water quantity degradation from climate change could negatively impact a population of any of the Austin blind and Jollyville Plateau salamanders in combination with other threats and contribute to significant declines in population sizes or habitat quality. We consider this to be a threat of moderate impact for the Austin blind and Jollyville Plateau salamanders now and in the future.

Physical Modification of Surface Habitat

The Austin blind and Jollyville Plateau salamanders are sensitive to direct physical modification of surface habitat from sedimentation, impoundments, flooding, feral hogs, livestock, and human activities. Direct mortality to salamanders can also occur as a result of these threats, such as being crushed by feral hogs, livestock, or humans.

Sedimentation

Elevated mobilization of sediment (mixture of silt, sand, clay, and organic debris) is a stressor that occurs as a result of increased velocity of water running off impervious surfaces (Schram 1995, p. 88; Arnold and Gibbons 1996, pp. 244–245). Increased rates of stormwater runoff also cause increased erosion through scouring in headwater areas and sediment deposition in downstream channels (Booth 1991, pp. 93, 102–105; Schram 1995, p. 88). Waterways are adversely affected in urban areas, where impervious cover levels are high, by sediment loads that are washed into streams or aquifers during storm events. Sediments are either deposited into layers or become suspended in the water column (Ford and Williams 1989, p. 537; Mahler and Lynch 1999, p. 177). Sediment derived from soil erosion has been cited as the greatest single source of pollution of surface waters by volume (Menzer and Nelson 1980, p. 632).

Excessive sediment from stormwater runoff is a threat to the physical habitat of salamanders because it can cover substrates (Geismar 2005, p. 2). Sediments suspended in water can clog gill structures in aquatic animals, which can impair breathing and reduce their ability to avoid predators or locate food sources due to decreased visibility (Schueler 1987, p. 1.5). Excessive deposition of sediment in streams can physically reduce the amount of available habitat and protective cover for aquatic organisms, by filling the interstitial spaces of gravel and rocks where they could otherwise hide. As an example, a California study found that densities of two salamander species were significantly lower in streams that experienced a large infusion of sediment from road construction after a storm event (Welsh and Ollivier 1998, pp. 1,118–1,132). The vulnerability of the salamander species in this California study was attributed to their reliance on interstitial spaces in the streambed habitats (Welsh and Ollivier 1998, p. 1,128).

Excessive sedimentation has contributed to declines in Jollyville Plateau salamander populations in the past. Monitoring by the COA found that, as sediment deposition increased at several sites, salamander abundances significantly decreased (COA 2001, pp. 101, 126). Additionally, the COA found that sediment deposition rates have increased significantly along one of the long-term monitoring sites (Bull Creek Tributary 5) as a result of construction activities upstream (O'Donnell *et al.* 2006, p. 34). This site has had significant declines in salamander abundance, based on 10 years of monitoring, and the COA attributes this decline to the increases in sedimentation (O'Donnell *et al.* 2006, pp. 34–35). The location of this monitoring site is within a large preserved tract. However, the headwaters of this drainage are outside the preserve and the development in this area increased sedimentation downstream and impacted salamander habitat within the preserved tract.

Effects of sedimentation on the Austin blind salamander is expected to be similar to the effects on the Jollyville Plateau salamander based on similarities in their ecology and life history needs. Analogies can also be drawn from data on the Barton Springs salamander. Barton Spring salamander population numbers are adversely affected by high turbidity and sedimentation (COA 1997, p. 13). Sediments discharge through Barton Springs, even during baseflow conditions (not related to a storm event) (Geismar 2005, p. 12). Storms can increase sedimentation rates substantially (Geismar 2005, p. 12). Areas in the immediate vicinity of the spring outflows lack sediment, but the remaining bedrock is sometimes covered with a layer of sediment several inches thick (Geismar 2005, p. 5). Sedimentation is a direct threat for the Austin blind salamander because its surface habitat in Barton Springs would fill with sediment if it were not for regular maintenance and removal (Geismar 2005, p. 12). Further development in the Barton Creek watershed, which contributes recharge to Barton Springs, will most likely be associated with diminished water clarity and a reduction in biodiversity of flora (COA 1997, p. 7). Additional threats from sediments as a source of contaminants were discussed in the ''Contaminants and Pollutants'' under the ''Water Quality Degradation'' section above.

The threat of physical modification of surface habitat from sedimentation by itself could cause irreversible declines in population sizes or habitat quality for any of the Austin blind and Jollyville Plateau salamanders' populations. It could also negatively impact the species in combination with other threats to contribute to significant declines. We consider this to be an ongoing threat of high impact for the Austin blind and Jollyville Plateau salamanders that is likely to increase in the future.

Impoundments

Impoundments can alter the salamanders' physical habitat in a variety of ways that are detrimental. They can alter the natural flow regime of streams, increase siltation, and support larger, predatory fish (Bendik 2011b, COA, pers. comm.), leading to a variety of impacts to the salamanders and their surface habitats. For example, a low-water crossing on a tributary of Bull Creek occupied by the Jollyville Plateau salamander resulted in sediment buildup above the impoundment and a scour hole below the impoundment that supported predaceous fish (Bendik 2011b, COA, pers. comm.). As a result, Jollyville Plateau salamanders were not found in this degraded habitat after the impoundment was constructed. When the crossing was removed in October 2008, the sediment buildup was removed, the scour hole was filled, and salamanders were later observed (Bendik 2011b, COA, pers. comm.). Many low-water crossings are present near other Jollyville Plateau salamander sites (Bendik 2011b, COA, pers. comm.).

All spring sites for the Austin blind salamander (Main, Eliza, and Sunken Garden Springs) have been impounded for recreational use. These sites were impounded in the early to mid-1900s. For example, a circular, stone amphitheater was built around Eliza Springs in the early 1900s. A concrete bottom was installed over the natural substrate at this site in the 1960s. It now discharges from 7 openings (each 1 ft (0.3 m) in diameter) in the concrete floor and 13 rectangular vents along the edges of the concrete, which were created by the COA to help restore flow. While the manmade structures help retain water in the spring pools during low flows, they have altered the salamander's natural environment. The impoundments have changed the Barton Springs ecosystem from a stream-like system to a more lentic (still water) environment, thereby reducing the water system's ability to flush sediments downstream and out of salamander habitat. Although a natural surface flow connection between Sunken Gardens Spring and Barton Creek has been restored recently (COA 2007a, p. 6), the Barton Springs system as a whole remains highly modified.

The threat of physical modification of surface habitat from impoundments by itself may not be likely to cause significant population declines, but it could negatively impact the species in combination with other threats and contribute to significant declines in the population size or habitat quality. We consider impoundments to be an ongoing threat of moderate impact to the Austin blind and Jollyville Plateau salamanders and their surface habitats that will likely continue in the future.

Flooding

Flooding as a result of rainfall events can considerably alter the substrate and hydrology of salamander habitat. Extreme flood events have occurred in the Austin blind and Jollyville Plateau salamander's surface habitats (Pierce 2011a, p. 10; TPWD 2011, p. 6; Turner 2009, p. 11; O'Donnell *et al.* 2005, p. 15). The increased flow rate from flooding causes unusually high dissolved oxygen concentrations, which may exert direct or indirect, sublethal effects (reduced reproduction or foraging success) on salamanders (Turner 2009, p. 11). Salamanders also may be flushed from the surface habitat by strong flows during flooding. Bowles *et al.* (2006, p. 117) observed no Jollyville Plateau salamanders in riffle habitat at one site during high water velocities and hypothesized that individual salamanders were either flushed downstream or retreated to the subsurface.

An increase in the frequency of flood events causes streambank and streambed erosion (Coles *et al.* 2012, p. 19), which can deposit sediment into salamander habitat. For example, Geismar (2005, p. 2) found that flooding increases contaminants and sediments in Barton Springs. In 2007, flooding resulted in repeated accumulation of sediment in the Barton Springs Pool that was so rapid that cleaning by COA staff was not frequent enough to keep the surface habitat from becoming embedded (COA 2007a, p. 4).

Flooding can alter the surface salamander habitat by deepening stream channels, which may increase habitat for predaceous fish. Much of the Austin blind and Jollyville Plateau salamanders' surface habitat is characterized by shallow water depth (COA 2001, p. 128; Pierce 2011a, p. 3), with the exception of the Austin blind salamander at Main and Sunken Garden Springs. However, deep pools are sometimes formed within stream channels from the scouring of floods. Tumlison *et al.* (1990, p. 172) found that the abundance of one *Eurycea* species decreased as water depth increased. This relationship may be caused by an increase in predation pressure, as deeper water supports predaceous fish populations. However, several central Texas *Eurycea* species are able to survive in deep water environments in the presence of many predators. For example, San Marcos salamander in Spring Lake, *Eurycea* sp. in Landa Lake, and Barton Springs salamander in Barton Springs Pool. All of these sites have vegetative cover, which may allow salamanders to avoid predation. Anti-predator behaviors may allow these species to co-exist with predaceous fish, but the effectiveness of these behaviors may be species-specific (reviewed in Pierce and Wall 2011, pp. 18–19) and many of the shallow, surface habitats of the Jollyville Plateau salamander do not have much vegetative cover.

The threat of physical modification of surface habitat from flooding by itself may not be likely to cause significant population declines, but it could negatively impact the species in combination with other threats and contribute to significant declines in the population size or habitat quality. We consider this to be a threat of moderate impact to the Austin blind and Jollyville Plateau salamanders that may increase in the future as urbanization and impervious cover increases within the surface watersheds of these species, causing more frequent and more intense streamflow flash flooding (see discussion in the ''Urbanization'' section under ''Water Quality Degradation'' above).

Feral Hogs

There are between 1.8 and 3.4 million feral hogs (*Sus scrofa*) in Texas (Texas A&M University (TAMU) 2011, p. 2), which is another source of physical habitat disturbance to salamander surface sites. They prefer to live around moist areas, including riparian areas near streams, where they can dig into the soft ground for food and wallow in mud to keep cool (Mapson 2004, pp. 11, 14–15). Feral hogs disrupt these ecosystems by decreasing plant species diversity, increasing invasive species abundance, increasing soil nitrogen, and exposing bare ground (TAMU 2012, p. 4). Feral hogs negatively impact surface salamander habitat by digging and wallowing in spring heads, which increases sedimentation downstream (O'Donnell *et al.* 2006, pp. 34, 46). This activity can also result in direct mortality of amphibians (Bull 2009, p. 243).

Feral hogs have become abundant in some areas where the Jollyville Plateau salamander occurs. O'Donnell *et al.* (2006, p. 34) noted that feral hog activity was increasing in the Bull and Cypress Creeks watersheds. Fortunately, feral hogs cannot access Austin blind salamander sites due to fencing and their location in downtown Austin.

The threat of physical modification of surface habitat from feral hogs by itself may not be likely to cause significant population declines, but it could negatively impact the species in combination with other threats and contribute to significant declines in the population size or habitat quality. We consider this to be an ongoing threat of moderate impact to the Jollyville Plateau salamander that will likely continue in the future. We do not consider physical habitat modification from feral hogs to be a threat to the Austin blind salamander at this time or in the future.

Livestock

Similar to feral hogs, livestock can negatively impact surface salamander habitat by disturbing the substrate and increasing sedimentation in the spring run where salamanders are often found. Poorly managed livestock grazing results in changes in vegetation (from grass-dominated to brush-dominated), which leads to increased erosion of the soil profile along stream banks (COA 1995, pp. 3–59) and sediment in salamander habitat. However, the Austin blind salamander's habitat is inside a COA park, and livestock are not allowed in the spring areas. Also, much of the Jollyville Plateau salamander habitat is in suburban areas, and we are not aware of livestock access to or damage in those areas. Therefore, we do not consider physical habitat modification from livestock to be a threat to the Austin blind or Jollyville Plateau salamanders at this time or in the future.

Other Human Activities

Some sites of the Austin blind and Jollyville Plateau salamanders have been directly modified by human-related activities. Frequent human visitation of sites occupied by the Austin blind and Jollyville Plateau salamanders may negatively affect the species and their habitat. Documentation from the COA of disturbed vegetation, vandalism, and the destruction of travertine deposits (fragile rock formations formed by deposit of calcium carbonate on stream bottoms) by foot traffic has been documented at one of their Jollyville Plateau salamander monitoring sites in the Bull Creek watershed (COA 2001, p. 21) and may have resulted in direct destruction of small amounts of the salamander's habitat. Other Jollyville Plateau salamander sites have also been impacted. Both Stillhouse Hollow Spring and Balcones District Park regularly receive visitors that modify the available cover habitat (by removing or arranging substrates). Balcones District Park is also regularly disturbed by off-leash dog traffic (Bendik 2012, COA, pers. comm.). Eliza Spring and Sunken Garden Spring, two of the three locations of the Austin blind salamander, also experience vandalism, despite the presence of fencing and signage (Dries 2011, COA, pers. comm.). The deep water of the third location (Parthenia Springs) likely protects the Austin blind salamander's surface habitat from damage from frequent human recreation. All of these activities can reduce the amount of cover available for salamander breeding, feeding, and sheltering.

The threat of physical modification of surface habitat from human visitation, recreation, and alteration by itself may not be likely to cause significant population declines, but it could negatively impact the species in combination with other threats and contribute to significant declines in the population size or habitat quality. We consider this to be an ongoing threat of moderate impact to the Austin blind and Jollyville Plateau salamanders that will likely continue in the future.

Conservation Efforts To Reduce Habitat Destruction, Modification, or Curtailment of Its Range

When considering the listing determination of species, it is important to consider conservation efforts that have been made to reduce or remove threats, such as the threats to the Austin blind and Jollyville Plateau Texas salamanders' habitat. A number of efforts have aimed at minimizing the habitat destruction, modification, or curtailment of the salamanders' ranges.

In a separate undertaking, and with the help of a grant funded through section 6 of the Act, the WCCF developed the Williamson County Regional HCP to obtain a section 10(a)(1)(B) permit for incidental take of federally listed endangered species in Williamson County, Texas. This HCP became final in October 2008. Although Jollyville Plateau salamanders present in southern Williamson County are likely influenced by the Edwards Aquifer Recharge Zone in northern Williamson County, the Williamson County Regional HCP does not include considerations for this species. However, in 2012, the WCCF began contracting to gather information on the Jollyville Plateau salamander in Williamson County.

Travis County and COA also have a regional HCP (the Balcones Canyonlands Conservation Plan) and section 10(a)(1)(B) permit that covers incidental take of federally listed species in Travis County. While the Jollyville Plateau salamander is not a covered species under that permit, the Balcones Canyonlands Preserve system offers some benefits to the Jollyville Plateau salamander in portions of the Bull Creek, Brushy Creek, Cypress Creek, and Long Hollow Creek drainages through preservation of open space (Service 1996, pp. 2–28, 2–29). Sixty-seven of 106 surface sites for the Jollyville Plateau salamander are within Balcones Canyonlands Preserves. However, eight of the nine COA monitoring sites occupied by the Jollyville Plateau salamander within the Balcones Canyonlands Preserve have experienced water quality degradation from disturbances occurring upstream and outside of the preserved tracts (O'Donnell *et al.* 2006, pp. 29, 34, 37, 49; COA 1999, pp. 6–11; Travis County 2007, p. 4).

Additionally, the Buttercup Creek HCP was established to avoid, minimize, and mitigate for the potential negative effects of construction and operation of single and multifamily residences and a school near and adjacent to currently occupied habitat of the endangered Tooth Cave ground beetle (*Rhadine persephone*) and other rare cave and karst species, including the Jollyville Plateau salamander, and to contribute to conservation of the listed and non-listed cave or karst fauna. The Buttercup HCP authorizes incidental take of endangered karst invertebrates, if encountered during construction. Under the Buttercup HCP, mitigation for take of the karst invertebrates was implemented by setting aside 12 separate cave preserves (130 ac (53 ha), 37 caves) and two greenbelt flood plains (33 ac (13 ha)) for a total of 163 ac (66 ha), which remain in a natural undisturbed condition and are preserved in perpetuity for the benefit of the listed and non-listed species. There are 21 occupied endangered karst invertebrate caves and 10 Jollyville Plateau salamander caves in the preserves. The shape and size of each preserve was designed to include surface drainage basins for all caves, the subsurface extent of all caves, and connectivity between nearby caves and features. Additionally, for those more sensitive cave preserves, particularly with regard to recharge, 7 of the 12 preserves are to be fenced off to restrict access for only maintenance, monitoring, and research. All preserves are regularly monitored, fences and gates are checked and repaired, and red imported fire ants (*Solenopsis invicta*) controlled. Surface water drainage from streets and parking areas will be diverted by permanent diversion structures to treatment systems and detention ponds or will discharge down-gradient of the cave preserves. An additional 3 to 4 in (76 to 102 mm) of topsoil are added in yards and landscaped areas for additional filtration and absorption of fertilizers, pesticides, and other common constituents, and an education and outreach program informs homeowners about the proper use of fertilizers and pesticides, the benefits of native landscaping, and the disposal of household hazardous waste.

In addition, several individual 10(a)(1)(B) permit holders in Travis County have established preserves and included provisions that are expected to benefit the Jollyville Plateau salamander. Twelve of the 16 known caves for the Jollyville Plateau salamander are located within preserves. Similar to the Williamson County Regional HCP and Balcones Canyonlands Conservation Plan, there is potential for adverse effects to salamander sites from land use activities outside the covered areas under the HCPs.

Furthermore, the COA is implementing the Barton Springs Pool HCP to avoid, minimize, and mitigate incidental take of the Barton Springs salamander resulting from the continued operation and maintenance of Barton Springs Pool and adjacent springs (COA 1998, pp. 1–53). Many of the provisions of the plan also benefit the Austin blind salamander. These provisions include: (1) Training lifeguard and maintenance staff to protect salamander habitat, (2) controlling erosion and preventing surface runoff from entering the springs, (3) ecological enhancement and restoration, (4) monthly monitoring of salamander numbers, (5) public outreach and education, and (6) establishment and maintenance of a captive-breeding program, which includes the Austin blind salamander. As part of this HCP, the COA completed habitat restoration of Eliza Spring and the main pool of Barton Springs in 2003 and 2004. A more natural flow regime was reconstructed in these habitats by removing large obstructions to flow. This HCP has recently been proposed for revision to include coverage for the Austin blind salamander and to extend the COA's permit for another 20 years (78 FR 23780, April 22, 2013).

Although these conservation efforts likely contribute water quality benefits to surface flow, surface habitats can be influenced by land use throughout the recharge zone of the aquifer that supplies its spring flow. Furthermore, the surface areas influencing subsurface water quality (that is draining the surface and flowing to the subsurface habitat) is not clearly delineated for many of the sites (springs or caves) for the Austin blind or Jollyville Plateau salamanders. Because we are not able to precisely assess additional pathways for negative impacts to these salamanders to occur, many of their sites may be affected by threats that cannot be mitigated through the conservation efforts that are currently ongoing.

Conclusion of Factor A

Degradation of habitat, in the form of reduced water quality and quantity and disturbance of spring sites (physical modification of surface habitat), is the primary threat to the Austin blind and Jollyville Plateau salamanders. This threat may affect only the surface habitat, only the subsurface habitat, or both habitat types. In consideration of the stressors currently impacting the salamander species and their habitats along with their risk of exposure to potential sources of this threat, we have found the threat of habitat destruction and modification within the ranges of the Austin blind and Jollyville Plateau salamanders to have severe impacts on these species, and we expect this threat to continue into the future.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

There is little available information regarding overutilization of the Austin blind and Jollyville Plateau salamanders for commercial, recreational, scientific, or educational purposes, although we are aware that some individuals of these species have been collected from their natural habitat for a variety of purposes. Collecting individuals from populations that are already small enough to experience reduced reproduction and survival due to inbreeding depression or become extirpated due to environmental or demographic stochasticity and other catastrophic events (see the discussion on small population sizes under *Factor E—Other Natural or Manmade Factors Affecting Its Continued Existence* below) can pose a risk to the continued existence of these populations. Additionally, there are no regulations currently in place to prevent or restrict the collections of salamanders from their habitat in the wild for scientific or other purposes, and we know of no plans within the scientific community to limit the amount or frequency of collections at known salamander locations. We recognize the importance of collecting for scientific purposes, such as for research, captive assurance programs, taxonomic analyses, and museum collections. However, removing individuals from small, localized populations in the wild, without any proposed plans or regulations to restrict these activities, could increase the population's vulnerability and decrease its resiliency and ability to withstand stochastic events.

Currently, we do not consider overutilization from collecting salamanders in the wild to be a threat by itself, but it may contribute to significant population declines, and could negatively impact the species in combination with other threats.

C. Disease or Predation

Chytridiomycosis (chytrid fungus) is a fungal disease that is responsible for killing amphibians worldwide (Daszak *et al.* 2000, p. 445). The chytrid fungus has been documented on the feet of Jollyville Plateau salamanders from 15 different sites in the wild (O'Donnell *et al.* 2006, pp. 22–23; Gaertner *et al.* 2009, pp. 22–23) and on Austin blind salamanders in captivity (Chamberlain 2011, COA, pers. comm.). However, the salamanders are not displaying any noticeable health effects (O'Donnell *et al.* 2006, p. 23). We do not consider chytridiomycosis to be a threat to the Austin blind and Jollyville Plateau salamanders at this time. We have no data to indicate that impacts from this disease may increase or decrease in the future.

A condition affecting Barton Springs salamanders may also affect the Austin blind salamander. In 2002, 19 Barton Springs salamanders, which co-occur with the Austin blind salamander, were found at Barton Springs with bubbles of gas occurring throughout their bodies (Chamberlain and O'Donnell 2003, p.

17). Three similarly affected Barton Springs salamanders also were found in 2003 (Chamberlain and O'Donnell 2003, pp. 17–18). Of the 19 salamanders affected in 2002, 12 were found dead or died shortly after they were found. Both adult and juvenile Barton Springs salamanders have been affected (Chamberlain and O'Donnell 2003, pp. 10, 17).

The incidence of gas bubbles in salamanders at Barton Springs is consistent with a disorder known as gas bubble disease, or gas bubble trauma, as described by Weitkamp and Katz (1980, pp. 664–671). In animals with gas bubble trauma, bubbles below the surface of the body and inside the cardiovascular system produce lesions and dead tissue that can lead to secondary infections (Weitkamp and Katz 1980, p. 670). Death from gas bubble trauma is apparently related to an accumulation of internal bubbles in the cardiovascular system (Weitkamp and Katz 1980, p. 668). Pathology reports on affected animals at Barton Springs found that the symptoms were consistent with gas bubble trauma (Chamberlain and O'Donnell 2003, pp. 17–18). The cause of gas bubble trauma is unknown, but its incidence has been correlated with water temperature. Gas bubble trauma has been observed in wild Barton Springs salamanders only on rare occasions (Chamberlain, unpublished data) and has been observed in Austin blind salamanders in captivity only when exposed to water temperatures approaching 80 °F (26.7 °C) (Chamberlain 2011, COA, pers. comm.). Given these limited observations, we do not consider gas bubble trauma to be a threat to the Austin blind salamander now or in the future.

To our knowledge, gas bubble trauma has not been observed in Jollyville Plateau salamanders. However, if an increase in water temperature is a causative factor, this species may also be at risk during droughts or other environmental stressors that result in increases in water temperature.

Regarding predation, COA biologists found Jollyville Plateau salamander abundances were negatively correlated with the abundance of predatory centrarchid fish (carnivorous freshwater fish belonging to the sunfish family), such as black bass (*Micropterus* spp.) and sunfish (*Lepomis* spp.) (COA 2001, p. 102). Predation of a Jollyville Plateau salamander by a centrarchid fish was observed during a May 2006 field survey (O'Donnell *et al.* 2006, p. 38). However, Bowles *et al.* (2006, pp. 117–118) rarely observed these predators in Jollyville Plateau salamander habitat. Centrarchid fish are currently present in two of three Austin blind salamander sites (Gillespie 2011, p. 87). Crayfish (another predator) occur in much of the habitat occupied by Jollyville Plateau salamanders. Both the Austin blind and Jollyville Plateau salamanders have been observed retreating into gravel substrate after cover was moved, suggesting these salamanders display antipredation behavior (Bowles *et al.* 2006, p. 117). Another study found that San Marcos salamanders (*Eurycea nana*) have the ability to recognize and show antipredator response to the chemical cues of introduced and native centrarchid fish predators (Epp and Gabor 2008, p. 612). However, we do not have enough data to indicate whether predation is a significant limiting factor for the Austin blind and Jollyville Plateau salamanders.

In summary, while disease and predation may be affecting individuals of these salamander species, these are not significant factors affecting the species' continued existence in healthy, natural ecosystems. Neither disease nor predation is occurring at a level that we consider to be a threat to the continued existence of the Austin blind and Jollyville Plateau salamanders now or in the future.

D. The Inadequacy of Existing Regulatory Mechanisms

The primary threats to the Austin blind and Jollyville Plateau salamanders are habitat degradation related to a reduction of water quality and quantity and disturbance at spring sites (see discussion under Factor A above). Therefore, regulatory mechanisms that protect water from the Trinity and Edwards Aquifers are crucial to the future survival of these species. Federal, State, and local laws and regulations have been insufficient to prevent past and ongoing impacts to the Austin blind and Jollyville Plateau salamanders and their habitats from water quality degradation, reduction in water quantity, and surface disturbance of spring sites, and are unlikely to prevent further impacts to the species in the future.

State and Federal Regulations

Laws and regulations pertaining to endangered or threatened animal species in the State of Texas are contained in Chapters 67 and 68 of the Texas Parks and Wildlife Department (TPWD) Code and Sections 65.171–65.176 of Title 31 of the Texas Administrative Code (T.A.C.). TPWD regulations prohibit the taking, possession, transportation, or sale of any of the animal species designated by State law as endangered or threatened without the issuance of a permit. The Austin blind and Jollyville Plateau salamanders are not listed on the Texas State List of Endangered or Threatened Species (TPWD 2013, p. 3). Even if they were, State threatened and endangered species laws do not contain protective provisions for habitat. At this time, these species are receiving no direct protection from State of Texas regulations.

Under authority of the T.A.C. (Title 30, Chapter 213), the TCEQ regulates activities having the potential for polluting the Edwards Aquifer and hydrologically connected surface streams through the Edwards Aquifer Protection Program or ''Edwards Rules.'' The Edwards Rules require a number of water quality protection measures for new development occurring in the recharge, transition, and contributing zones of the Edwards Aquifer. The Edwards Rules were enacted to protect existing and potential uses of groundwater and maintain Texas Surface Water Quality Standards. Specifically, a water pollution abatement plan (WPAP) must be submitted to the TCEQ in order to conduct any construction-related or post-construction activities on the recharge zone. The WPAP must include a description of the site and location maps, a geologic assessment conducted by a geologist, and a technical report describing, among other things, temporary and permanent best management practices (BMPs).

However, the permanent BMPs and measures identified in the WPAP are designed, constructed, operated, and maintained to remove 80 percent of the incremental increase in annual mass loading of total suspended solids from the site caused by the regulated activity. This necessarily results in some level of water quality degradation since up to 20 percent of total suspended solids are ultimately discharged from the site into receiving waterways. Separate Edwards Aquifer protection plans are required for organized sewage collection systems, underground storage tank facilities, and aboveground storage tank facilities. Regulated activities exempt from the requirements of the Edwards Rules are: (1) The installation of natural gas lines; (2) the installation of telephone lines; (3) the installation of electric lines; (4) the installation of water lines; and (5) the installation of other utility lines that are not designed to carry and will not carry pollutants, storm water runoff, sewage effluent, or treated effluent from a wastewater treatment facility.

Temporary erosion and sedimentation controls are required to be installed and maintained for any exempted activities located on the recharge zone. Individual land owners who seek to construct single-family residences on sites are exempt from the Edwards Aquifer protection plan application requirements provided the plans do not exceed 20 percent impervious cover. Similarly, the Executive Director of the TCEQ may waive the requirements for permanent BMPs for multifamily residential subdivisions, schools, or small businesses when 20 percent or less impervious cover is used at the site.

The best available science indicates that measurable degradation of stream habitat and loss of biotic integrity occurs at levels of impervious cover within a watershed much less than this (see Factor A discussion above). The single known location of the Austin blind salamander and half of the known Jollyville Plateau salamander locations occur within those portions of the Edwards Aquifer regulated by the TCEQ. The TCEQ regulations do not address land use, impervious cover limitations, some nonpoint-source pollution, or application of fertilizers and pesticides over the recharge zone (30 TAC 213.3). In addition, these regulations were not intended or designed specifically to be protective of the salamanders. We are unaware of any water quality ordinances more restrictive than the TCEQ's Edwards Rules in Travis or Williamson Counties outside the COA.

Texas has an extensive program for the management and protection of water that operates under State statutes and the Federal Clean Water Act (CWA). It includes regulatory programs such as the following: Texas Pollutant Discharge Elimination System, Texas Surface Water Quality Standards, and Total Maximum Daily Load Program (under Section 303(d) of the CWA).

In 1998, the State of Texas assumed the authority from the Environmental Protection Agency (EPA) to administer the National Pollutant Discharge Elimination System. As a result, the TCEQ's TPDES program has regulatory authority over discharges of pollutants to Texas surface water, with the exception of discharges associated with oil, gas, and geothermal exploration and development activities, which are regulated by the Railroad Commission of Texas. In addition, stormwater discharges as a result of agricultural activities are not subject to TPDES permitting requirements. The TCEQ issues two general permits that authorize the discharge of stormwater and non-stormwater to surface waters in the State associated with: (1) small municipal separate storm sewer systems (MS4) (TPDES General Permit #TXR040000) and (2) construction sites (TPDES General Permit #TXR150000). The MS4 permit covers small municipal separate storm sewer systems that were fully or partially located within an urbanized area, as determined by the 2000 Decennial Census by the U.S. Census Bureau, and the construction general permit covers discharges of storm water runoff from small and large construction activities impacting greater than 1 acre of land. In addition, both of these permits require new discharges to meet the requirements of the Edwards Rules.

To be covered under the MS4 general permit, a municipality must submit a Notice of Intent (NOI) and a copy of their Storm Water Management Program (SWMP) to TCEQ. The SWMP must include a description of how that municipality is implementing the seven minimum control measures, which include the following: (1) Public education and outreach; (2) public involvement and participation; (3) detection and elimination of illicit discharges; (4) construction site stormwater runoff control (when greater than 1 ac (0.4 ha) is disturbed); (5) post-construction stormwater management; (6) pollution prevention and good housekeeping for municipal operations; and (7) authorization for municipal construction activities (optional). Municipalities located within the range of the Austin blind and Jollyville Plateau salamanders that are covered under the MS4 general permit include the Cities of Cedar Park, Round Rock, Austin, Leander, and Pflugerville, as well as Travis and Williamson Counties.

To be covered under the construction general permit, an applicant must prepare a stormwater pollution and prevention plan (SWP3) that describes the implementation of practices that will be used to minimize, to the extent practicable, the discharge of pollutants in stormwater associated with construction activity and non-stormwater discharges. For activities that disturb greater than 5 ac (2 ha), the applicant must submit an NOI to TCEQ as part of the approval process. As stated above, the two general permits issued by the TCEQ do not address discharge of pollutants to surface waters from oil, gas, and geothermal exploration and geothermal development activities, stormwater discharges associated with agricultural activities, and from activities disturbing less than 5 acres (2 ha) of land. Despite the significant value the TPDES program has in regulating point-source pollution discharged to surface waters in Texas, it does not adequately address all sources of water quality degradation, including nonpoint-source pollution and the exceptions mentioned above, that have the potential to negatively impact the Austin blind and Jollyville Plateau salamanders.

In reviewing the 2010 and 2012 Texas Water Quality Integrated Reports prepared by the TCEQ, the Service identified 14 of 28 (50 percent) stream segments located within surface watersheds occupied by the Austin blind and Jollyville Plateau salamanders where parameters within water samples exceeded screening level criteria (TCEQ 2010a, pp. 546–624; TCEQ 2010b, pp. 34–68; TCEQ 2012b, pp. 35–70; TCEQ 2012c, pp. 646–736). Four of these 28 (14 percent) stream segments have been identified as impaired waters as required under sections 303(d) and 304(a) of the Clean Water Act ''. . .for which effluent limitations are not stringent enough to implement water quality standards'' (TCEQ 2010c, pp. 77, 82–83; TCEQ 2012d, pp. 67, 73). The analysis of surface water quality monitoring data collected by TCEQ indicated ''screening level concerns'' for nitrate, dissolved oxygen, impaired benthic communities, sediment toxicity, and bacteria. The TCEQ screening level for nitrate (1.95 mg/L) is within the range of concentrations (1.0 to 3.6 mg/L) above which the scientific literature indicates may be toxic to aquatic organisms (Camargo *et al.* 2005, p. 1,264; Hickey and Martin 2009, pp. ii, 17–18; Rouse 1999, p. 802). In addition, the TCEQ screening level for dissolved oxygen (5.0 mg/L) is similar to that recommended by the Service in 2006 to be protective of federally listed salamanders (White *et al.* 2006, p. 51). Therefore, water quality data collected and summarized by the TCEQ supports our concerns with the adequacy of existing regulations to protect the Austin blind and Jollyville Plateau salamanders from the effects of water quality degradation.

To discharge effluent onto the land, the TCEQ requires wastewater treatment systems within the Barton Springs Segment of the Edwards Aquifer recharge and contributing zones to obtain Texas Land Application Permits (TLAP) (Ross 2011, p. 7). Although these permits are designed to protect the surface waters and underground aquifer, studies have demonstrated reduced water quality downstream of TLAP sites (Mahler *et al.* 2011, pp. 34–35; Ross 2011, pp. 11–18). Ross (2011, pp. 18–21) attributes this to the TCEQ's failure to conduct regular soil monitoring for nutrient accumulation on TLAP sites and the failure to conduct in-depth reviews of TLAP applications. A study by the U.S. Geological Survey concluded that baseline water quality in the Barton Springs Segment of the Edwards Aquifer, which is occupied by the Austin blind salamander, in terms of nitrate had shifted upward between 2001 and 2010 and was at least partially the result of an increase in the land application of treated wastewater (Mahler *et al.* 2011, pp. 34–35).

Local Ordinances and Regulations

The COA's water quality ordinances (COA Code, Title 25, Chapter 8) provide some water quality regulatory protection to the Austin blind and Jollyville Plateau salamander's habitat within Travis County. Some of the protections include buffers around critical environmental features and waterways (up to 400 ft (122 m)), permanent water quality control structures (sedimentation and filtration ponds), wastewater system restrictions, and impervious cover limitations (COA Code, title 25, Chapter 8; Turner 2007, pp. 1–2). The ordinances range from relatively strict controls in its Drinking Water Protection Zones to lesser controls in its Desired Development Zones. For example, a 15 percent impervious cover limit is in place for new developments within portions of the Barton Springs Zone, one of the Drinking Water Protection Zones, while up to 90 percent impervious cover is permitted within the Suburban City Limits Zone, one of the Desired Development Zones.

In the period after the COA passed water quality ordinances in 1986 and 1991, sedimentation and nutrients decreased in the five major Austin-area creeks (Turner 2007, p. 7). Peak storm flows were also lower after the enactment of the ordinances, which may explain the decrease in sedimentation (Turner 2007, p. 10). Likewise, a separate study on the water quality of Walnut Creek (Jollyville Plateau salamander habitat) from 1996 to 2008 found that water quality has either remained the same or improved (Scoggins 2010, p. 15). These trends in water quality occurred despite a drastic increase in construction and impervious cover during the same time period (Turner 2007, pp. 7–8; Scoggins 2010, p. 4), indicating that the ordinances are effective at mitigating some of the impacts of development on water quality. Another study in the Austin area compared 18 sites with stormwater controls (retention ponds) in their watersheds to 20 sites without stormwater controls (Maxted and Scoggins 2004, p. 8). In sites with more than 40 percent impervious cover, more contaminant-sensitive macroinvertebrate species were found at sites with stormwater controls than at sites without controls (Maxted and Scoggins 2004, p. 11).

Local ordinances have not been completely effective at protecting water quality to the extent that sedimentation, contaminants, pollution, and changes in water chemistry no longer impact salamander habitat (see ''Stressors and Sources of Water Quality Degradation'' discussion under Factor A above). A study conducted by the COA of four Jollyville Plateau salamander spring sites within two subdivisions found that stricter water quality controls (wet ponds instead of standard sedimentation/filtration ponds) did not necessarily translate into improved groundwater quality (Herrington *et al.* 2007, pp. 13–14). In addition, water quality data analyzed by the COA showed significant increases in conductivity, nitrate, and sodium between 1997 and 2005 at two Jollyville Plateau salamander long-term monitoring sites, which also had significant declines in salamander counts (O'Donnell *et al.* 2006, p. 12).

In addition, Title 7, Chapter 245 of the Texas Local Government Code permits ''grandfathering'' of certain local regulations. Grandfathering allows developments to be exempted from new requirements for water quality controls and impervious cover limits if the developments were planned prior to the implementation of such regulations. However, these developments are still obligated to comply with regulations that were applicable at the time when project applications for development were first filed (Title 7, Chapter 245 of the Texas Local Government Code, p. 1).

On January 1, 2006, the COA banned the use of coal tar sealant (Scoggins *et al.* 2009, p. 4909), which has been shown to be the main source of PAHs in Austin-area streams (Mahler *et al.* 2005, p. 5,565). However, historically applied coal tar sealant lasts for several years and can remain a source of PAHs to aquatic systems (DeMott *et al.* 2010, p. 372). A study that examined PAH concentrations in Austin streams before the ban and 2 years after the ban found no difference, indicating that either more time is needed to see the impact of the coal tar ban, or that other sources (for example, airborne and automotive) are contributing more to PAH loadings (DeMott *et al.* 2010, pp. 375–377). Furthermore, coal tar sealant is still legal outside of the COA's jurisdiction and may be contributing PAH loads to northern portions of the Jollyville Plateau salamander's habitat.

The LCRA Highland Lakes Watershed Ordinance applies to lands located within the Lake Travis watershed in northwestern Travis County, as well as portions of Burnet and Llano Counties. This ordinance was implemented by LCRA beginning in 2006 to protect water quality in the Highland Lakes region. There are 14 Jollyville Plateau salamander sites located within the northwestern portion of Travis County covered by this ordinance. Development in this area is required to protect water quality by: (1) Providing water quality volume based on the 1-year storm runoff in approved best management practices (BMPs) (practices that effectively manage stormwater runoff quality and volume), (2) providing buffer zones around creeks that remain free of most construction activities, (3) installing temporary erosion and sediment control, (4) conducting water quality education, and (5) requiring water quality performance monitoring of certain BMPs. However, as with TPDES permitting discussed above, agricultural activities are exempt from the water quality requirements contained in the Highland Lakes Watershed Ordinance (LCRA 2005, pp. 8–21).

The Cities of Cedar Park and Round Rock, and Travis and Williamson Counties have some jurisdiction within watersheds occupied by either the Austin blind or Jollyville Plateau salamanders. The Service has reviewed ordinances administered by each of these municipalities to determine if they contain measures protective of salamanders above and beyond those already required through other regulatory mechanisms (Clean Water Act, T.A.C., etc.). Each of the cities has implemented their own ordinances that contain requirements for erosion control and the management of the volume of stormwater discharged from developments within their jurisdictions. However, as discussed above under Factor A, measurable degradation of stream habitat and loss of biotic integrity can occur at low levels of impervious cover within a watershed, and there are no impervious cover limit restrictions in Travis or Williamson Counties or for development within the municipalities of Cedar Park and Round Rock where the Jollyville Plateau salamander occurs.

Groundwater Conservation Districts

The Barton Springs/Edwards Aquifer Conservation District permits and regulates most wells on the Barton Springs segment of the Edwards Aquifer, subject to the limits of the State of Texas law. They have established two desired future conditions for the Freshwater Edwards Aquifer within the Northern Subdivision of Groundwater

Management Area 10: (1) An extreme drought desired future condition of 6.5 cubic feet per second (cfs) (0.18 cubic meter per second (cms)) measured at Barton Springs, and (2) an ''all-conditions'' desired future condition of 49.7 cfs (1.41 cms) measured at Barton Springs. These desired future conditions are meant to assure an adequate supply of freshwater for well users and adequate flow for endangered species. There are no groundwater conservation districts in northern Travis or southern Williamson Counties, so groundwater pumping continues to be unregulated in these areas (TPWD 2011, p. 7).

Conclusion of Factor D

Surface water quality data collected by TCEQ and COA indicates that water quality degradation is occurring within many of the surface watersheds occupied by the Austin blind and Jollyville Plateau salamanders despite the existence of numerous State and local regulatory mechanisms to manage stormwater and protect water quality (Turner 2005a, pp. 8–17, O'Donnell *et al.* 2006, p. 29, TCEQ 2010a, pp. 546–624; TCEQ 2010b, pp. 34–68; TCEQ 2010c, pp. 77, 82–83; TCEQ 2012b, pp. 35–70; TCEQ 2012c, pp. 646–736; TCEQ 2012d, pp. 67, 73). No regulatory mechanisms are in place to manage groundwater withdrawals in northern Travis or southern Williamson Counties. Human population growth and urbanization in Travis and Williamson Counties are projected to continue into the future as well as the associated impacts to water quality and quantity (see Factor A discussion above). Therefore, we conclude that the existing regulatory mechanisms are not providing adequate protection for the Austin blind and Jollyville Plateau salamanders or their habitats either now or in the future.

E. Other Natural or Manmade Factors Affecting Their Continued Existence

Small Population Size and Stochastic Events

The Austin blind and Jollyville Plateau salamanders may be more susceptible to threats and impacts from stochastic events because of their small population sizes (Van Dyke 2008, p. 218). The risk of extinction for any species is known to be highly inversely correlated with population size (O'Grady *et al.* 2004, pp. 516, 518; Pimm *et al.* 1988, pp. 774–775). In other words, the smaller the population, the greater the overall risk of extinction. Population size estimates that take into account detection probability have not been generated at most sites for these species, but mark–recapture studies at some of the highest quality sites for Jollyville Plateau salamanders estimated surface populations as low as 78 and as high as 1,024 (O'Donnell *et al.* 2008, pp. 44–45).

At small population levels, the effects of demographic stochasticity (the variability in population growth rates arising from random differences among individuals in survival and reproduction within a season) alone greatly increase the risk of local extinctions (Van Dyke 2008, p. 218). Although it remains a complex field of study, conservation genetics research has demonstrated that long-term inbreeding depression (a pattern of reduced reproduction and survival as a result of genetic relatedness) can occur within populations with effective sizes of 50 to 500 individuals and may also occur within larger populations as well (Frankham 1995, pp. 305–327; Latter *et al.* 1995, pp. 287–297; Van Dyke 2008, pp. 155–156).

Current evidence from integrated work on population dynamics shows that setting conservation thresholds at only a few hundred individuals does not properly account for the synergistic impacts of multiple threats facing a population (Traill *et al.* 2010, p. 32). Studies across taxonomic groups have found both the evolutionary and demographic constraints on populations require sizes of at least 5,000 adult individuals to ensure long-term persistence (Traill *et al.* 2010, p. 30). Only one site for the Jollyville Plateau salamanders at Wheless Spring has an average population estimate of greater than 500 individuals based on results of a mark–recapture study (O'Donnell *et al.* 2008, p. 46).

Through a review of survey information available in our files and provided to us during the peer review and public comment period for the proposed rule, we noted the highest number of individuals counted during survey events that have occurred over the last 10 years. We used these survey counts as an index of salamander population health and relative abundance. We recognize these counts do not represent true population counts or estimates because they are reflective of only the number of salamanders observed in the surface habitat at a specific point in time. However, the data provide the best available information to consider relative population sizes of salamanders.

Through this assessment, we determined that surveys at many sites have never yielded as many as 50 individuals. In fact, 33 of the 106 (31 percent) Jollyville Plateau salamander surface sites have not yielded as many as 5 individuals at any one time in the last 10 years. Furthermore, surveys or salamander counts of only 8 of the 106 (8 percent) Jollyville Plateau salamander surface sites have resulted in more than 50 individuals at a time over the last 10 years. We also found that many of the salamander population counts have been low or unknown.

For the Austin blind salamander, the highest count observed at a single site over the last 10 years was 34 individuals; however, numbers this high are very rare for this species. Counts of three individuals or less have been reported most frequently since 1995. Because most of the sites occupied by the Austin blind and Jollyville Plateau salamanders are not known to have many individuals, any of the threats described in this final rule or even stochastic events that would not otherwise be considered a threat could extirpate populations. As populations are extirpated, the overall risk of extinction of the species is increased.

Small population sizes can also act synergistically with other traits (such as being a habitat specialist and having limited distribution, as is the case with the Austin blind and Jollyville Plateau salamanders) to greatly increase risk of extinction (Davies *et al.* 2004, p. 270). Stochastic events from either environmental factors (random events such as severe weather) or demographic factors (random causes of births and deaths of individuals) may also heighten the effect of other threats to the salamander species because of their limited range and small population sizes (Melbourne and Hastings 2008, p. 100).

In conclusion, we do not consider small population size to be a threat in and of itself to the Austin blind or Jollyville Plateau salamanders, but their small population sizes make them more vulnerable to extinction from other existing or potential threats, such as a major stochastic event. We consider the level of impacts from stochastic events to be moderate for the Jollyville Plateau salamander, because this species has more populations over a broader range. On the other hand, recolonization following a stochastic event is not likely for the Austin blind salamander due to its limited distribution and low numbers. Therefore, the impact from a stochastic event for the Austin blind salamander is a significant threat.

Ultraviolet Radiation

Increased levels of ultraviolet-B (UV–B) radiation, due to depletion of the stratospheric ozone layers, may lead to declines in amphibian populations

(Blaustein and Kiesecker 2002, pp. 598–600). For example, research has demonstrated that UV–B radiation causes significant mortality and deformities in developing long-toed salamanders (*Ambystoma macrodactylum*) (Blaustein *et al.* 1997, p. 13,735). Exposure to UV–B radiation reduces growth in clawed frogs (*Xenopus laevis*) (Hatch and Burton, 1998, p. 1,783) and lowers hatching success in Cascades frogs (*Rana cascadae*) and western toads (*Bufo boreas*) (Kiesecker and Blaustein 1995, pp. 11,050–11,051). In lab experiments with spotted salamanders, UV–B radiation diminished their swimming ability (Bommarito *et al.* 2010, p. 1151). Additionally, UV–B radiation may act synergistically (the total effect is greater than the sum of the individual effects) with other factors (for example, contaminants, pH, pathogens) to cause declines in amphibians (Alford and Richards 1999, p. 141; see ''Synergistic and Additive Interactions among Stressors'' below). Some researchers have indicated that future increases in UV–B radiation will have significant detrimental impacts on amphibians that are sensitive to this radiation (Blaustein and Belden 2003, p. 95).

The effect of increased UV–B radiation on the Austin blind and Jollyville Plateau salamanders is unknown. It is unlikely the few cave populations of Jollyville Plateau salamanders that are restricted entirely to the subsurface are exposed to UV–B radiation. In addition, exposure of the Austin blind salamander may be limited because they largely reside underground. Surface populations of these species may receive some protection from UV–B radiation through shading from trees or from hiding under rocks at some spring sites. Substrate alteration may put these species at greater risk of UV–B exposure and impacts. Because eggs are likely deposited underground (Bendik 2011b, COA, pers. comm.), UV–B radiation may have no impact on the hatching success of these species.

In conclusion, the effect of increased UV–B radiation has the potential to cause deformities or developmental problems to individuals, but we do not consider this stressor to significantly contribute to the risk of extinction of the Austin blind and Jollyville Plateau salamanders at this time. However, UV–B radiation could negatively affect any of the Austin blind and Jollyville Plateau salamanders' surface populations in combination with other threats (such as water quality or water quantity degradation) and contribute to significant declines in population sizes.

Deformities in Jollyville Plateau Salamanders

Jollyville Plateau salamanders observed at the Stillhouse Hollow monitoring sites have shown high incidences of deformities, such as curved spines, missing eyes, missing limbs or digits, and eye injuries (O'Donnell *et al.* 2006, p. 26). The Stillhouse Hollow location was also cited as having the highest observation of dead Jollyville Plateau salamanders (COA 2001, p. 88). Although water quality is relatively low in the Stillhouse Hollow drainage (O'Donnell *et al.* 2006, pp. 26, 37), no statistical correlations were found between the number of deformities and nitrate concentrations (O'Donnell *et al.* 2006, p. 26). Environmental toxins are the suspected cause of salamander deformities (COA 2001, pp. 70–74; O'Donnell *et al.* 2006, p. 25), but deformities in amphibians can also be the result of genetic mutations, parasitic infections, UV–B radiation, or the lack of an essential nutrient. More research is needed to elucidate the cause of these deformities. We consider deformities to be a low-level impact to the Jollyville Plateau salamander at this time because this stressor is an issue at only one site, is not affecting the entire population there, and does not appear to be an issue for the other salamander species.

Other Natural Factors

The highly restricted ranges of the salamanders and entirely aquatic environment make them extremely vulnerable to threats such as decreases in water quality and quantity. This is especially true for the Austin blind salamander, which is found in only one locality comprising three hydrologically connected springs of Barton Springs. Due to its limited distribution, the Austin blind salamander is sensitive to stochastic incidences, such as storm events (which can dramatically affect dissolved oxygen levels), catastrophic contaminant spills, and leaks of harmful substances. One catastrophic spill event in Barton Springs could potentially cause the extinction of the Austin blind salamander in the wild.

Although rare, catastrophic events pose a significant threat to small populations because they have the potential to eliminate all individuals in a small group (Van Dyke 2008, p. 218). In the proposed rule, we discussed that the presence of several locations of Jollyville Plateau salamanders close to each other provides some possibility for natural recolonization for populations of these species if any of these factors resulted in a local extirpation event (Fagan *et al.* 2002, p. 3,255). Although it may be possible for *Eurycea* salamanders to travel through aquifer conduits from one surface population to another, or that two individuals from different populations could breed in subsurface habitat, there is no direct evidence that they currently migrate from one surface population to another on a regular basis. Just because there is detectable gene flow between two populations does not necessarily mean that there is current or routine dispersal between populations that could allow for recolonization of a site should the population be extirpated by a catastrophic event (Gillespie 2012, University of Texas, pers. comm.).

In conclusion, restricted ranges could negatively affect any of the Austin blind and Jollyville Plateau salamanders' populations in combination with other threats (such as water quality or water quantity degradation) and lead to the species being at a higher risk of extinction. We consider the level of impacts from stochastic events to be moderate for the Jollyville Plateau salamander, because even though this species has more populations over a broader range, the range is still restricted and the species' continued existence could be compromised by a common event. On the other hand, recolonization following a stochastic event is less likely for the Austin blind salamander due to its limited distribution and low numbers. Therefore, the impact from a stochastic event for the Austin blind salamander is a significant threat.

Synergistic and Additive Interactions Among Stressors

The interactions among multiple stressors (contaminants, UV–B radiation, pathogens) may be contributing to amphibian population declines (Blaustein and Kiesecker 2002, p. 598). Multiple stressors may act additively or synergistically to have greater detrimental impacts on amphibians compared to a single stressor alone. Kiesecker and Blaustein (1995, p. 11,051) found a synergistic effect between UV–B radiation and a pathogen in Cascades frogs and western toads. Researchers demonstrated that reduced pH levels and increased levels of UV–B radiation independently had no effect on leopard frog (*Rana pipiens*) larvae; however, when combined, these two caused significant mortality (Long *et al.* 1995, p. 1,302). Additionally, researchers demonstrated that UV–B radiation increases the toxicity of PAHs, which can cause mortality and deformities on developing amphibians (Hatch and Burton 1998, pp. 1,780–

1,783). Beattie *et al.* (1992, p. 566) demonstrated that aluminum becomes toxic to amphibians at low pH levels. Also, disease outbreaks may occur only when there are contaminants or other stressors in the environment that reduce immunity (Alford and Richards 1999, p. 141). For example, Christin *et al.* (2003, pp. 1,129–1,132) demonstrated that mixtures of pesticides reduced the immunity to parasitic infections in leopard frogs.

Currently, the effect of synergistic stressors on the Austin blind and Jollyville Plateau salamanders is not fully known. Furthermore, different species of amphibians differ in their reactions to stressors and combinations of stressors (Kiesecker and Blaustein 1995, p. 11,051; Relyea *et al.* 2009, pp. 367–368; Rohr *et al.* 2003, pp. 2,387–2,390). Studies that examine the effects of interactions among multiple stressors on the Austin blind and Jollyville Plateau salamanders are lacking. However, based on the number of examples in other amphibians, the possibility of synergistic effects on these salamanders cannot be discounted.

Conclusion of Factor E

The effect of increased UV–B radiation is an unstudied stressor to the Austin blind and Jollyville Plateau salamanders that has the potential to cause deformities or development problems. The effect of this stressor is low at this time. Deformities have been documented in the Jollyville Plateau salamander, but at only one location (Stillhouse Hollow). We do not know what causes these deformities, and there is no evidence that the incidence rate is increasing or spreading. Therefore, the effect of UV–B radiation is low. Finally, small population sizes at most of the sites for the salamanders increases the risk of local extirpation events. We do not necessarily consider small population size to be a threat in and of itself to the Austin blind and Jollyville Plateau salamanders, but their small population sizes make them more vulnerable to extirpation from other existing or potential threats, such as stochastic events. Thus, we consider the level of impacts from stochastic events to be moderate for the Jollyville Plateau salamander and high for the Austin blind salamanders due to its more limited distribution and low numbers.

Conservation Efforts To Reduce Other Natural or Manmade Factors Affecting Its Continued Existence

We have no information on any conservation efforts currently under way to reduce the effects of UV–B radiation, deformities, small population sizes, or limited ranges on the Austin blind and Jollyville Plateau salamanders.

Cumulative Impacts

Cumulative Effects From Factors A Through E

Some of the threats discussed in this finding could work in concert with one another to cumulatively create situations that impact the Austin blind and Jollyville Plateau salamanders. Some threats to the species may seem to be of low significance by themselves, but when considered with other threats that are occurring at each site, such as small population sizes, the risk of extirpation is increased. Furthermore, we have no direct evidence that salamanders currently migrate from one population to another on a regular basis, and many of the populations are situated in a way (that is, they are isolated from one another) where recolonization of extirpated sites is very unlikely. Cumulatively, as threats to the species increase over time in tandem with increasing urbanization within the surface watersheds of these species, more and more populations will be lost, which will increase the species' risk of extinction.

Overall Threats Summary

The primary factor threatening the Austin blind and Jollyville Plateau salamanders is the present or threatened destruction, modification, or curtailment of its habitat or range (Factor A). Degradation of habitat, in the form of reduced water quality and quantity and disturbance of spring sites (surface habitat), is the primary threat to the Austin blind and Jollyville Plateau salamanders. Reductions in water quality occur primarily as a result of urbanization, which increases the amount of impervious cover in the watershed and exposes the salamanders to more hazardous material sources. Impervious cover increases storm flow, erosion, and sedimentation. Impervious cover also changes natural flow regimes within watersheds and increases the transport of contaminants common in urban environments, such as oils, metals, and pesticides. Expanding urbanization results in an increase of contaminants, such as fertilizers and pesticides, within the watershed, which degrades water quality at salamander spring sites. Additionally, urbanization increases nutrient loads at spring sites, which can lead to decreases in dissolved oxygen levels. Construction activities are a threat to both water quality and quantity because they can increase sedimentation and exposure to contaminants, as well as dewater springs by intercepting aquifer conduits.

Various other threats to habitat exist for the Austin blind and Jollyville Plateau salamanders as well. Drought, which may be compounded by the effects of global climate change, also degrades water quantity and reduces available habitat for the salamanders. Water quantity can also be reduced by groundwater pumping and decreases in baseflow due to increases in impervious cover. Flood events contribute to the salamanders' risks of extinction by degrading water quality through increased contaminants levels and sedimentation, which may damage or alter substrates, and by removing rocky substrates or washing salamanders out of suitable habitat. Impoundments are also a threat to the Austin blind and Jollyville Plateau salamanders. Feral hogs are a threat to Jollyville Plateau salamanders, because they can physically alter their surface habitat and increase nutrients. Additionally, catastrophic spills and leaks remain a threat for many salamander locations. All of these threats are projected to increase in the future as the human population and development increases within watersheds that provide habitat for these salamanders. Some of these threats are moderated, in part, by ongoing conservation efforts, such as HCPs, preserves, and other programs in place to protect land from the effects of urbanization and to gather water quality data that would be helpful in designing conservation strategies for the salamander species. Overall, we consider the combined threats of Factor A to be ongoing and with a high degree of impact to the Austin blind and Jollyville Plateau salamanders and their habitats.

Another factor affecting these salamander species is Factor D, the inadequacy of existing regulatory mechanisms. Surface water quality data collected by TCEQ indicates that water quality degradation is occurring within many of the surface watersheds occupied by the Austin blind and Jollyville Plateau salamanders despite the existence of numerous State and local regulatory mechanisms to manage stormwater and protect water quality. Human population growth and urbanization in Travis and Williamson Counties are projected to continue into the future as well as the associated impacts to water quality and quantity (see Factor A discussion above). Because existing regulations are not providing adequate protection for the salamanders or their habitats, we consider the existing regulatory mechanisms inadequate to protect the

Austin blind and Jollyville Plateau salamanders now and in the future.

Under Factor E we identified several stressors that could negatively impact the Austin blind and Jollyville Plateau salamanders, including the increased risk of local extirpation events due to small population sizes, UV–B radiation, and deformities. Although none of these stressors rose to the level of being considered a threat by itself, small population sizes and restricted ranges make the Austin blind and Jollyville Plateau salamanders more vulnerable to extirpation from other existing or potential threats, such as stochastic events. Thus, we consider the level of impacts from stochastic events to be high for the Austin blind and Jollyville Plateau salamanders due to their low numbers, and especially high for the Austin blind salamander due to its limited distributions.

Determination

Standard for Review

Section 4 of the Act, and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(b)(1)(a), the Secretary is to make threatened or endangered determinations required by subsection 4(a)(1) solely on the basis of the best scientific and commercial data available to her after conducting a review of the status of the species and after taking into account conservation efforts by States or foreign nations. The standards for determining whether a species is threatened or endangered are provided in section 3 of the Act. An endangered species is any species that is ''in danger of extinction throughout all or a significant portion of its range.'' A threatened species is any species that is ''likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.'' Per section 4(a)(1) of the Act, in reviewing the status of the species to determine if it meets the definitions of threatened or endangered, we determine whether any species is an endangered species or a threatened species because of any of the following five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence.

We evaluated whether the Austin blind and Jollyville Plateau salamanders are in danger of extinction now (that is, an endangered species) or are likely to become in danger of extinction in the foreseeable future (that is, a threatened species). The foreseeable future refers to the extent to which the Secretary can reasonably rely on predictions about the future in making determinations about the future conservation status of the species. A key statutory difference between a threatened species and an endangered species is the timing of when a species may be in danger of extinction, either now (endangered species) or in the foreseeable future (threatened species).

Listing Status Determination for the Austin Blind Salamander

Based on our review of the best available scientific and commercial information, we conclude that the Austin blind salamander is in danger of extinction now throughout all of its range and, therefore, meets the definition of an endangered species. This finding, explained below, is based on our conclusions that this species has only one known population that occurs at three spring outlets in Barton Springs, the habitat of this population has experienced impacts from threats, and these threats are expected to increase in the future. We find the Austin blind salamander is at an elevated risk of extinction now, and no data indicate that the situation will improve without significant additional conservation intervention. We, therefore, find that the Austin blind salamander warrants an endangered species listing status determination.

Present and future degradation of habitat (Factor A) is the primary threat to the Austin blind salamander. This threat has primarily occurred in the form of reduced water quality from introduced and concentrated contaminants (for example, PAHs, pesticides, nutrients, and trace metals), increased sedimentation, and altered stream flow regimes. These stressors are primarily the result of human population growth and subsequent urbanization within the watershed and recharge and contributing zones of the Barton Springs Segment of the Edwards Aquifer. Urbanization is currently having impacts on Austin blind salamander habitat. For example, a study by the U.S. Geological Survey concluded that baseline water quality in the Barton Springs Segment of the Edwards Aquifer, in terms of nitrate, had shifted upward between 2001 and 2010 and was at least partially the result of an increase in the land application of treated wastewater (Mahler *et al.* 2011, pp. 34–35). Based on our analysis of impervious cover, the surface watershed and groundwater recharge and contributing zones of Barton Springs have levels of impervious cover that are likely causing habitat degradation. As a result, the best available information indicates that habitat degradation from urbanization is causing a decline in the Austin blind salamander population throughout the species' range now and will cause population declines in the future, putting this population at an elevated risk of extirpation.

Further degradation of water quality within the Austin blind salamander's habitat is expected to continue into the future, primarily as a result of an increase in urbanization. Substantial human population growth is ongoing within this species' range, indicating that the urbanization and its effects on Austin blind salamander habitat will increase in the future. The Texas State Data Center (2012, pp. 496–497) has reported a population increase of 94 percent for Travis County, Texas, from the year 2010 to 2050. Data indicate that water quality degradation at Barton Springs continues to occur despite the existence of current regulatory mechanisms in place to protect water quality; therefore, these mechanisms are not adequate to protect this species and its habitat now, nor do we anticipate them to sufficiently protect the species in the future (Factor D).

An additional threat to the Austin blind salamander is hazardous materials that could be spilled or leaked potentially resulting in the contamination of both surface and groundwater resources. For example, a number of point-sources of pollutants exist within the Austin blind salamander's range, including 7,600 wastewater mains and 9,470 known septic facilities in the Barton Springs Segment of the Edwards Aquifer as of 2010 (Herrington *et al.* 2010, pp. 5, 16). Because this species occurs in only one population in Barton Springs, a single but significant hazardous materials spill within stream drainages of the Austin blind salamander has the potential to cause this species to go extinct.

In addition, construction activities resulting from urban development may negatively impact both water quality and quantity because they can increase sedimentation and dewater springs by intercepting aquifer conduits. It has been estimated that total suspended sediment loads have increased 270 percent over predevelopment loadings within the Barton Springs Segment of the Edwards Aquifer (COA 1995, pp. 3–10). The risk of a hazardous material spill and effects from construction activities will increase as urbanization within the range of the Austin blind salamander increases.

The habitat of Austin blind salamanders is sensitive to direct physical habitat modification, particularly due to human vandalism of the springs and the Barton Springs impoundments. Eliza Spring and Sunken Garden Spring, two of the three spring outlets of the Austin blind salamander, experience vandalism, despite the presence of fencing and signage (Dries 2011, COA, pers. comm.). Also, the impoundments have changed the Barton Springs ecosystem from a stream-like system to a more lentic (still-water) environment, thereby reducing the water system's ability to flush sediments downstream and out of salamander habitat. In combination with the increased threat from urbanization, these threats are likely driving the Austin blind salamander to the brink of extinction now.

Future climate change could also affect water quantity and spring flow for the Austin blind salamander. Climate change could compound the threat of decreased water quantity at salamander spring sites by decreasing precipitation, increasing evaporation, and increasing the likelihood of extreme drought events. The Edwards Aquifer is projected to experience additional stress from climate change that could lead to decreased recharge and low or ceased spring flows given increasing pumping demands (Loáiciga *et al.* 2000, pp. 192–193). Evidence of climate change has been observed in Texas, such as the record-setting drought of 2011, with extreme droughts becoming much more probable than they were 40 to 50 years ago (Rupp *et al.* 2012, pp. 1053–1054). Drought lowers water quality in Barton Springs due to saline water encroachments in the Barton Springs Segment of the Edwards Aquifer (Slade *et al.* 1986, p. 62; Johns 2006, p. 8). Recent droughts have negatively impacted Austin blind salamander abundance (Dries 2012, pp. 16–18), reducing the resiliency of the sole population. Therefore, climate change is an ongoing threat to this species and contributes to the likelihood of the Austin blind salamander becoming extinct now.

Other natural or manmade factors (Factor E) affecting the Austin blind salamander population include UV–B radiation, small population sizes, stochastic events (such as floods or droughts), and synergistic and additive interactions among the stressors mentioned above. While these factors are not threats to the existence of the Austin blind salamander in and of themselves, in combination with the threats summarized above, these factors make the Austin blind salamander population less resilient and more vulnerable to extinction now.

Because of the fact-specific nature of listing determinations, there is no single metric for determining if a species is ''in danger of extinction'' now. In the case of the Austin blind salamander, the best available information indicates that habitat degradation has occurred throughout the only known Austin blind salamander population. The threat of urbanization indicates that this Austin blind salamander population is currently at an elevated risk of extinction now and will continue to be at an elevated risk in the future. These impacts are expected to increase in severity and scope as urbanization within the range of the species increases. Also, the combined result of increased impacts to habitat quality and inadequate regulatory mechanisms leads us to the conclusion that Austin blind salamanders are in danger of extinction now. This Austin blind salamander population has become degraded from urbanization, low resiliency and is subsequently at an elevated risk from climate change impacts and catastrophic events (for example, drought, floods, hazardous material spills). Therefore, because the only known Austin blind salamander population is at an elevated risk of extinction, the Austin blind salamander is in danger of extinction throughout all of its range now, and appropriately meets the definition of an endangered species (that is, in danger of extinction now).

Under the Act and our implementing regulations, a species may warrant listing if it is threatened or endangered throughout all or a significant portion of its range. The threats to the survival of this species occur throughout its range and are not restricted to any particular significant portion of its range. Accordingly, our assessments and determinations apply to this species throughout its entire range.

In conclusion, as described above, the Austin blind salamander is subject to significant threats now, and these threats will continue to become more severe in the future. After a review of the best available scientific information as it relates to the status of the species and the five listing factors, we find the Austin blind salamander is currently on the brink of extinction. Therefore, on the basis of the best available scientific and commercial information, we list the Austin blind salamander as an endangered species in accordance with section 3(6) of the Act. We find that a threatened species status is not appropriate for the Austin blind salamander because the overall risk of extinction is high at this time. The one existing population is not sufficiently resilient or redundant to withstand present and future threats, putting this species in danger of extinction now.

Listing Determination for the Jollyville Plateau Salamander

In the proposed rule (77 FR 50768, August 22, 2012), the Jollyville Plateau salamander species was proposed as endangered, rather than threatened, because at that time, we determined the threats to be imminent, and their potential impacts to the species would be catastrophic given the very limited range of the species. For this final determination, we took into account data that was made available after the proposed rule published, information provided by commenters on the proposed rule, and further discussions within the Service to determine whether the Jollyville Plateau salamander should be classified as endangered or threatened. Based on our review of the best available scientific and commercial information, we conclude that the Jollyville Plateau salamander is likely to become in danger of extinction in the foreseeable future throughout all of its range and, therefore, meets the definition of a threatened species, rather than endangered. This finding, explained below, is based on our conclusions that many populations of the species have begun to experience impacts from threats to its habitat, and these threats are expected to increase in the future. As the threats increase, we expect Jollyville Plateau salamander populations to be extirpated, reducing the overall representation and redundancy across the species' range and increasing the species' risk of extinction. We find the Jollyville Plateau salamander will be at an elevated risk of extinction in the future, and no data indicate that the situation will improve without significant additional conservation intervention. We, therefore, find that the Jollyville Plateau salamander warrants a threatened species listing status determination.

Present and future degradation of habitat (Factor A) is the primary threat to the Jollyville Plateau salamander. This threat has primarily occurred in the form of reduced water quality from introduced and concentrated contaminants (for example, PAHs, pesticides, nutrients, and trace metals), increased sedimentation, and altered stream flow regimes. These stressors are primarily the result of human population growth and subsequent urbanization within the watersheds and recharge and contributing zones of the groundwater supporting spring and cave sites. Urbanization affects both surface and subsurface habitat and is currently having impacts on Jollyville Plateau salamander counts. For example, Bendik (2011a, pp. 26–27) demonstrated that declining trends in counts are correlated with high levels of impervious cover. Based on our analysis of impervious cover (which we use as a proxy for urbanization) throughout the range of the Jollyville Plateau salamander, 81 of the 93 surface watersheds occupied by Jollyville Plateau salamanders have levels of impervious cover that are likely causing habitat degradation. As a result, the best available information indicates that habitat degradation from urbanization is causing declines in Jollyville Plateau salamander populations throughout most of the species' range now or will cause population declines in the future, putting these populations at an elevated risk of extirpation.

Further degradation of water quality within the Jollyville Plateau salamander's habitat is expected to continue into the future, primarily as a result of an increase in urbanization. Substantial human population growth is ongoing within this species' range, indicating that the urbanization and its effects on Jollyville Plateau salamander habitat will increase in the future. The Texas State Data Center (2012, pp. 496–497, 509) has reported a population increase of 94 percent and 477 percent for Travis and Williamson Counties, Texas, respectively, from the year 2010 to 2050. Data indicate that water quality degradation in sites occupied by Jollyville Plateau salamanders continues to occur despite the existence of current regulatory mechanisms in place to protect water quality; therefore, these mechanisms are not adequate to protect this species and its habitat now, nor do we anticipate them to sufficiently protect the species in the future.

Adding to the likelihood of the Jollyville Plateau salamander becoming endangered in the future is the risk from hazardous materials that could be spilled or leaked, potentially resulting in the contamination of both surface and groundwater resources. For example, a number of point-sources of pollutants exist within the Jollyville Plateau salamander's range, including leaking underground storage tanks and sewage spills from pipelines (COA 2001, pp. 16, 21, 74). A significant hazardous materials spill within stream drainages of the Jollyville Plateau salamander has the potential to threaten the long-term survival and sustainability of multiple populations.

In addition, construction activities resulting from urban development may negatively impact both water quality and quantity because they can increase sedimentation and dewater springs by intercepting aquifer conduits. Increased sedimentation from construction activities has been linked to declines in Jollyville Plateau salamander counts at multiple sites (Turner 2003, p. 24; O'Donnell *et al.* 2006, p. 34). The risk of a hazardous material spill and effects from construction activities will increase as urbanization within the range of the Jollyville Plateau salamander increases.

The habitat of Jollyville Plateau salamanders is sensitive to direct physical habitat modification, such as those resulting from human recreational activities, impoundments, feral hogs, and livestock. Destruction of Jollyville Plateau salamander habitat has been attributed to vandalism (COA 2001, p. 21), human recreational use (COA 2001, p. 21), impoundments (O'Donnell *et al.* 2008, p. 1; Bendik 2011b, pers. comm.), and feral hog activity (O'Donnell *et al.* 2006, pp. 34, 46). Because these threats are impacting a limited number of sites, they are not causing the Jollyville Plateau salamander to be on the brink of extinction now. However, in combination with the increased threat from urbanization, these threats are likely to drive the Jollyville Plateau salamander to the brink of extinction in the foreseeable future.

Future climate change could also affect water quantity and spring flow for the Jollyville Plateau salamander. Climate change could compound the threat of decreased water quantity at salamander spring sites by decreasing precipitation, increasing evaporation, and increasing the likelihood of extreme drought events. The Edwards Aquifer is predicted to experience additional stress from climate change that could lead to decreased recharge and low or ceased spring flows given increasing pumping demands (Loáiciga *et al.* 2000, pp. 192–193). Climate change could cause spring sites with small amounts of discharge to go dry and no longer support salamanders, reducing the overall redundancy and representation for the species. Evidence of climate change has been observed in Texas, such as the record-setting drought of 2011, with extreme droughts becoming much more probable than they were 40 to 50 years ago (Rupp *et al.* 2012, p. 1,053–1,054). Therefore, climate change is an ongoing threat to this species and will add to the likelihood of the Jollyville Plateau salamander becoming endangered within the foreseeable future.

Other natural or manmade factors (Factor E) affecting all Jollyville Plateau salamander populations include UV–B radiation, small population sizes, stochastic events (such as floods or droughts), and synergistic and additive interactions among the stressors mentioned above. While these factors are not threats to the existence of the Jollyville Plateau salamander in and of themselves in combination with the threats summarized above, these factors make Jollyville Plateau salamander populations less resilient and more vulnerable to population extirpations in the foreseeable future.

Because of the fact-specific nature of listing determinations, there is no single metric for determining if a species is "in danger of extinction" now. In the case of the Jollyville Plateau salamander, the best available information indicates that habitat degradation has resulted in measureable impacts on salamander counts. But, given that there are 106 surface and 16 cave populations, it is unlikely that any of the current threats are severe enough to impact all of the sites and result in overall species extirpation in the near future. The Jollyville Plateau salamander's risk of extinction now is not high (it is not in danger of extinction now). However, the threat of urbanization will cause the Jollyville Plateau salamander to be at an elevated risk of extirpation in the future. Also, the combined result of increased impacts to habitat quality and inadequate regulatory mechanisms leads us to the conclusion that Jollyville Plateau salamanders will likely be in danger of extinction within the foreseeable future. As Jollyville Plateau salamander populations become more degraded, isolated, or extirpated from urbanization, the species will lose resiliency and be at an elevated risk from climate change impacts and catastrophic events, such as drought, floods, and hazardous material spills. These events will affect all known extant populations, putting the Jollyville Plateau salamander at a high risk of extinction. Therefore, because the resiliency of populations is expected to decrease in the foreseeable future, the Jollyville Plateau salamander will be danger of extinction throughout all of its range in the foreseeable future, and appropriately meets the definition of a threatened species (that is, in danger of extinction in the foreseeable future).

After a review of the best available scientific information as it relates to the status of the species and the five listing factors, we find the Jollyville Plateau salamander is not currently in danger of extinction, but will be in danger of extinction in the future throughout all of its range. Therefore, on the basis of the best available scientific and commercial information, we are listing the Jollyville Plateau salamander as a threatened species, in accordance with section 3(6) of the Act. We find that an endangered species status is not appropriate for the Jollyville Plateau salamander because the species is not in danger of extinction at this time. While some threats to the Jollyville Plateau salamander are occurring now, the impacts from these threats are not yet at a level that puts this species in danger of extinction now. Habitat degradation and associated salamander count declines have been observed at urbanized sites. Furthermore, some Jollyville Plateau salamander sites are located within preserves and receive some protections from threats occurring to the species now. While the populations within preserves are not free from the impacts of urbanization, they are at a lower risk of extirpation because of the protections in place. Even so, with future urbanization outside of the preserves and the added effects of climate change, we expect habitat degradation to continue into the foreseeable future to the point where the species has an increased risk of extinction.

Under the Act and our implementing regulations, a species may warrant listing if it is threatened or endangered throughout all or a significant portion of its range. The threats to the survival of this species occur throughout its range and are not restricted to any particular significant portion of its range. Accordingly, our assessments and determinations apply to this species throughout its entire range.

Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened species under the Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing results in public awareness and conservation by Federal, State, tribal, and local agencies, private organizations, and individuals. The Act encourages cooperation with the States and requires that recovery actions be carried out for all listed species. The protection required by Federal agencies and the prohibitions against certain activities are discussed, in part, below.

The primary purpose of the Act is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of such conservation efforts is the recovery of these listed species, so that they no longer need the protective measures of the Act. Subsection 4(f) of the Act requires the Service to develop and implement recovery plans for the conservation of endangered and threatened species. The recovery planning process involves the identification of actions that are necessary to halt or reverse the decline in the species' status by addressing the threats to its survival and recovery. The goal of this process is to restore listed species to a point where they are secure, self-sustaining, and functioning components of their ecosystems.

Recovery planning includes the development of a recovery outline shortly after a species is listed and preparation of a draft and final recovery plan. The recovery outline guides the immediate implementation of urgent recovery actions and describes the process to be used to develop a recovery plan. Revisions of the plan may be done to address continuing or new threats to the species, as new substantive information becomes available. The recovery plan identifies site-specific management actions that set a trigger for review of the five factors that control whether a species remains endangered or may be downlisted or delisted, and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (comprising species experts, Federal and State agencies, nongovernmental organizations, and stakeholders) are often established to develop recovery plans. When completed, the recovery outline, draft recovery plan, and the final recovery plan will be available on our Web site (*http://www.fws.gov/endangered*), or from our Austin Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Implementation of recovery actions generally requires the participation of a broad range of partners, including other Federal agencies, States, tribes, nongovernmental organizations, businesses, and private landowners. Examples of recovery actions include habitat restoration (for example, restoration of native vegetation), research, captive propagation and reintroduction, and outreach and education. The recovery of many listed species cannot be accomplished solely on Federal lands because their range may occur primarily or solely on non-Federal lands. To achieve recovery of these species requires cooperative conservation efforts on private, State, tribal, and other lands.

Once these species are listed, funding for recovery actions will be available from a variety of sources, including Federal budgets, State programs, and cost-share grants for non-Federal landowners, the academic community, and nongovernmental organizations. In addition, pursuant to section 6 of the Act, the State of Texas will be eligible for Federal funds to implement management actions that promote the protection or recovery of the Austin blind and Jollyville Plateau salamanders. Information on our grant programs that are available to aid species recovery can be found at: *http://www.fws.gov/grants.*

Section 7(a) of the Act requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if any is designated. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR Part 402. Section 7(a)(4) of the Act requires Federal agencies to confer with the Service on any action that is likely to jeopardize the continued existence of a species proposed for listing or result in destruction or adverse modification of proposed critical habitat. If a species is listed subsequently, section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species or destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Service.

Federal agency actions within the species habitat that may require conference or consultation or both as described in the preceding paragraph include management, construction, and any other activities with the possibility of altering aquatic habitats, groundwater flow paths, and natural flow regimes within the ranges of the Austin blind and Jollyville Plateau salamanders. Such consultations could be triggered through the issuance of section 404 Clean Water Act permits by the Army Corps of Engineers or other actions by the Service, U.S. Geological Survey, and Bureau of Reclamation; construction and maintenance of roads or highways by the Federal Highway Administration; landscape-altering activities on Federal lands administered by the Department of Defense; and construction and management of gas pipelines and power line rights-of-way by the Federal Energy Regulatory Commission.

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to all endangered wildlife. The prohibitions of section 9(a)(2) of the Act, codified at 50 CFR 17.21 for endangered wildlife, in part, make it illegal for any person subject to the jurisdiction of the United States to take (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import, export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any listed species. Under the Lacey Act (18 U.S.C. 42–43; 16 U.S.C. 3371–3378), it is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. Certain exceptions apply to agents of the Service and State conservation agencies.

We may issue permits to carry out otherwise prohibited activities involving endangered and threatened wildlife species under certain circumstances. Regulations governing permits are codified at 50 CFR 17.22 for endangered wildlife, and at 50 CFR 17.32 for threatened wildlife. With regard to endangered wildlife, a permit must be issued for the following purposes: for scientific purposes, to enhance the propagation or survival of the species, and for incidental take in connection with otherwise lawful activities.

Required Determinations

Regulatory Planning and Review (Executive Orders 12866 and 13563)

Executive Order 12866 provides that the Office of Information and Regulatory Affairs in the Office of Management and Budget (OMB) will review all significant rules. The Office of Information and Regulatory Affairs has determined that this rule is not significant.

Executive Order 13563 reaffirms the principles of E.O. 12866 while calling for improvements in the nation's regulatory system to promote predictability, to reduce uncertainty, and to use the best, most innovative, and least burdensome tools for achieving regulatory ends. The executive order directs agencies to consider regulatory approaches that reduce burdens and maintain flexibility and freedom of choice for the public where these approaches are relevant, feasible, and consistent with regulatory objectives. E.O. 13563 emphasizes further that regulations must be based on the best available science and that the rulemaking process must allow for public participation and an open exchange of ideas. We have developed this rule in a manner consistent with these requirements.

Paperwork Reduction Act of 1995 (44 U.S.C. 3501 et seq.)

This rule does not contain any new collections of information that require approval by OMB under the Paperwork Reduction Act. This rule will not impose recordkeeping or reporting requirements on State or local governments, individuals, businesses, or organizations. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

National Environmental Policy Act

We have determined that environmental assessments and environmental impact statements, as defined under the authority of the National Environmental Policy Act (NEPA; 42 U.S.C. 4321 *et seq.*), need not be prepared in connection with listing a species as an endangered or threatened species under the Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244).

Data Quality Act

In developing this rule, we did not conduct or use a study, experiment, or survey requiring peer review under the Data Quality Act (Pub. L. 106–554).

References Cited

A complete list of all references cited in this rule is available on the Internet at *http://www.regulations.gov* or upon request from the Field Supervisor, Austin Ecological Services Field Office (see **ADDRESSES**).

Author(s)

The primary author of this document is staff from the Austin Ecological Services Field Office (see **ADDRESSES**) with support from the Arlington, Texas, Ecological Services Field Office.

List of Subjects in 50 CFR Part 17

Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, Transportation.

Regulation Promulgation

Accordingly, we amend part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, as follows:

PART 17—[AMENDED]

■ 1. The authority citation for part 17 continues to read as follows:

Authority: 16 U.S.C. 1361–1407; 1531–1544; 4201–4245; unless otherwise noted.

■ 2. Amend § 17.11(h) by adding entries for ''Salamander, Austin blind'' and ''Salamander, Jollyville Plateau'' in alphabetical order under AMPHIBIANS to the List of Endangered and Threatened Wildlife to read as follows:

§ 17.11 Endangered and threatened wildlife.

* * * * *

(h) * * *

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
*	*	*	*	*	*	*	
AMPHIBIANS							
*	*	*	*	*	*	*	
Salamander, Austin blind.	*Eurycea waterlooensis.*	U.S.A. (TX)	Entire	E	817	17.95(d)	NA
*	*	*	*	*	*	*	
Salamander, Jollyville Plateau.	*Eurycea tonkawae*	U.S.A. (TX)	Entire	T	817	17.95(d)	NA
*	*	*	*	*	*	*	

* * * * *

Dated: August 5, 2013.

Dan Ashe,

Director, U.S. Fish and Wildlife Service.

[FR Doc. 2013–19715 Filed 8–19–13; 8:45 am]

BILLING CODE 4310–55–P