

## **APPENDIX 1:**

### **Development of the Hydrology Protocol**

## *Why Develop a Hydrology Protocol?*

Perennial, intermittent, and ephemeral, as they pertain to all types of waterbodies, are defined in New Mexico's water quality standards (WQS). Amendments adopted by the Water Quality Control Commission in 2005 created new sections in the WQS that established designated uses and criteria for unclassified waters. Three separate provisions addressed ephemeral waters, intermittent waters, and perennial waters. The new provisions responded to a long-standing EPA concern that all waters, not only specifically identified classified waters, must be protected by WQS in compliance with the Clean Water Act (CWA).

EPA supported the concept of these provisions, but disagreed that the designated aquatic life and recreation uses satisfied the CWA and EPA regulations. CWA section 101(a)(2) requires water quality standards to provide, wherever attainable, water quality for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water – functions commonly referred to as “fishable/swimmable” uses. EPA's current water quality standards regulation effectively establishes a rebuttable presumption that, at a minimum, all surface waters (ephemeral, intermittent and perennial) can support “fishable/swimmable” uses until additional supporting documentation can be provided to demonstrate that such uses are not attainable. EPA does not expect New Mexico to adopt uses for ephemeral or intermittent waters that cannot be attained, but in those instances, 40 CFR 131.10(j)(1) requires the State to submit a use attainability analysis (UAA) to support a designated use that does not meet the CWA §101(a)(2) objective.

The *Hydrology Protocol* was developed to provide supporting documentation for the UAA process, especially for identifying attainable uses on ephemeral streams. Under federal regulation, CWA §101(a)(2) uses may be considered infeasible only if one of the factors listed in 40 CFR 131.10(g) applies. The two factors most likely to apply under ephemeral or intermittent conditions are that “natural, ephemeral, intermittent, or low flow conditions or water levels prevent the attainment of the use...” or that “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.” The *Hydrology Protocol* provides a tool for evaluating these factors as they relate to flow and water level.

The Surface Water Quality Bureau (SWQB) developed the *Hydrology Protocol* in response to EPA's concerns about the 2005 WQS amendments. It is expected to be an important tool in identifying unclassified ephemeral streams. However, because the WQS refer in numerous cases to the hydrology of classified water bodies, the SWQB anticipates using the protocol to distinguish intermittent from perennial streams when necessary, thus reducing the controversy that has at times accompanied such determinations.

## *How Was the Protocol Developed?*

The SWQB initiated development of the Hydrology Protocol in February 2008. The objective was to develop a scientifically sound *and* practical protocol that evaluates the hydrology, biology, and geomorphology of stream features to determine if a stream or river is ephemeral, intermittent, or perennial. After reviewing approaches used in other states, SWQB adapted a stream evaluation methodology developed by the North Carolina Division of Water Quality (NCDWQ 2005\*) to conditions in New Mexico. In this approach, field indicators of hydrological, biological, and physical characteristics are ranked using a weighted, four-tiered scoring system. A numerical rating system format was used based on requests from the EPA, the regulated community in New Mexico, and other stakeholders for an objective, practical scoring mechanism for determining the hydrologic status of a stream. As discussed below, a stream reach is determined to be ephemeral, intermittent, or perennial based on the overall score and other supporting information.

Relevant characteristics and scoring thresholds were developed using a preliminary dataset from 25 sites in 2008 (Table 1). Sites with known hydrologic characteristics, either due to the presence of USGS stream gauges and/or historic water quality datasets or due to assessment unit comments in the [303\(d\) List of Assessed Waters](#) and/or staff observation and suggestion, were selected to test the approach adapted from North Carolina. The results of this collection effort were used to develop a draft version of the protocol. The methodology was then beta tested during the 2009 field season using data collected from an additional 32 sites across a range of hydrologic and ecological conditions (Table 2). The 2009 sites used to beta test the protocol were typically already established SWQB water quality stations and were selected based on (1) the presence of a stream gauge, (2) ecoregion and proximity to other sampling sites, and (3) staff observation and suggestion.

Data from perennial, intermittent, and ephemeral streams were assessed using analysis of variance (ANOVA). The ANOVA procedure is one of the most powerful statistical techniques and is used to test the hypothesis that the means among two or more groups are equal. This analysis was used to verify which field indicators are useful in differentiating hydrologic systems in New Mexico by determining if the variation between groups was statistically significant (Table 3). Based on the results of this analysis a number of indicators were either removed from the protocol because they were not significant or their use was limited to applying only when they are observed (see Table 3 for details).

With relevant indicators being set, the final task was to develop numeric thresholds for distinguishing among ephemeral, intermittent and perennial waters. The minimum and maximum total score in each waterbody class were determined (Table 3) and the

---

\* North Carolina Division of Water Quality (NCDWQ). 2005. [Identification methods for the origins of intermittent and perennial streams. Version 3.1](#). North Carolina Department of Environment and Natural Resources, Division of Water Quality. Raleigh, NC.

distribution of total scores was evaluated. It was quite evident by the data that there were scores that strictly fell within one particular waterbody type (ephemeral, intermittent, or perennial) and scores that overlapped between the different groups (Figure 1). From this review, a minimum total score of 9.0 is set as a guideline to distinguish ephemeral channels from non-ephemeral ones. In addition, a Level 1 score greater than 22.0 should be used to distinguish perennial streams from non-perennial streams. SWQB recognizes that there is inherent variability in nature, therefore Level 1 scores between 9 and 12 may be ephemeral but will be recognized as intermittent until further data collection and analysis through a Level 2 evaluation or detailed UAA can more clearly determine that the stream is ephemeral. Similarly, Level 1 scores between 19 and 22 may be intermittent but will be recognized as perennial until further data collection and analysis indicate that the stream is intermittent. Table 4 summarizes the numeric thresholds for distinguishing among ephemeral, intermittent and perennial waters. Unfortunately, the dataset is not large enough at this time to perform a distribution analysis to evaluate the fit of the score ranges in Table 4.

The *Hydrology Protocol* is considered to be an evolving, living document. . In the event that new data indicate the threshold values used in this protocol are not appropriate and/or if new standards are adopted, SWQB will review the protocol, the related threshold values and differentiating scores. Revisions to the protocol will be proposed to the WQCC as needed in accordance with the process for updating the Water Quality Management Plan/Continuing Planning Process.

**Table 1. Site List for Hydrology Protocol – 2008**

STATION NAME (Stream Gauge ID, if applicable)	STORET ID	WATERBODY TYPE	STREAM DETERMINATION*	Ecoregion	Date Evaluated
Eagle Creek at CR 33 near Dunken	<i>new station</i>	EPHEMERAL STREAM	303d List (WQS reference)	Plains	10/28/2008
Guaje abv Rendija (E089)	28GuajeC007.2	EPHEMERAL STREAM	Stream gauge/303d List	Xeric	7/22/2008
Arroyo Chamiso at Avenida de las Campanas	<i>new station</i>	EPHEMERAL STREAM	Staff observation/suggestion	Xeric	6/25/2008
Rio Salado at NM 550 Nature Trail	<i>new station</i>	EPHEMERAL STREAM	Staff observation/suggestion	Xeric	9/10/2008
Pueblo Canyon abv Bayo WWTP outfall	28Pueblo002.6	EPHEMERAL STREAM	303d List (WQS reference)	Mtns/Xeric	7/21/2008
San Pablo Canyon abv Rio Puerco	33SPablo000.2	EPHEMERAL STREAM	Staff observation/suggestion	Mtns/Xeric	9/18/2008
Canon de Valle abv SR 501 (E253)	30Valle006.0	EPHEMERAL STREAM	Stream gauge/303d List	Mountains	7/22/2008
Arroyo San Jose abv Hwy 96	<i>new station</i>	EPHEMERAL STREAM	Staff observation/suggestion	Mountains	9/16/2008
Apache Creek	80Apache001.5	INTERMITTENT STREAM	Staff observation/suggestion	Mountains	10/9/2008
Water Canyon abv SR 501 (E252)	30WaterC016.6	INTERMITTENT STREAM	Stream gauge/303d List	Mountains	7/21/2008
Santa Fe River blw Frenchie's Field	30SantaFo44.5	INTERMITTENT STREAM	303d List (WQS reference)	Mtns/Xeric	6/26/2008
Senorito Creek blw Nacimiento Mine	33Senorio06.8	INTERMITTENT STREAM	303d List (WQS reference)	Mtns/Xeric	9/18/2008
Carlisle Creek below Carlisle Mine	78Carliso22.3	INTERMITTENT STREAM	303d List (WQS reference)	Mtns/Xeric	10/7/2008
Rio Penasco at NM 24 bridge near Dunken (08397600)	59RPenas108.4	PERENNIAL STREAM	Stream gauge/ suggestion	Plains	10/28/2008
Vallecito Ck at Paliza Campground	31RValle015.5	PERENNIAL STREAM	303d List/ suggestion	Mountains	9/10/2008
La Jara Creek abv irrigation diversion	33LaJara009.7	PERENNIAL STREAM	Staff observation/suggestion	Mountains	9/16/2008
Nacimiento Creek at Eureka Rd. crossing	33Nacimio08.0	PERENNIAL STREAM	303d List (WQS reference)	Mountains	9/16/2008
San Francisco River at Luna	80SanFra154.1	PERENNIAL STREAM	303d List (WQS reference)	Mountains	10/8/2008
Whitewater Creek abv campground	80WhiteWoo8.8	PERENNIAL STREAM	303d List (WQS reference)	Mountains	10/8/2008
Trout Creek at FR 19 bridge	80TroutC002.1	PERENNIAL STREAM	Staff observation/suggestion	Mountains	10/9/2008
Lower Santa Fe River Preserve	30SantaFo30.5	PERENNIAL STREAM	303d List (WQS reference)	Xeric	6/25/2008
Galisteo Creek in Galisteo	30Galisto50.4	PERENNIAL STREAM	Staff observation/suggestion	Xeric	9/9/2008
Galisteo Creek at Hwy 14 near Cerrillos (08317850)	30Galisto30.9	PERENNIAL STREAM	Retired gauge/suggestion	Xeric	9/9/2008
Jemez River abv San Ysidro at NM 4 (08324000)	31JemezRo37.0	PERENNIAL STREAM	Stream gauge/303d List	Xeric	9/10/2008
Gila River at NM 92 Bridge near Virden, NM (09432000)	78GilaRio11.5	PERENNIAL RIVER	Stream gauge/303d List	Xeric	10/7/2008

**NOTES:** \* Waterbody type was determined using known hydrologic characteristics, either due to the presence of a stream gauge and/or historic water quality datasets or due to assessment unit comments in the [303\(d\) List of Assessed Waters](#) and/or staff observation and suggestion.

**Table 2. Site List for Hydrology Protocol – 2009**

STATION NAME (Stream Gauge ID, if applicable)	STORET ID	WATERBODY TYPE*	Ecoregion	Date Evaluated
Rio Peñasco at Dayton, NM (08398500)	59RPenas009.1	EPHEMERAL STREAM	Plains	Sep-09
Rito de los Pinos @ USFS gate on FR 95	33RPinos006.8	EPHEMERAL STREAM	Mountains	6/16/2009
Tijeras Arroyo near Albuquerque, NM (08330600)	32Tijera000.1	EPHEMERAL STREAM	Xeric	6/25/2009
Galisteo Creek blw Galisteo Dam (08317950)	<i>new station</i>	EPHEMERAL STREAM	Xeric	6/25/2009
Rocky Arroyo at Hwy bridge nr Carlsbad (08401900)	<i>new station</i>	EPHEMERAL STREAM	Xeric	Sep-09
Dark Canyon at Carlsbad, NM (08405150)	<i>new station</i>	EPHEMERAL STREAM	Xeric	Sep-09
Revuelto Creek nr Logan, NM (07227100)	11Revuelo03.9	INTERMITTENT STREAM	Plains	7/1/2009
Tinaja Creek above Canadian River	04Tinaja010.1	INTERMITTENT STREAM	Plains	6/9/2009
Perico Creek blw Hwy 402	14Perico012.3	INTERMITTENT STREAM	Plains	6/30/2009
Pueblo Canyon abv SR 502 (E060)	28Pueblo000.3	INTERMITTENT STREAM	Mtns - Xeric	6/4/2009
Cebolla Creek (Rio Pescado to headwaters)	<i>new station</i>	INTERMITTENT STREAM	Xeric - Mtns	5/19/2009
Santa Fe River below Cerro Gordo Rd	30SantaFo52.4	INTERMITTENT STREAM	Xeric - Mtns	5/13/2009
Rio Peñasco near Helena Road (08397620)	59RPenas090.0	INTERMITTENT STREAM	Mountains	Sep-09
Rio Nutria above Tampico Draw	75RNutrio30.2	INTERMITTENT STREAM	Mountains	5/20/2009
Rio Fernando de Taos at Hwy 64 bridge	28RFerna031.7	INTERMITTENT STREAM	Mountains	Sep-09
Gallinas Creek at Lower Gallinas Camground	45Gallino21.5	INTERMITTENT STREAM	Mountains	5/26/2009
Cold Springs Creek above Mimbres R.	45ColdSp009.3	INTERMITTENT STREAM	Mountains	5/26/2009
San Miguel Arroyo @ old Hwy 44	33SanMigo05.7	INTERMITTENT STREAM	Xeric	6/17/2009
Rito Leche at Cubita Rd	33RLeche001.3	INTERMITTENT STREAM	Xeric	6/16/2009
Shumway at Hwy 64 bridge	67Shumwa002.4	INTERMITTENT STREAM	Xeric	6/17/2009
Canadian River at NM 104 at milemarker 88	09Canadi144.5	PERENNIAL RIVER	Plains	7/1/2009
Seneca Creek abv Clayton Lake	16Seneca043.0	PERENNIAL STREAM	Plains	6/30/2009
Rayado Creek near Cimarron, NM (07208500)	05Rayado033.8	PERENNIAL STREAM	Plains	Sep-09
Coyote Creek near Golondrinas, NM (07218000)	07Coyote004.2	PERENNIAL STREAM	Plains	Sep-09
Vermejo River near Dawson, NM (07203000)	04Vermejo38.8	PERENNIAL STREAM	Mountains	6/9/2009
Ponil Creek near Cimarron, NM (07207500)	05PonilCo25.5	PERENNIAL STREAM	Mountains	Sep-09
Rio Nutria near Ramah, NM (09386900)	75RNutrio28.0	PERENNIAL STREAM	Mountains	5/20/2009
Tesuque Crk abv diversions nr Santa Fe (08302500)	28Tesuqu023.4	PERENNIAL STREAM	Mountains	6/4/2009
Pecos River at Windy Bridge (08378500)	<i>new station</i>	PERENNIAL STREAM	Mountains	Sep-09
La Plata River near Farmington, NM (09367500)	67LaPlato00.3	PERENNIAL RIVER	Xeric	6/17/2009
Animas River at Farmington, NM (09364500)	66Animas001.7	PERENNIAL RIVER	Xeric	6/17/2009
Pecos R blw Dark Canyon at Carlsbad (08405200)	60PecosRo93.2	PERENNIAL RIVER	Xeric	Sep-09

NOTES: \* Waterbody type was determined based on application of the Hydrology Protocol and stream gauge data, if applicable.

**Table 3. Average Field Scores of Hydrology Protocol Stream Indicators**

Stream Indicator	Waterbody Type		
	Ephemeral	Intermittent	Perennial
1.1 Water in Channel <sup>A</sup>	0.18	3.18	5.53
1.2 Fish <sup>A</sup>	0	0.21	1.42
1.3 Benthic Macroinvertebrates <sup>A</sup>	0	1.15	2.22
1.4 Filamentous Algae/Periphyton <sup>A</sup>	0	1.06	2.03
1.5 Differences in Vegetation <sup>A</sup>	0.91	2.09	2.63
1.6 Absence of Upland Plants in Streambed <sup>A</sup>	1.96	2.32	2.92
1.7 Sinuosity <sup>A</sup>	0.77	1.28	1.63
1.8 Entrenchment Ratio <sup>A</sup>	0.68	1.72	1.89
1.9 Riffle-Pool Sequence <sup>A</sup>	0.09	0.79	1.86
1.10 Particle Size or Substrate Sorting <sup>A</sup>	0.61	0.85	2.42
1.11 Hydric Soils <sup>A</sup>	0.27	0.35	2.00
1.12 Sediment on Plants/Debris <sup>B</sup>	0.32	0.62	0.81
1.13 Seeps and Springs <sup>NS, ^</sup>	0	0.29	0.39
1.14 Iron-oxidizing Bacteria/Fungi <sup>NS, ^</sup>	0	0.18	0.33
<b>MINIMUM TOTAL SCORE</b>	<b>2.00</b>	<b>9.00</b>	<b>19.5</b>
<b>MAXIMUM TOTAL SCORE</b>	<b>11.3</b>	<b>21.0</b>	<b>32.0</b>
<b>AVERAGE TOTAL SCORE</b>	<b>5.80</b>	<b>15.3</b>	<b>26.5</b>
Continuous Bed and Bank <sup>NS, *</sup>	2.35	2.35	2.84
Leaf Litter <sup>NS, *</sup>	1.03	0.95	1.25
Braided Channel <sup>NS, *</sup>	0.25	0	0.50

NOTES: <sup>A</sup> Difference is significant at  $p < 0.005$  level

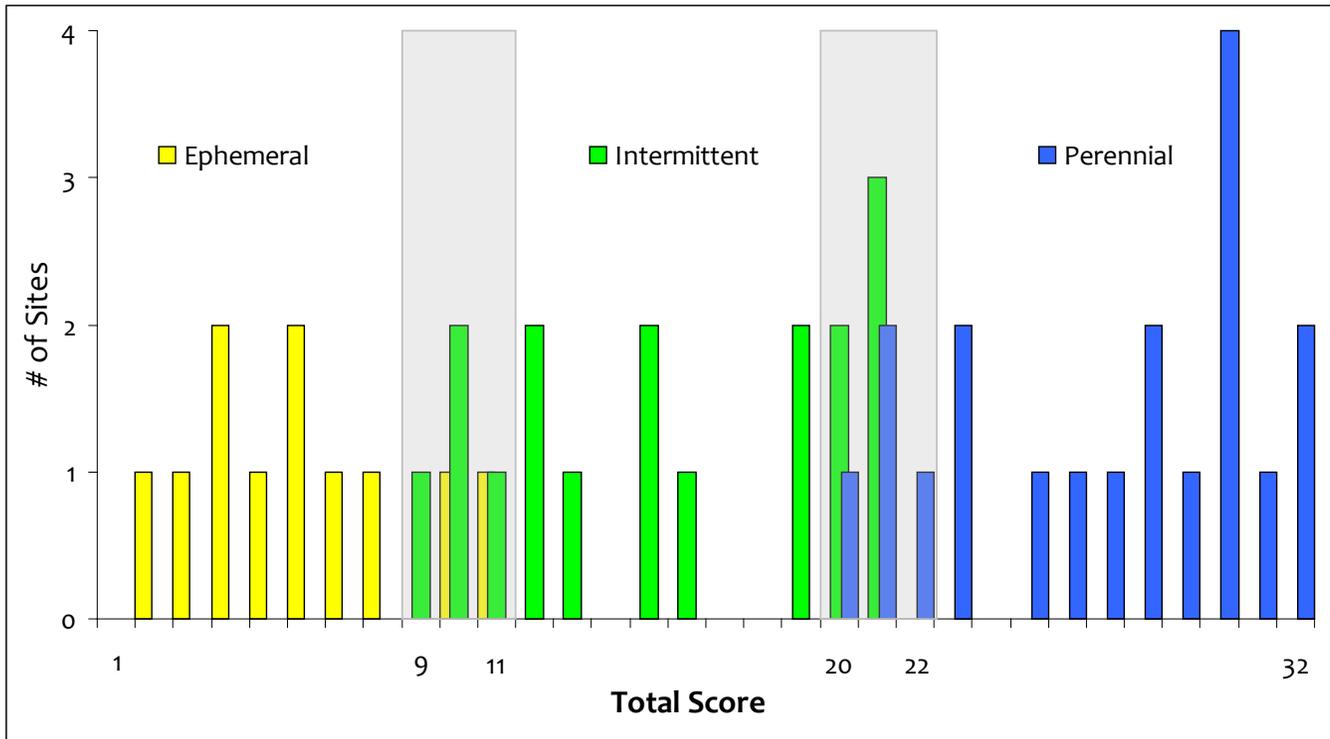
<sup>B</sup> Difference is significant at  $p < 0.01$  level

<sup>NS</sup> Difference is not significant

<sup>^</sup> Field indicator was not statistically significant between waterbody types but may be useful in the determination of perenniality, thus it was included in the protocol as a supplemental indicator only.

<sup>\*</sup> Field indicator was evaluated in the field but was not useful in differentiating hydrologic systems in New Mexico, thus it was not included in the protocol.

**Figure 1. Distribution of Total Scores used to determine threshold ranges**



**Table 4. Summary of Score Interpretation**

Waterbody Type	Level 1 Total Score	Stream Determination
<b>Ephemeral</b>	<b>Less than 9.0*</b>	<b>Stream is ephemeral</b>
	$\geq 9.0$ and $< 12.0$	Stream is recognized as intermittent until further analysis indicates that the stream is ephemeral
<b>Intermittent</b>	$\geq 12.0$ and $\leq 19.0$	<b>Stream is intermittent</b>
	$> 19.0$ and $\leq 22.0$	Stream is recognized as perennial until further analysis indicates that the stream is intermittent
<b>Perennial</b>	<b>Greater than 22.0</b>	<b>Stream is perennial</b>

\* If there are aquatic macroinvertebrates and/or fish the stream is at least intermittent.