USE ATTAINABILITY ANALYSIS
AQUATIC LIFE USE DESIGNATION FOR PERENNIAL PORTIONS OF DOG CANYON CREEK
TULAROSA VALLEY CLOSED BASIN, OTERO COUNTY, NM

NEW MEXICO ENVIRONMENT DEPARTMENT
SURFACE WATER QUALITY BUREAU
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INTRODUCTION

The New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB) conducted a Use Attainability Analysis (UAA) in accordance with 40 C.F.R. § 131.10(g) (Appendix A) to determine the most appropriate and protective aquatic life use for the perennial portions of Dog Canyon Creek in southern New Mexico. The coldwater aquatic life use is not attainable because "naturally occurring pollutant concentrations (i.e., high water temperatures resulting from natural ambient air temperatures) prevent the attainment of the [coldwater aquatic life] use" (40 C.F.R. § 131.10(g)(1)) and therefore a coolwater aquatic life use is the most protective aquatic life use that is naturally attainable.

Section 101(a)(2) of the Federal Water Pollution Control Act, 33 U.S.C. §§ 1251-1387, (Clean Water Act or CWA) requires that wherever attainable, water quality shall provide for the protection and propagation of fish, shellfish and wildlife and for recreation in and on the water. These are often referred to as the "fishable, swimmable" uses for a water body. In order to remove a §101(a)(2) use or change it to a more appropriate designation with less stringent criteria, a state or tribe must conduct a UAA demonstrating that the use is not attainable due to one or more of the six factors listed in 40 C.F.R. § 131.10(g) (see Appendix A). These use-specific criteria are specified in 20.6.4.15 NMAC.

As defined in 20.6.4.7 NMAC, the State of New Mexico's water quality standards classify surface waters of the state into "segments". Each segment has several designated uses[1], including one of seven aquatic life designated uses which are descriptive of the conditions, including thermal ranges, that should be attainable if not already existing, to support biotic communities. These aquatic life use criteria are specified in 20.6.4.900 NMAC.

Each segment contains one or more AUs, which are water bodies or sections of a water body with similar characteristics. These AUs are designed to represent surface waters with homogenous water quality (WERF 2007). Dog Canyon Creek was originally named Dog Canyon (Tularosa Creek to headwaters). However, in 2010, NMED changed its name to Dog Canyon Creek (perennial portions) to acknowledge that surface flows are not perennial and do not reach Tularosa Valley (NMED/SWQB 2014). Instead, surface flows from Dog Canyon Creek are lost to evaporation or infiltration into the alluvial surface. Dog Canyon Creek thus drains into the Rio Tularosa Closed Basin but is not a tributary to Tularosa Creek. Dog Canyon Creek (perennial portions) has only one AU identified as NM-2801_20.

[1] Designated use means a use specified in 20.6.4.97-899 NMAC for a surface water of the state whether or not it is being attained. 20.6.4.7.D(3) NMAC.

Perennial portions of Dog Canyon Creek are currently classified in the water quality standards segment 20.6.4.801 NMAC:

20.6.4.801 CLOSED BASINS - Rio Tularosa east of the old U.S. highway 70 bridge crossing east of Tularosa and all perennial tributaries to the Tularosa basin except Three Rivers and excluding waters on the Mescalero tribal lands.

A. Designated Uses: coldwater aquatic life, irrigation, livestock watering, wildlife habitat, public water supply and primary contact.

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: the monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

The coldwater aquatic life use for Dog Canyon Creek (perennial portions) is listed as impaired due to temperature exceedences. It was first listed as impaired due to temperature in 2006 based on NMED's 2004 water quality survey data. More recent thermograph data from 2010 and 2012 confirmed the impairment and it has remained on the list of impaired waters in subsequent years. However, NMED noted in the Record of Decision (NMED/SWQB 2014) that the coldwater aquatic life use may not be appropriate and that a review of the water quality standard was warranted. The purpose of this UAA is to review the standards and identify the appropriate aquatic life use for the perennial portions of Dog Canyon Creek.

WATERSHED DESCRIPTION

The Dog Canyon Creek watershed (Figure 1) is located in the Tularosa Valley closed basin (HUC 13050003) in southern New Mexico. Streams in closed, or "endorheic" basins retain water and create no outflows to external bodies of water such as rivers or oceans. Dog Canyon is one of several large erosional canyons on the steep western escarpment of the Sacramento Mountains. The watershed has an area of approximately 40 square miles (mi^2) and Dog Canyon Creek has a total reach of 5.84 miles. Elevations range from 4,000 feet (ft) at the mouth of the canyon in the Tularosa Valley to 9,000 ft in the Sacramento Mountains. Dog Canyon Creek originates within the conifer pine forests of the Lincoln National Forest and swiftly transitions to Madrean lower montane woodlands before ending in the Chihuahuan basin where it disseminates across an alluvial fan approximately 10 miles south of Alamogordo. The mouth of the canyon, and furthest downstream section, is contained in Oliver Lee Memorial State Park. Impact from human activity in the canyon containing the perennial reaches consists of light recreational use and some historical grazing (EMNRD, 2001). There are no National Pollutant Discharge Elimination System (NPDES) permitted point source discharges to Dog Canyon Creek, and there is very little development on the state park or surrounding national forest areas. Dog Canyon Creek has previously been identified as a reference stream due to minimal anthropogenic impacts to its water quality (NMED/SWQB 2014).

Non-perennial portions of Dog Canyon Creek are believed to be ephemeral, i.e., flowing in response to precipitation events however, it is still classified as intermittent until such a time in which an assessment can be conducted. Two short perennial reaches are present, one in the Oliver Lee Memorial State Park ("Nature Trail") which extends approximately 0.5 miles in length but

does not extend past the mouth of the canyon (EMNRD 2001) and another 1.4 miles upstream from the Park in the Lincoln National Forest ("Line Cabin"). The length of the perennial reach within the Lincoln National Forest has not been established but it appears from aerial photography to be about one third to one half mile (Figures 2 and 3). NMED has a water quality monitoring station at each of these locations identified as "48DogCan002.7 at the Nature Trail" and "48DogCan005.9 at Line Cabin" (see Figure 1). These perennial reaches are sustained by rain and snow-melt that make their way through cracks, fractures and bedding planes in the mountains and emerge as seeps and springs from the various limestone formations of the canyon. Topographic maps, aerial photos and pertinent literature did not indicate any perennial or intermittent flow other than the perennial reaches

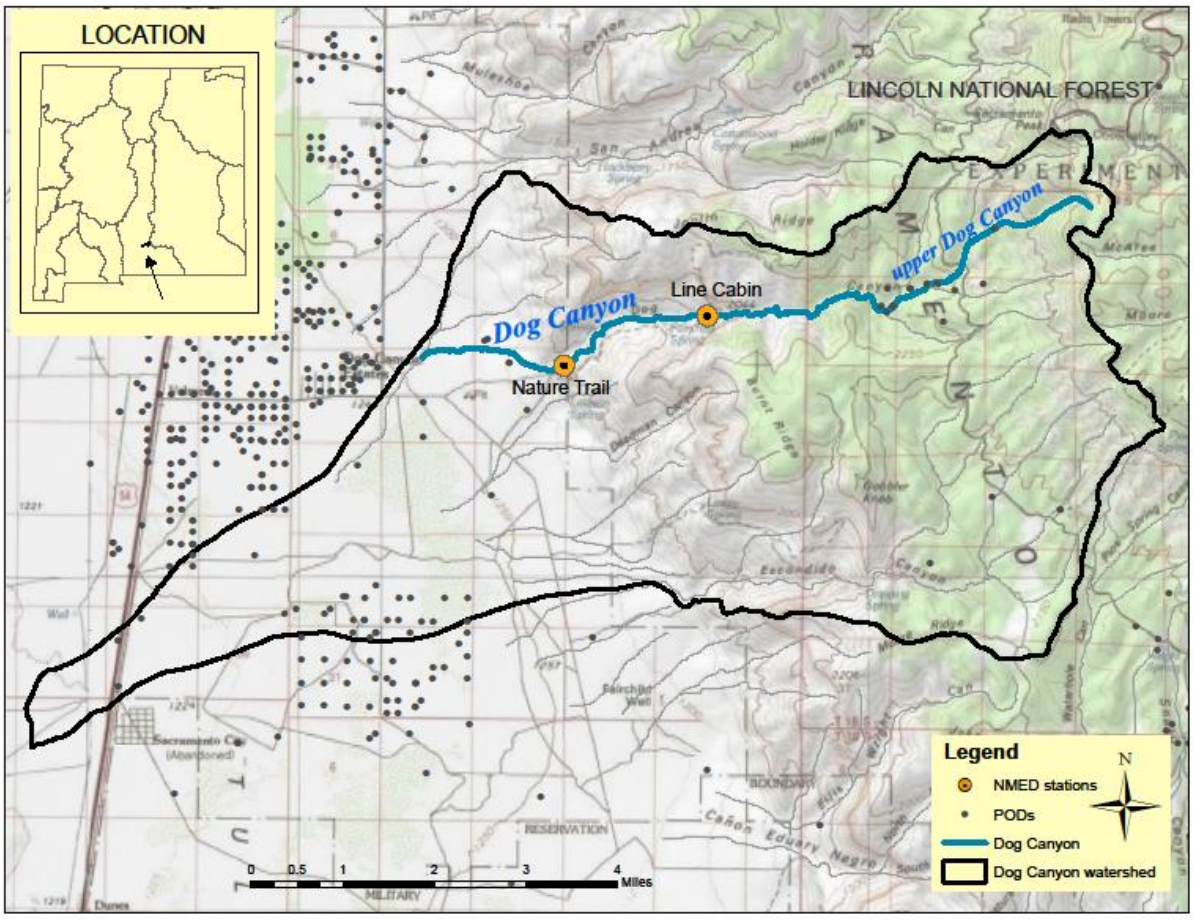

Figure 1. Dog Canyon Creek Watershed

Figure 2. Perennial reach of Dog Canyon Creek at the Nature Trail

Figure 3. Perennial reach of Dog Canyon Creek at Line Cabin

Surface diversions and groundwater pumping can result in decreased streamflow and may also cause an increase in water temperature. NMED considered wells and surface diversions in Dog Canyon to assess their potential impact on surface water flows and temperatures. In the nineteenth century, ranchers diverted water from the springs for orchards and livestock in what is now the Oliver Lee Memorial State Park. These diversions are no longer used. Water for the state park operations is supplied by wells with a minimum depth to water of 190 feet, and withdrawals of three acre feet per year or less (EMNRD 2001). NMED also obtained records from the New Mexico Office of the State Engineer (NMOSE) for points of diversion (PODs) from wells and surface water within one mile of Dog Canyon or its tributaries (NMOSE 2012). A total of 21 PODs were identified (see Figure 4). Most PODs had no metering information and actual withdrawal amounts are unknown. NMED evaluated PODs individually based on their location in the watershed, allowed use and amount of diversion.

There were five PODs in the lower watershed, all of which were located at least one-half mile below the mouth of Dog Canyon. Three of these PODs were wells. Two were surface diversions dating from 1911 and 1921. These were permitted for 2318 and 1560 acre feet per year respectively, despite the absence of surface water at those locations. According to the NMOSE, these PODs were licensed for flood waters only, and there were no records of these water rights ever being used (Personal communication with D. Mercer, Sept. 22, 2014). In the upper watershed (upstream of the line cabin), there were eleven wells and five surface PODs. There are two owners for the eleven wells registered with the Office of the State Engineer; each well was designated for domestic use of three or less acre feet per year. Two of the five surface PODs had been cancelled and two others were for small impoundments at springs to create pools for livestock watering. The fifth was permitted for irrigation, although aerial photos do not indicate surface water in the vicinity. The lower portion of the watershed (downstream of the nature trail) has twelve ground water wells all registered under Holloman Air Force Base and two surface diversions issued in 1911 and 1921, respectively, for flood water diversions to be used for irrigation.

There has been little human development in the watershed, and no evidence of substantial flow apart from the perennial reaches at Line Cabin and the Nature Trail. Records from the NMOSE did not indicate any extensive water use capable of impacting flow in Dog Canyon Creek. There was no evidence of diversions of the perennial reaches at the Nature Trail or at Line Cabin. Although Dog Canyon is located in an arid region where water would have been highly coveted, there have been very few water permits or declarations here over the past 100 years, suggesting that extensive water was not available either historically or currently.

ECOREGIONAL ANALYSIS

Ecoregions denote areas of general similarity in ecosystems and in the type, quality and quantity of environmental resources; they are designed to serve as a spatial framework for the research, assessment, management and monitoring of ecosystems and ecosystem components. In recognizing the spatial differences in the capacities and potentials of ecosystems, ecoregions stratify the environment by its probable response to disturbance (Omernik, 1995). The various Level IV ecoregions in New Mexico have been classified into three sedimentation categories – Mountain (M), Foothills (F), and Xeric (X) - based on principal component analysis of habitat variables (Jessup, et al. 2010). For perennial streams that support their designated aquatic life use,

these ecoregion categories roughly correspond to the ALU designations of HQCW/coldwater, coolwater and warmwater/marginal warmwater, respectively (Jessup et al. 2010).

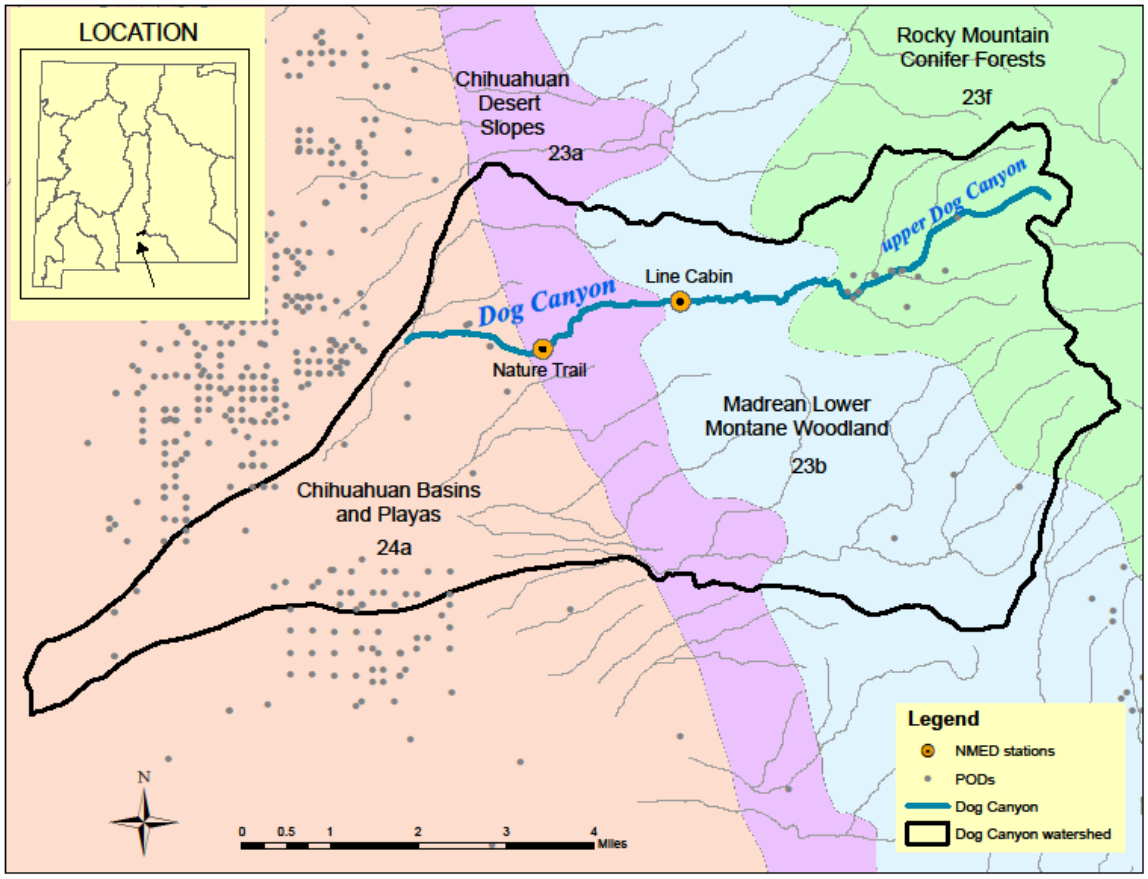

Figure 4. Dog Canyon Creek Ecoregions

Despite its relatively short length, Dog Canyon Creek spans two Level III ecoregions (Ecoregion 23-Arizona/ New Mexico Mountains and Ecoregion 24-Chihuahuan Desert) and four Level IV ecoregions (Griffith et al, 2006), as shown on Figure 4. Some characteristics of these ecoregions are summarized in Table 2. The highest elevation of Dog Canyon Creek is located at 9,000 feet in Ecoregion 23f (M). This ecoregion supports conifer forests and moderate to high gradient intermittent and some perennial streams. It receives 18-28 inches of annual precipitation, and is frost-free only 3 to 4.5 months out of the year. There is no evidence of perennial surface flow in this section of Dog Canyon Creek. The creek continues through Ecoregion 23b (F), which is lower in elevation and consequently warmer and drier than Ecoregion 23f. Vegetation is primarily woodland. The creek forms a steep canyon through Ecoregion 23a (F), which is lower in elevation and even warmer and drier than Ecoregion 23b. Vegetation consists of shrub and grassland, and surface water is limited to springs and ephemeral streams. The mouth of Dog Canyon Creek marks a transition to the Chihuahuan Desert ecoregion 24a (X), where it drains into the Tularosa Valley Closed Basin. This is an arid region, with less than 13 inches of annual precipitation (Griffith et al, 2006), and is frost-free most of the year. As is typical of this ecoregion, surface flow of Dog

Canyon in this portion is most likely ephemeral, flowing only in response to localized precipitation events. The two major perennial reaches and their respective water quality monitoring stations; 48DogCan002.7 at the "Nature Trail" and 48DogCan005.9 at "Line Cabin", occur in the 23a and 23b Foothill ecoregions, respectively.

Table 1. Characteristics of the Dog Canyon Creek watershed ecoregions (Summarized from Griffith et al., 2006)

Code	Name (category)	Elevation (ft.)	Physiography	Hydrology	Annual precip (in.)	Mean July Max Temp (°C)
23	Level III Ecoregion - Arizona/ New Mexico Mountains					
23a	Chihuahuan Desert Slopes (Foothills)	4500-6500	Lower slopes of Guadalupe and Sacramento Mountains, cut by steep canyons.	Moderate gradient ephemeral streams that carry water only after periodic storms. Water is scarce; the few streams that originate from springs at higher elevations do not persist beyond the mouths of major canyons.	15-18	29
23b	Madrean Lower Montane Woodlands (Foothills)	4200-8400	High hills and low mountains, some deep canyons.	Mostly moderate to high gradient intermittent streams; a few perennial rivers.	13-20	31
23f	Rocky Mountain Conifer Forests (Mountains)	7000-9600	Open low mountains and high mountains with steep slopes, numerous canyons.	Mostly moderate to high gradient intermittent and some perennial streams.	18-28	25
24	Level III Ecoregion - Chihuahuan Deserts					
24a	Chihuahuan Basins and Playas (Xeric)	2842-5749	Depressions or grabens filled with sediment to form flat to rolling basins.	Alluvial basins surrounding major rivers or internally drained (closed) basins. Streams ephemeral.	9-13	35

AIR-WATER TEMPERATURE CORRELATION

DESCRIPTION OF THE MODEL

Numeric water quality temperature criteria for specific aquatic life uses under New Mexico's water quality standards are expressed in terms of maximum temperature (T_{MAX}), the temperature not to be exceeded for four or more consecutive hours in a 24-hour period on more than three consecutive days (4T3) and the temperature not to be exceeded for six or more consecutive hours in a 24-hour

period on more than three consecutive days (6T3) (20.6.4.7 NMAC and 20.6.4.900.H NMAC, Table 2). The Maximum Weekly Average Temperature (MWAT) is a measure of chronic temperature trends calculated from daily temperature measurements averaged over the seven contiguous days of highest daily averages from the record. New Mexico's water quality standards do not require the use of the MWAT for temperature assessments; however, the MWAT statistic is widely adopted and a large body of comparative literature exists relating MWAT to thermal requirements of freshwater fish (Brungs and Jones, 1977).

Table 2. Aquatic life use temperature criteria (°C) (20.6.4.900.H NMAC)

Criterion	High Quality Coldwater	Coldwater	Marginal Coldwater	Coolwater	Warmwater	Marginal Warmwater
4T3	20	-	-	-	-	-
6T3	-	20	25	-	-	-
T_{MAX}	23	24	29	29	32.2	32.2

A dash (-) indicates that the criterion is not applicable to the aquatic life use.

The T_{MAX}, 4T3, 6T3 and MWAT are summary statistics derived from water temperature datasets as recorded by thermographs. Thermographs are dataloggers that can record water or air temperatures continuously at preset temporal intervals (*e.g.*, hourly) over extended periods of time (e.g., several months). NMED deploys thermographs in a water body throughout the summer months in accordance with the Department's Standard Operating Procedure 6.3, and assesses the validated data to identify impairments.

Air temperatures, either modeled or measured, are more readily available and spatially representative than periodic and spatially limited stream temperature datasets. Due to the limited availability of stream temperature datasets, the SWQB has developed an Air-Water Temperature Correlation (AWTC) model for New Mexico streams. The AWTC model allows for the estimation of attainable MWAT, T_{MAX}, 4T3 and 6T3 water temperatures given the 30 year July average ambient air temperature (ATEMP) for a given area (NMED/SWQB, 2011). The model was based on recorded thermograph data from 293 New Mexico stream locations and assumes that, in streams which do not receive groundwater inputs sufficient to change the water temperature, air temperature has the greatest influence on stream temperature (Bartholow, 2002). The model uses average July temperatures because July is the month in which the highest annual temperatures typically occur. In the absence of site-specific measured data, air temperature inputs to the AWTC were obtained using the Parameter-elevation Regression on Independent Slopes Model (PRISM). PRISM predicts air temperatures based on site-specific characteristics (PRISM Climate Group, 2004; Daly et al, 2008). It has been shown through the AWTC that absent appreciable influence of microclimates and ground water, ATEMP as determined through PRISM is nearly equivalent to the MWAT. The T_{MAX}, 4T3 or 6T3 can be calculated from ATEMP using correlation equations.

Sources of potential error in the AWTC model include: (1) The PRISM record of July temperatures used in the model are averaged for a period of 30 years between 1981-2010. Averaging may smooth extremes and obscure trends in the modeled temperature record. This, in combination with inter-annual variation in the water temperature record could lead to differences between the observed and predicted results; and, (2) The PRISM model interpolates values based on a

minimum 800meter (m) map grid cell (640,000 m^2). In mountainous areas in particular, it integrates data from a range of elevations which may reduce the precision of the results.

APPLICATION TO DOG CANYON CREEK

The perennial reaches of Dog Canyon Creek were assessed for T_{MAX} and the 6T3 as required for the coldwater aquatic life use (20.6.4.7 NMAC). NMED conducted monitoring of Dog Canyon Creek in 2004, 2010 and 2012, and deployed water thermographs in the summer months of 2010 and 2012. NMED applied the temperature correlation model described above to each thermograph location. Modeling results (predicted) and thermograph measurements (observed) for the T_{MAX} are shown in Table 3**.** Observed T_{MAX} temperatures at both stations were several degrees cooler than predicted.

Where streamflow consists primarily of spring discharge and groundwater seepage, the primary influence on surface water temperature is emergent groundwater temperature. Once exposed at the surface, waters are then subject to ambient air temperatures. This situation often results in stream temperatures significantly cooler than predicted through the air-water temperature correlation model. The thermograph record from the Nature Trail shows pattern of depressed diel temperature swings (2 to 3 degrees) indicative of groundwater domination. The thermograph from the Line Cabin shows a pattern of occasionally depressed diel swings, indicative of a varying mix of groundwater and runoff influences.

Average July temperatures for the reference period 1981-2010 were obtained from PRISM using the settings for 800 m grid cells with interpolation. According to the correlation model, the July T_{MAX} in Dog Canyon Creek may exceed 29°C naturally. However, the perennial reaches of the creek are localized and spring fed. Observed water temperatures at both locations were cooler than predicted by ambient air temperature alone. T_{MAX} at both locations were identical when measured in the same year (2010), perhaps indicating that the two springs may tap into the same groundwater source. Thermograph temperatures for both reaches exceeded the coldwater T_{MAX} of 24°C but below the coolwater T_{MAX} of 29°C, as defined in 20.6.4.900.H(2) and (4), respectively (see Table 3). This data indicates the attainable conditions for the perennial reaches of Dog Canyon Creek are more closely associated with a coolwater aquatic life use than the coldwater aquatic life use.

Table 3. Observed and predicted water temperatures (°C) for Dog Canyon Creek (perennial portions)

Station #	Station location	Elev (ft)	ATEMP*	Predicted T_{MAX}	Year	Observed T_{MAX}
48DogCan002.7	Nature Trail	4480	25.5	32.2	2010	26.4
					2012	25.8
48DogCan005.9	Line cabin	5784	22.5	29.0	2010	26.4

* PRISM Climate Group, Oregon State University,http://prism.oregonstate.edu, accessed 25 Oct 2016

AQUATIC LIFE

New Mexico's aquatic life uses and associated criteria protect the aquatic community based on physiologic thermal tolerances. Fish community data are often used to identify an appropriate aquatic life use based on water temperature. Where the fish community is mixed regarding thermal preferences, a preponderance of evidence is used to best assess the most probable or natural state of the water body. NMED requested fish collection records for the Tularosa Valley Closed Basin from the Museum of Southwest Biology (UNM 2014). There were no records from Dog Canyon Creek. According to Oliver Lee Memorial State Park's management plan, the isolated perennial reaches of Dog Canyon support a thriving riparian and aquatic system of wildlife, birds, insects and amphibians, but no fish (EMNRD 2001). There is no evidence that a fish community ever has existed in these reaches.

CONCLUSION

Dog Canyon Creek is a minimally impacted reference stream in a warm and arid climate. Cool groundwater keeps surface water temperatures cooler than expected given ambient air temperatures alone. It is likely, in this situation, that the prevailing actual water temperature is equivalent the attainable temperature. The naturally warm and arid conditions preclude attainment of coldwater aquatic life habitat; however, conditions can and do support a coolwater aquatic life ecosystem.

This UAA demonstrates that coolwater is the most protective attainable aquatic life use for the perennial reaches of Dog Canyon Creek. The coolwater aquatic life use is defined as an aquatic habitat that is naturally intermediate between cold and warm habitats (see Appendix B). The ecoregions, ambient air temperatures, observed water temperatures, groundwater cooling effect and the natural conditions of the stream all indicate that the coolwater aquatic life use is appropriate. The coldwater aquatic life use is not attainable because "*naturally occurring pollutant concentrations prevent the attainment of the use*…." (40 C.F.R. § 131.10(g)(1), see Appendix A). Specifically, naturally occurring thermal pollution (heat) in the water body due to ambient air temperatures prevents attainment of the coldwater aquatic life use.

To implement this standards change, it will be necessary to add a new water quality segment. NMED recommends the following water quality Segment be added to the standards:

20.6.4.810 CLOSED BASINS – Perennial reaches of Dog Canyon Creek

A. Designated Uses: coolwater aquatic life, irrigation, livestock watering, wildlife habitat, public water supply and primary contact.

B. Criteria: the use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses, except that the following segment-specific criteria apply: the monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less, single sample 235 cfu/100 mL or less.

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APPENDIX A

40 C.F.R. § 131.10(g):

(g) States may remove a designated use which is not an existing use, as defined in Sec. 131.3, or establish sub-categories of a use if the State can demonstrate that attaining the designated use is not feasible because:

(1) Naturally occurring pollutant concentrations prevent the attainment of the use; or

(2) Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating State water conservation requirements to enable uses to be met; or

(3) Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or

(4) Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use; or

(5) Physical conditions related to the natural features of the water body, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or

(6) Controls more stringent than those required by sections 301(b) and 306 of the Act would result in substantial and widespread economic and social impact.

APPENDIX B

DEFINITIONS 20.6.4.7 NMAC:

C.
(4) "Coldwater" in reference to an aquatic life use means a surface water of the state where the water temperature and other characteristics are suitable for the support or propagation or both of coldwater aquatic life.

(5) "Coolwater" in reference to an aquatic life use means the water temperature and other characteristics are suitable for the support or propagation of aquatic life whose physiological tolerances are intermediate between and may overlap those of warm and coldwater aquatic life.

H.
(1) "High quality coldwater" in reference to an aquatic life use means a perennial surface water of the state in a minimally disturbed condition with considerable aesthetic value and superior coldwater aquatic life habitat. A surface water of the state to be so categorized must have water quality, stream bed characteristics and other attributes of habitat sufficient to protect and maintain a propagating coldwater aquatic life population.

L.
(2) "Limited aquatic life" as a designated use, means the surface water is capable of supporting only a limited community of aquatic life. This subcategory includes surface waters that support aquatic species selectively adapted to take advantage of naturally occurring rapid environmental changes, ephemeral or intermittent water, high turbidity, fluctuating temperature, low dissolved oxygen content or unique chemical characteristics.

M.
(1) "Marginal coldwater" in reference to an aquatic life use means that natural intermittent or low flows, or other natural habitat conditions severely limit maintenance of a coldwater aquatic life population or historical data indicate that the temperature in the surface water of the state may exceed 25°C (77°F).

(2) "Marginal warmwater" in reference to an aquatic life use means natural intermittent or low flow or other natural habitat conditions severely limit the ability of the surface water of the state to sustain a natural aquatic life population on a continuous annual basis; or historical data indicate that natural water temperature routinely exceeds 32.2°C (90°F).

W.
(1) "Warmwater" with reference to an aquatic life use means that water temperature and other characteristics are suitable for the support or propagation or both of warmwater aquatic life.