Arizona Department of Environmental Quality

Total Maximum Daily Load for Copper and Lead in the Upper Queen Creek Watershed (HUC1505010004)

Queen Creek (15050100-014A, -014B, -014C),

Arnett Creek tributary (15050100-1818),

Unnamed Tributary to Queen Creek UQ3 (15050100-1843)

September 2026

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LIST OF ACRONYMS, SYMBOLS, AND UNITS

§	Section (for federal or state rules or statutes)
∑	Summation
µg/L	Micrograms per Liter
A.A.C.	Arizona Administrative Code
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AgL	Agricultural Livestock Watering (Water Quality Standard)
AMLs	Abandoned Mine Lands
A.R.S.	Arizona Revised Statues
A&We	Aquatic Wildlife Ephemeral (Water Quality Standard)
A&Wedw	Aquatic Wildlife Effluent Dependent Water (Water Quality Standard)
AWQS	Aquifer Water Quality Standards
A&Ww	Aquatic Wildlife and Warm Water (Water Quality Standard)
AZPDES	Arizona Pollutant Discharge Elimination System
BMPs	Best Management Practices
$CaCO_3$	Calcium Carbonate
CGP	Construction General Permit
C.F.R.	Code of Federal Regulations
cfs	Cubic Feet per Second
CS	Composite Sensitivity
Cu	Copper

CWA	Clean Water Act
EPA	United States Environmental Protection Agency
FBC	Full-Body Contact (Water Quality Standard)
FC	Fish Consumption (Water Quality Standard)
HSPF	Hydrological Simulation Program – FORTRAN
HUC	USGS Hydrologic Unit Code
LA	Load Allocation
LDC	Load Duration Curve
mgd	Million Gallons per Day
mg/d	Milligrams per Day
mg/L	Milligrams per Liter
MOS	Margin of Safety
MRDS	Mineral Resources Data System
MS4	Municipal Separate Storm Sewer System
MSGP	Multi-Sector General Permit
MWTP	Mine Water Treatment Plant
NLCD	National Land Cover Database
NPS	Nonpoint Source
OHV	Off-Highway Vehicles
Pb	Lead
PBC	Partial-Body Contact (Water Quality Standard)
pH	logarithmic scale used to specify the acidity or basicity of aqueous solutions
PRISM	Parameter-Elevation Regressions on Independent Slopes Model
PS	Point Source
QC	Queen Creek
QCWG	Queen Creek Working Group
RPD	Relative Percent Difference
SSS	Site-Specific Standards
SSURGO	Soil Survey Geographic Database
TMDL	Total Maximum Daily Load
TNF	Tonto National Forest
TSS	Total Suspended Solids
UQ2	Unnamed Tributary (UQ2) to Queen Creek
UQ3	Unnamed Tributary (UQ3) to Queen Creek
UQCW	Upper Queen Creek Watershed, HUC10-1505010004
USFS	United States Forest Service
USGS	United States Geological Survey
VRP	Volunteer Remediation Project
WBID	Waterbody Identifier
WLA	Waste Load Allocation
WOTUS	Waters of the United States
WQBEL	Water Quality Based Effluent Limitation
WQS	Water Quality Standard
WQX	Water Quality Exchange
WWTP	Wastewater Treatment Plant
XWN	Arizona Cross-Watershed Network

Section 1 INTRODUCTION

To fulfill Clean Water Act (CWA) requirements, states submit a biennial Integrated Report (IR) to the U.S. Environmental Protection Agency (EPA). This report combines the CWA Section 305(b) water quality assessment with the Section 303(d) list of impaired waterbodies requiring action. The CWA mandates that states establish a priority ranking for these impaired waters and develop and implement a Total Maximum Daily Load (TMDL) for each §303(d)-listed impairment.

The purpose of a TMDL is to identify the pollutant reductions necessary for a waterbody to attain and maintain applicable water quality standards and fully support its designated uses. A TMDL is defined as the sum of individual waste load allocations (WLAs) for point sources (PS) and load allocations (LAs) for nonpoint sources (NPS) and natural background, ensuring the waterbody's overall capacity to assimilate pollutant loading—its loading capacity—is not exceeded (40 C.F.R. §130.2).The upper reach of Queen Creek (15050100-014A) was listed as impaired in the 2002 IR; that listing was followed by the middle reach of Queen Creek (15050100-014B) in 2004, and the lower reach of Queen Creek (15050100-14C), Arnett Creek (15050100-1818), and an unnamed tributary to Queen Creek (UQ3, 15050100-1843) in 2010; each for dissolved copper. Additionally, Queen Creek (150501000-014A) was listed as impaired for total lead in the 2010 IR. These listings require TMDL development.

This TMDL report is organized with the following sections, addressing all required components of a TMDL:

- **Problem Statement** describing the impairment(s) to be addressed by these TMDLs (Section 2);
- **Setting** presents the physical conditions in and around Queen Creek, Arnett Creek, and UQ3 that influence pollutant loading conditions (Section 3);
- **Water Quality Standards and Numeric Endpoint Targets** identify the applicable designated uses and criteria that are used for data assessment and TMDL calculations (Section 4);
- **Data Evaluation** presents a review of available water quality data, including a comparison to applicable criteria (Section 5);
- **Source Assessment** identifies potential sources of the pollutants of concern (Section 6);
- **Technical Approach** presents the range of approaches and the selected approach for TMDL development (Section 7);
- **Linkage Analysis** describes the methodology and analyses conducted to calculate the relationship between pollutant sources and receiving water conditions (Section 8);
- **TMDL Development** presents the loading capacity and allocations, the identified margin of safety (MOS), and seasonality and critical conditions (Section 9);
- **Implementation Planning** describes the regulatory and non-regulatory mechanisms by which the relevant stakeholders may achieve compliance with the TMDL allocations (Section 10); and
- **Public Participation** describes the activities undertaken to ensure adequate participation in the TMDL development process by members of the public and any significant comments on the TMDL from members of the public (Section 11).

Section 2 PROBLEM STATEMENT

The waterbodies of Queen Creek (15050100-014A, 15050100-014B, and 15050100-014C), Arnett Creek (15050100-1818), and Unnamed Tributary to Queen Creek, UQ3, (15050100-1843) within the Upper Queen Creek watershed (UQCW) are listed as impaired due to dissolved copper. Additionally, Queen Creek (15050100-014A) is listed as impaired due to total lead. These pollutant parameters have caused or contributed to the loss of designated uses within these waterbodies (Table 1). The 303(d) listed waterbodies within the watershed are shown in Figure 1.

Table 1. Impaired waterbody ID, waterbody name, pollutant causing impairment, use designation, year of listing, and source of pollutant.

Waterbody Assessment Unit and Waterbody Name	Pollutant	Impaired Designated Uses	Year Listed	Pollutant Sources
15050100-014A, Queen Creek-Headwaters to Superior WWTP	Dissolved Copper	Aquatic & Wildlife Warm Water	2002	Historic mining operations & natural background conditions
	Total Lead	Partial Body Contact	2010	Historic mining operations & natural background conditions
15050100-014B, Queen Creek-Superior WWTP to Potts Canyon	Dissolved Copper	Aquatic & Wildlife Effluent Dependent	2004	Historic mining operations & natural background conditions
15050100-014C, Queen Creek- Potts Canyon to Whitlow Dam	Dissolved Copper	Aquatic & Wildlife Warm Water	2010	Historic mining operations & natural background conditions
15050100-1818, Arnett Creek	Dissolved Copper	Aquatic & Wildlife Warm Water	2010	Historic mining operations & natural background conditions
15050100-1843, Unnamed Tributary to Queen Creek (UQ3)	Dissolved Copper	Aquatic & Wildlife Ephemeral	2010	Historic mining operations & natural background conditions

The Unnamed Tributary (UQ2) to Queen Creek, WBID 15050100-1000, was also impaired for dissolved copper in 2010. ADEQ completed a WOTUS evaluation for all impaired surface waters in the watershed as part of the TMDL watershed analysis. UQ2 was determined to be non-WOTUS and not included in the report. UQ2, however, was used in the HSPF model and included for calculations in the TMDLs pollutant loading analysis.

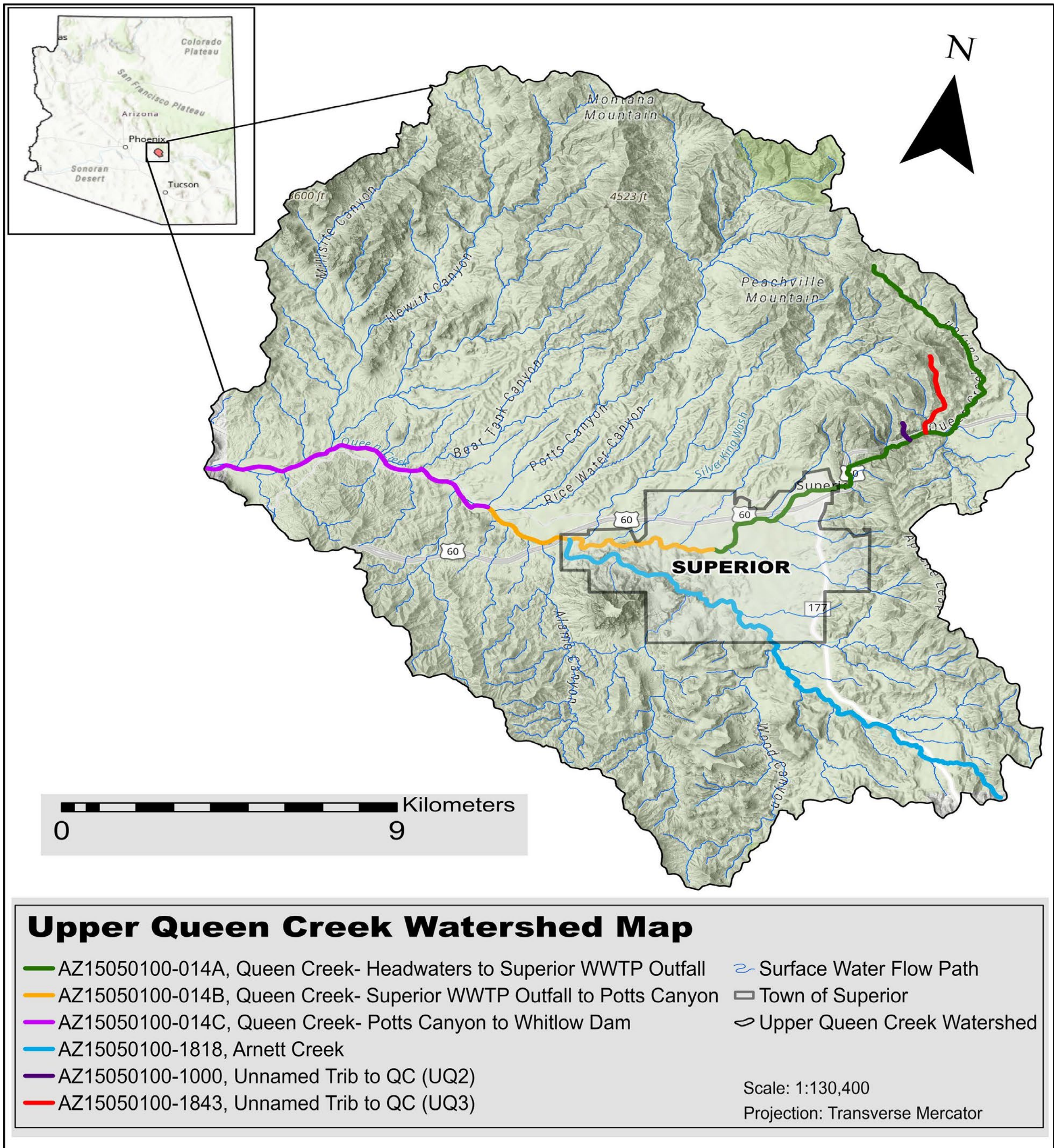

Figure 1. Location of 303(d) listed waterbodies in the UQCW.

Section 3 SETTING

The UQCW is approximately 64 miles east of Phoenix, AZ in Pinal County. The watershed is found within the northeastern portion of the Middle Gila Subbasin (HUC 15050100). The UQCW includes the drainage area to Whitlow Dam, just upstream of Queen Valley, AZ. The watershed is mostly undeveloped with the only major populated area being the town of Superior. The town is located on the eastern side of the watershed at the intersection of highways US Route 60 and State Route 177.

The headwaters of Queen Creek begin in the northeast edge of the watershed below Fortuna Peak as a high gradient, intermittent, arid mountain stream. Queen Creek descends southwesterly towards and through the town of Superior, then to the Whitlow Ranch Dam at the end of the watershed, then continues west to the Roosevelt Irrigation Canal near Queen Creek, AZ.

The upper watershed is dominated by bedrock outcrops and shallow soils. Two prominent tributary groups flow into Queen Creek at this rocky higher elevation. Several unnamed tributaries on the northern ridge of the canyon, including UQ2 and UQ3 flow to Queen Creek from steep bedrock cliffs. A second set of high elevation tributaries originates on the easterly side of a prominent ridge known as Apache Leap and joins Queen Creek in the area known as Oak Flat. From here, Queen Creek flows steeply approximately 2.5 miles along US Highway 60 toward the town of Superior. From Superior to the Whitlow Ranch flood control dam, the stream takes on the characteristics of a low gradient, desert foothill stream dominated by thick piedmont sediments and infrequent undulating bedrock.

The UQCW is located within Arizona's "Copper Triangle", a region of the state typified by rich copper deposits. As a result of the abundant copper in the region, large-scale mining has occurred in the watershed since at least the late 1870s after silver and copper were discovered near current day Superior. The watershed's metal rich geology, combined with a deep-seated history of mining has created a complex relationship of metals loading to surface waters in the watershed.

3.1 Geology, Topography and Land Use-Cover

3.1.1 Soil Characteristics

Soil type and characteristics from Soil Survey Geographic Database[1] (SSURGO) were used to inform the HSPF model utilized to establish TMDLs for the impaired waters. The soil types for the watershed are presented in Figure 2. The SSURGO data was used to inform model parameterization. Mined lands shown in Figure 2 were determined by a combination of SSURGO and a digitized map layer created by environmental consultants SWCA. The mined lands layer is made up of current and historic mining land use footprints in the watershed.

[1] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.nrcs.usda.gov/.

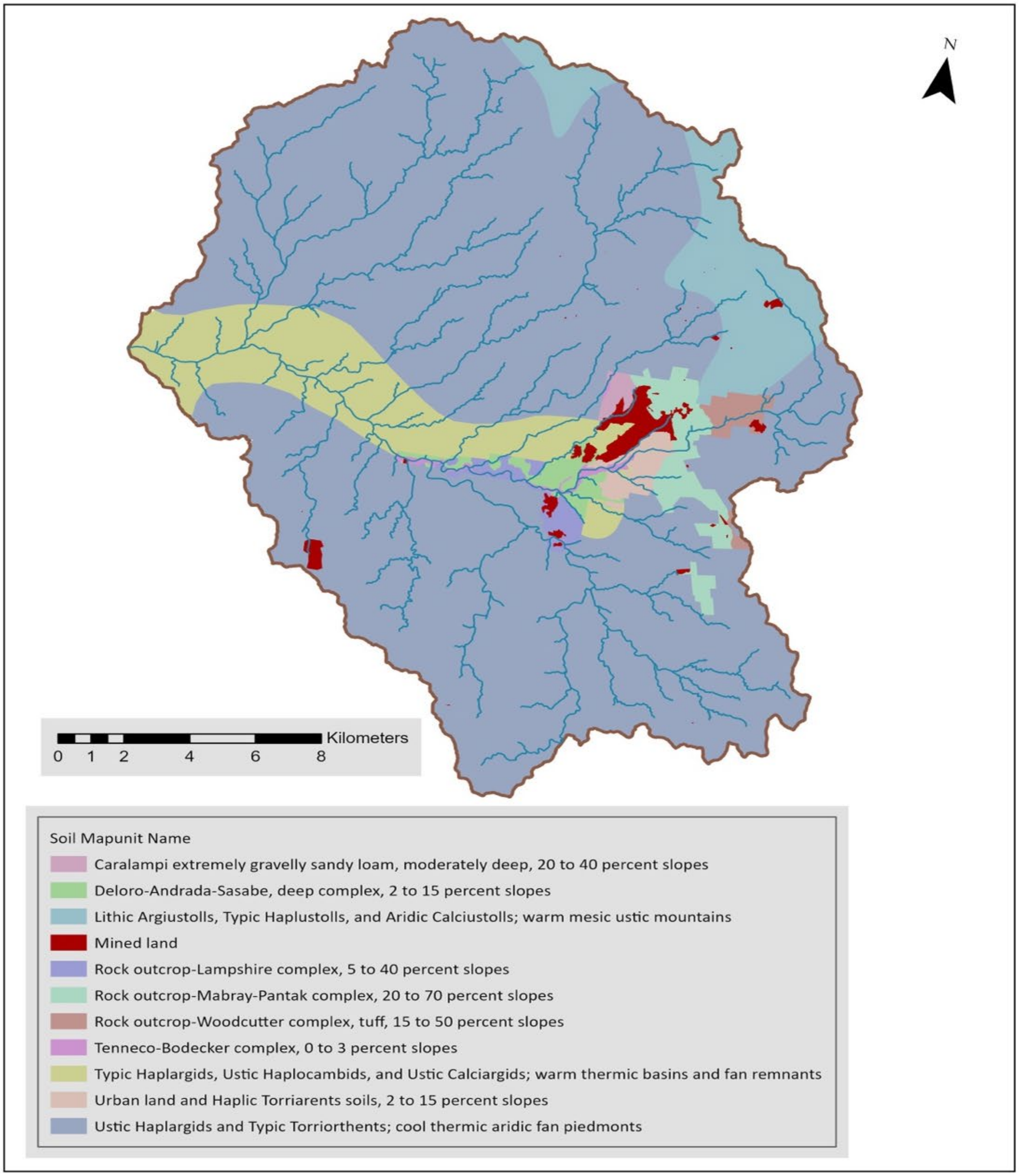

Figure 2. SSURGO distribution of soil types and mined land.

3.1.2 SLOPE

The land slopes range from near vertical in the highest reaches in the northern and eastern portion of the watershed to generally flat gentle foothills in the middle and western areas (Figure 3). However, to parameterize the HSPF model, the average slope was calculated 100 yards on either side of each model reach segment.

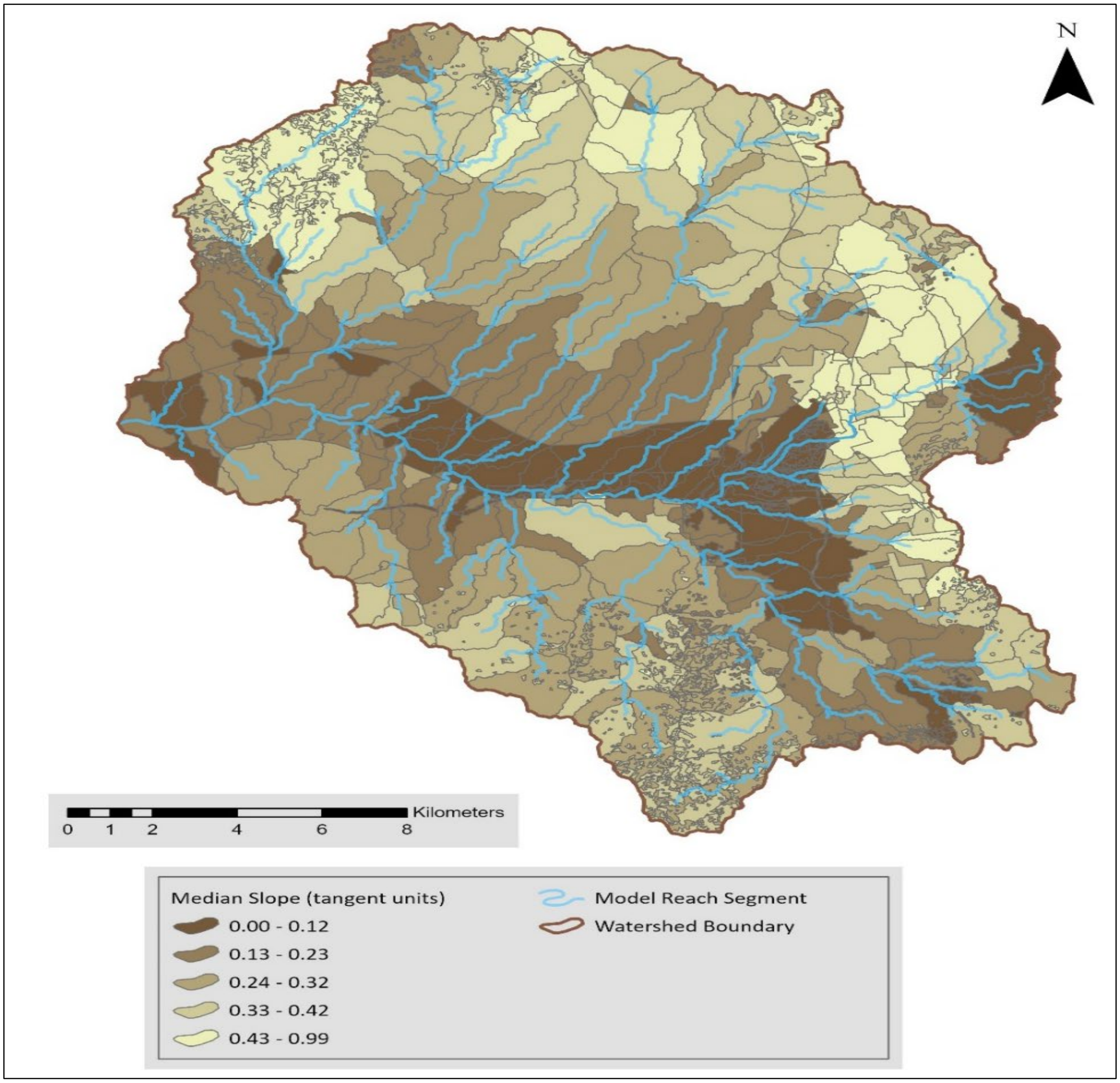

Figure 3. Land slopes in the Queen Creek watershed shown as the median tangent value for each model sub-basin.

3.1.3 LAND USE/LAND COVER

The watershed is dominated by shrub/scrub having greater than 90 percent coverage, with herbaceous cover over approximately five percent of the area. All other land uses are less than one percent of the area (Figure 4). In and around the town of Superior consists of developed open space, and low- to high-density residential and commercial buildings. Farther downstream, the Queen Creek watershed becomes less channelized due to changes in topography and human-made flood mitigation structures resulting in portions of emergent wetland features near Whitlow Ranch Dam (USGS, 2025). Mined lands are classified as both Barren and Developed land in the figure.

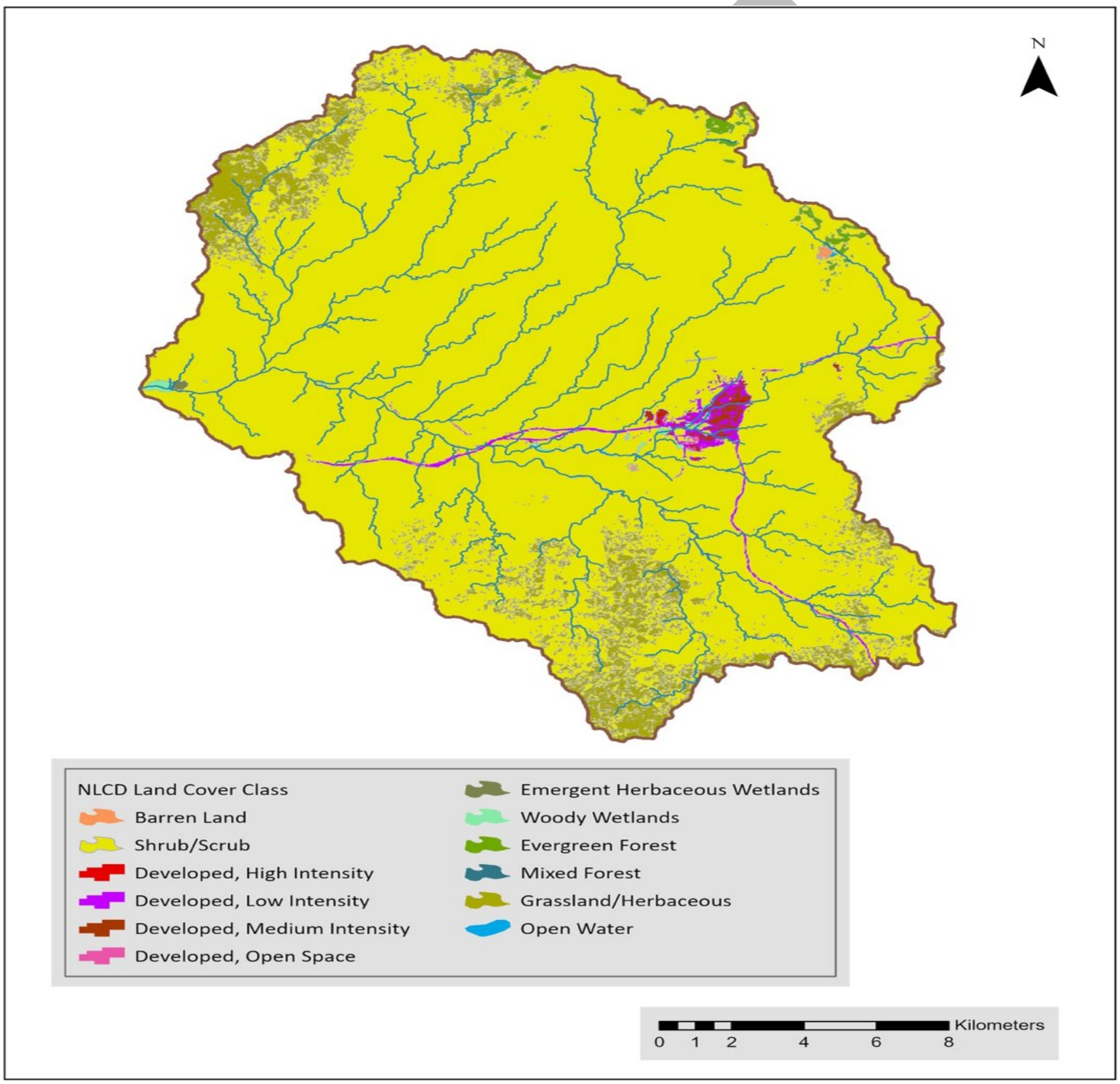

Figure 4. Land use and land cover within the Queen Creek watershed.

3.2 CLIMATE

Climate in the Queen Creek watershed varies with elevation. Climate data for the Town of Superior is presented in Table 2. Higher elevations in the mountains are cooler and substantially wetter than desert in the lower elevation areas of the watershed.

There are two regional wet seasons; a summer monsoon with intense precipitation characterized by spotty and short duration convective thunderstorms, and the winter with longer duration lower intensity events associated with passing low-pressure cold fronts. Snow may fall in the higher elevation areas of the watershed but typically melts within a few days.

Table 2. Climate data for Superior, AZ extracted from the Western Regional Climate Center.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Record high (°F)	81	87	91	96	105	111	112	110	106	102	89	83	112
Mean daily maximum (°F)	60.9	64.1	68.5	76.4	86.1	95.6	97.7	95.4	92.3	82.5	69.8	61.6	79.2
Mean daily minimum (°F)	43.2	45.4	48.2	54.4	62.7	72.0	75.7	74.2	71.2	62.0	51.1	44.0	58.7
Record low (°F)	20	20	24	29	38	51	59	61	50	33	29	19	19
Average rainfall (inches)	2.00	1.98	2.02	0.80	0.34	0.26	1.91	2.80	1.48	1.18	1.41	2.11	18.29
Average rainy days (≥ 0.1 inch)	4	4	4	2	1	1	4	5	3	2	2	4	36
Average rainy days (≥ 0.5 inch)	2	1	2	1	0	0	1	2	1	1	1	2	14
Average rainy days (≥ 1.0 inch)	0	0	0	0	0	0	0	1	0	0	0	1	2

Section 4 WATER QUALITY STANDARDS AND NUMERIC ENDPOINT TARGETS

Water quality standards are legal standards promulgated by the State of Arizona (Title 18, Chapter 11 of the Arizona Administrative Code [A.A.C. R18-11]) which establishes designated uses for waters of the state, along with rules and criteria for the protection of those uses. See Table 5 for specific water quality targets. Water quality standards are composed of three elements:

1. Designated Uses
2. Narrative and/or Numeric Water Quality Criteria, and
3. Antidegradation Policy

A numeric endpoint target identifies the specific goal or endpoint for the TMDL which signifies attainment of the waterbody's assigned designated uses. The numeric target may be equivalent to a numeric water quality criterion (if one exists), or it may represent a numeric translation of a narrative water quality standard. This section identifies the water quality standard(s) and designated use(s) applicable to the waterbody and identifies appropriate numeric endpoint targets in TMDLs for dissolved copper in Queen Creek, Arnett Creek, and UQ3, and total lead in Queen Creek.

4.1 Water Quality Standards

Queen Creek, Arnett Creek, and UQ3 are listed as impaired due to water quality which is inconsistent with the support of applicable designated uses for aquatic and wildlife. Additionally, the upper reach of Queen Creek, -014A, is listed as impaired due to water quality which is inconsistent with the support of partial body contact.

4.1.1 Designated Uses

40 C.F.R. 131.3(f) defines designated uses as "those uses specified in the water quality standards regulations for each waterbody or segment whether or not they are being attained." The State of Arizona has established ten designated uses at A.A.C. R18-11-104, as well as narrative and numeric criteria for protection of those uses. Waterbodies and their designated uses are listed in A.A.C. R18-11, Appendix B. Waterbodies not listed in A.A.C. R18-11, Appendix B, but which are tributaries to a listed waterbody, are assigned designated uses according to the Tributary Rule in R18-11-105. Designated uses applicable to the waterbodies subject to this TMDL are listed in Table 3.

Table 3. Designated uses applicable to the impaired waterbodies addressed in the TMDL.

Designated Use	Description	Waterbodies
Agricultural Livestock Watering (AgL)	The use of surface water as a water supply for consumption by livestock.	Queen Creek (15050100-014A) Queen Creek (15050100-014C)
Aquatic and Wildlife (warm water) (A&Ww)[1]	The use of a surface water by animals, plants, or other warm-water organisms, generally occurring at an elevation less than 5,000 feet, for habitation, growth, or propagation.	Queen Creek (15050100-014A) Queen Creek (15050100-014C) Arnett Creek (15050100-1818)
Aquatic and Wildlife (ephemeral) (A&We)[1]	The use of an ephemeral water by animals, plants, or other organisms, excluding fish, for habitation, growth, or propagation.	UQ3 (15050100-1843)
Aquatic and Wildlife (effluent-dependent water) (A&Wedw)[1]	The use of an effluent-dependent water by animals, plants or other organisms for habitation, growth, or propagation.	Queen Creek (15050100-014B)
Fish Consumption (FC)	The use of a surface water by humans for harvesting aquatic organisms for consumption. Harvestable aquatic organisms include, but are not limited to, fish, clams, turtles, crayfish, and frogs.	Queen Creek (15050100-014C) Arnett Creek (15050100-1818)
Full-Body Contact (FBC)	The use of a surface water for swimming or other recreational activity causes the human body to come into direct contact with the water to the point of complete submergence. The use is such that ingestion of the water is likely and sensitive body organs, such as the eyes, ears, or nose, may be exposed to direct contact with the water.	Queen Creek (15050100-014C) Arnett Creek (15050100-1818)
Partial-Body Contact (PBC)[1]	The recreational use of a surface water that may cause the human body to come into direct contact with the water, but normally not to the point of complete submergence (for example, wading or boating). The use is such that ingestion of the water is not likely and sensitive body organs, such as the eyes, ears, or nose, will not normally be exposed to direct contact with the water.	Queen Creek (15050100-014A) Queen Creek (15050100-014B) UQ3 (15050100-1843)

[1] Designated Use not attaining water quality standards.

4.1.2 Water Quality Criteria

Arizona has promulgated water quality standards approved by EPA in that are applicable to copper and lead in UQCW at A.A.C. R18-11, Appendix A. Table 4 summarizes the water quality criteria.

Table 4. Applicable water quality criteria to this TMDL effort.

Designated Use	Parameter	Criterion[1]
Agricultural Livestock Watering (AgL)	Total Copper	500 µg/L
	Total Lead	100 µg/L
Aquatic and Wildlife (warm water) (A&Ww)[2], Aquatic and Wildlife (effluent-dependent water) (A&Wedw)[2]	Dissolved Copper	15.9 µg/L (Acute) 10.5 µg/L (Chronic)
	Dissolved Lead	78.7 µg/L (Acute) 3.1 µg/L (Chronic)
Aquatic and Wildlife (ephemeral) (A&We)[2]	Dissolved Copper	27.6 µg/L (Acute)
	Dissolved Lead	166 µg/L (Acute)
Full-Body Contact (FBC) and Partial-Body Contact (PBC)[2]	Total Copper	1,300 µg/L
	Total Lead	15 µg/L

[1] Aquatic life criteria calculated at a hardness of 120 mg/L as $CaCO_3$.
[2] Designated Use not attaining water quality standards.

Per Title 18 of the Arizona Administrative Code (A.A.C.) Chapter 11, Department of Environmental Quality – Water Quality Standards, (18 A.A.C. 11) the Aquatic and Wildlife Warmwater (A&Ww) and Aquatic and Wildlife Effluent Dependent (A&Wedw) chronic dissolved copper water quality standard (WQS) is an equation based on the concurrently collected hardness, as follows:

A&Ww and A&Wedw chronic dissolved Cu WQS (mg/L): $e^{(0.8545*LN(Hardness)-1.702)}*(0.96)$

The Aquatic Wildlife Ephemeral (A&We) dissolved copper WQS is evaluated for acute effects and is calculated as follows:

A&We acute dissolved Cu (mg/L): $e^{(0.9422*LN(Hardness)-1.1514)}*(0.96)$

For both of the above equations, hardness[2] is measured in mg/L as $CaCO_3$. For A&Ww, the hardness is measured in the receiving water, and for A&Wedw and A&We, the hardness is evaluated in the effluent discharging to the receiving water. The 0.96 term at the end of each of the above equations is the translator from total to dissolved copper.

[2] Per footnote to Table 1 of 18 A.A.C. 11: Hardness, expressed as mg/L $CaCO_3$, is determined according to the following criteria:

"If the receiving water body has an A&We or A&Ww designated use, then hardness is based on the hardness of the receiving water body from a sample taken at the same time that the sample for the metal is taken, except that the hardness may not exceed 400 mg/L $CaCO_3$. "

"If the receiving water has an A&Wedw or A&We designated use, then the hardness is based on the hardness of the effluent from a sample taken at the same time that the sample for the metal is taken, except that the hardness may not exceed 400 mg/L $CaCO_3$."

The 303(d) listed impairment for total lead is based on the Partial Body Contact (PBC) use with WQS:

PBC total Pb WQS = 15 µg/L

4.1.3 ANTIDEGRADATION POLICY

The Antidegradation Policy promulgated in A.A.C. R18-11-107(B) states that:

> "Tier 1: The level of water quality necessary to support an existing use shall be maintained and protected. No degradation of existing water quality is permitted in a surface water where the existing water quality does not meet the applicable water quality standards."

Tier 1 antidegradation protection applies to surface waters listed on the state's 303(d) list, including those covered under this TMDL, for the pollutant that resulted in the listing. Based on the above provision, the Antidegradation Policy prohibits any water quality degradation which would interfere with or prevent attainment with existing designated uses.

4.2 TMDL NUMERIC ENDPOINT TARGETS

Numeric targets are a required component of a TMDL. A numeric target is the quantitative value used to calculate the loading capacity and evaluate whether the applicable designated uses are attained. The aquatic and wildlife metals criteria are functions of hardness. A watershed hardness of 120 mg/L as CaCO3 is representative of watershed conditions (see Section 5.1) and is used to calculate the WQS in Table 4. The lowest concentration is selected for the TMDL numeric target for dissolved copper. Dissolved lead is meeting WQS in all surface water segments in the watershed, except in the most upper reach of Queen Creek, -014A, where total lead is listed as impaired under the PBC beneficial use. Per the available data (see Section 5.1), an order of magnitude reduction in total lead is necessary to comply with the designated use. The total lead PBC objective is the TMDL numeric target. The selected targets are listed in Table 5.

Table 5. UQCW TMDL numeric targets.

Pollutant Parameters	TMDL Numeric Target
Dissolved Copper (A&Ww and A&Wedw)	10.5 µg/L
Dissolved Copper (A&We)	27.6 µg/L
Total Lead	15 µg/L

Section 5 DATA EVALUATION

An important step in the TMDL development process is the review of existing water quality monitoring data. Examination of these data assists in defining the impairment that the TMDL will address and provides a basis for future implementation efforts by identifying potential sources through pattern analysis. This section provides a review of the available water quality and sediment quality data in the UQCW.

5.1 Water Quality Data – Streams and Effluent

Superior Wastewater Treatment Plant (WWTP) monitoring data are summarized in Table 6. Data availability was limited to the period of 2019 through 2025. Water quality monitoring for metals and hardness is performed quarterly, and total suspended solids are measured monthly. More recent reported effluent copper concentrations were three orders of magnitude less than earlier values and were assumed to have incorrect unit conversions which were corrected prior to summarizing and as shown in Table 6. All lead measurements resulted in non-detect at a lab detection limit of 0.001 mg/L, therefore one half that value, 0.0005 mg/L, is assumed for the model input. The average discharge flow rate is approximately 0.21 mgd (0.33 cfs).

Table 6. Water quality data for Superior WWTP for the period 2019 through 2025.

Parameter	Units	n	Mean	25th Percentile	Median	75th Percentile
Copper, total recoverable	µg/L	26	8.5	5.1	6.3	11.8
Lead, total recoverable	µg/L	16	0.5[1]	0.5[1]	0.5[1]	0.5[1]
Hardness, total	mg/L[2]	28	158	140	150	170
Solids, total suspended	mg/L	66	6.6	0.5	3.0	8.9

1 All measurements not detected at 0.001 mg/L. One half detection limited used as a substitute.

2 Measured as $CaCO_3$

Water quality data (ambient) for rivers and streams used in this effort were extracted from the national Water Quality Portal (the WQX component) for the period 2001–2025. Water quality sampling locations on HSPF model reaches are shown in Figure 5. All sample locations on tributaries to the HSPF model reaches were not considered in the model calibration as they may be unrepresentative of the larger tributaries and main stem of QC. The bulk of water quality data were collected prior to 2014 with only occasional sampling events between 2014 and 2025.

Available dissolved copper water quality monitoring data are summarized in Table 7. Available total lead water quality data are summarized in Table 8. Receiving water data for total hardness and total suspended solids are presented in Table 9. For both copper and lead concentration, the total fraction shows a higher degree of variability than the dissolved fraction due to the high level of metals associated with soil particles. In some locations, the mean concentration is greater than the 75th percentile implying extremely high concentrations in the dataset.

The water quality data were reviewed as part of the QA/QC data quality review, prior to their use in calibrating the HSPF model. The following analyses and checks were completed:

1. Review existing qualifiers published in the Water Quality Portal.
2. Check for negative values.
3. Check for and reconcile different measurement unit assignments.
4. Complete a mass balance check for dissolved versus total fractions using a relative percent difference (RPD) threshold of 20 percent. Discarded samples that were above the RPD threshold.
5. Examine consistent laboratory analytical methods used.
6. Assess detection in field blanks.
7. Check the consistency of replicates using a RPD threshold of 20 percent and then insert the *maximum of the pair* if the RPD was below 20 percent.

8. Check for outliers, both moderate and extreme, review, and discard extreme values if not appropriate.

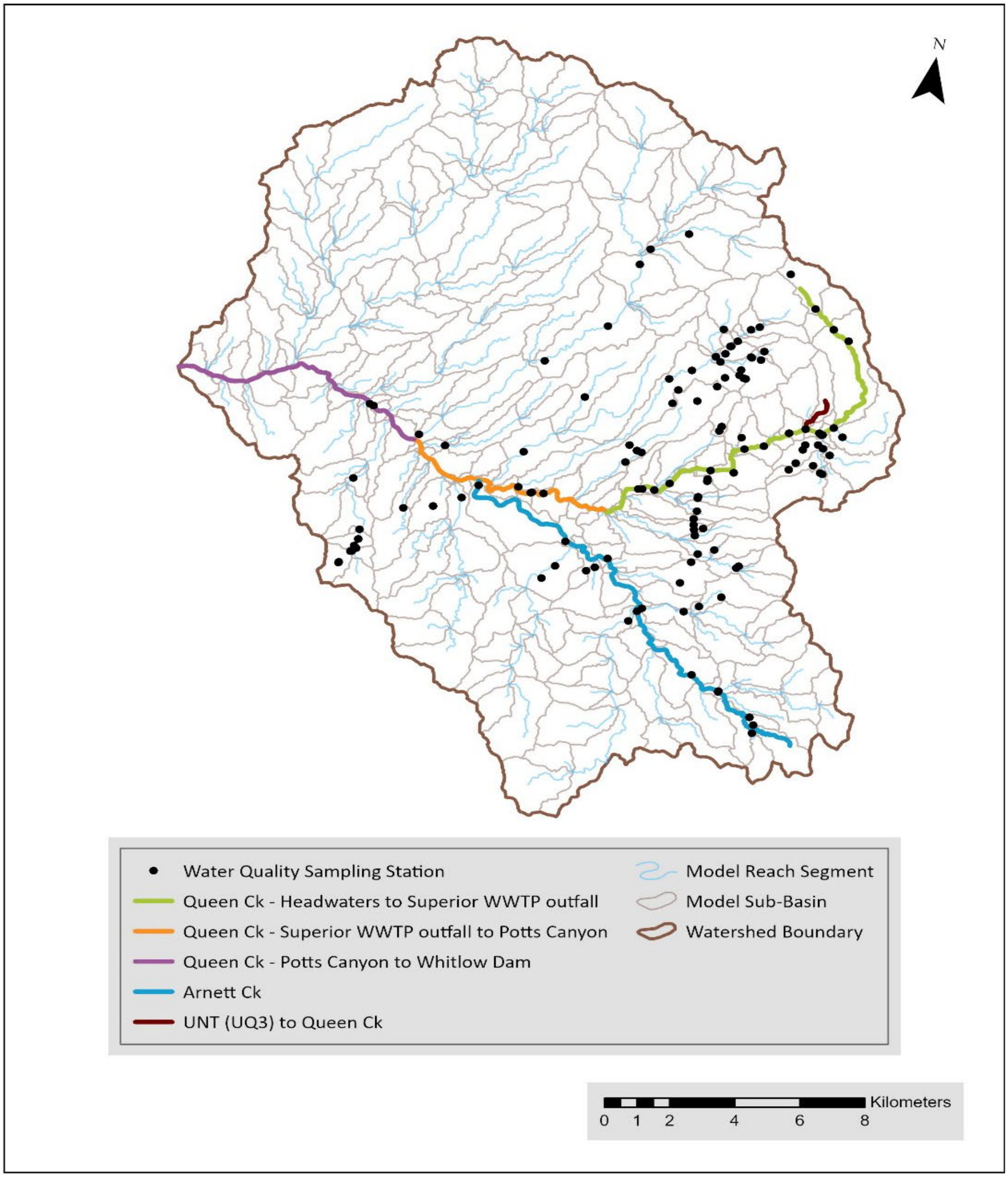

Figure 5. Water quality monitoring sites on HSPF reaches in the UQCW.

Table 7. Available dissolved copper water quality data in the UQCW.

Parameter/ Location	Year Range of Data[1]	n	Concentration (µg/L)			
			Mean	25th Percentile	Median	75th Percentile
-014A 303d[2]	2001-2023	112	13.9	8.4	11.0	14.3
-014A Tributaries	2009-2010	13	58.9	8.4	11.3	26.3
-014B 303d[3]	2002-2023	52	15.3	9.3	11.5	17
-014B Tributaries	2003-2023	122	13.8	6.7	11.0	18
-014C 303d[4]	2005-2024	12	20.6	10.0	17.5	26.3
-014CTributaries	2005-2025	205	31.8	20.0	32.8	41
Arnett Creek 303d[5]	2003-2014	24	21.1	4.7	18.9	26
Arnett Tributaries	2004-2016	45	11.3	7.1	9.8	13
UQ3 303d[6]	2010-2010	3	27.6	25.3	26.4	29.3

1 Data may not be available for all years in range
2 Queen Creek from headwaters to Superior WWTP outfall
3 Queen Creek from Superior WWTP outfall to Potts Canyon
4 Queen Creek from Potts Canyon to Whitlow Dam
5 Arnett Creek from headwaters to confluence with Queen Creek
6 Unnamed Tributary to Queen Creek

Table 8. Available total lead water quality data in the UQCW.

Parameter/ Location	Year Range of Data[1]	n	Concentration (µg/L)			
			Mean	25th Percentile	Median	75th Percentile
-014A[2] 303d	2001-2023	108	1,317	2.5	30.4	140
-014A Tributaries	2009-2010	13	339	2.8	33.0	213
-014B[3] 303d	2002-2023	53	49.9	5.0	26.0	64.0
-014B Tributaries	2003-2023	126	117	2.5	11.5	82.6
-014C[4] 303d	2005-2024	12	221	10.3	70.5	130
-014CTributaries	2005-2025	205	178	2.5	20.0	62.0
Arnett[5] 303d	2003-2014	26	19.7	1.5	2.5	6.8
Arnett Tributaries	2004-2016	43	189	21.5	81.0	235
UQ3[6] 303d	2010-2010	3	4.1	3.1	4.9	5.5

1 Data may not be available for all years in range
2 Queen Creek from headwaters to Superior WWTP outfall
3 Queen Creek from Superior WWTP outfall to Potts Canyon
4 Queen Creek from Potts Canyon to Whitlow Dam

5 Arnett Creek from headwaters to confluence with Queen Creek
6 Unnamed Tributary to Queen Creek

Table 9. Available total hardness and total suspended solids data in the UQCW.

Parameter/ Location	Year Range of Data[1]	n	Concentration (mg/L)			
			Mean	25th Percentile	Median	75th Percentile
Total Hardness						
-014A[2] 303d	2001-2012	67	174	75	110	165
-014A Tributaries	2010-2010	12	375	110	190	553
-014B[3] 303d	2002-2009	45	189	89	120	183
-014B Tributaries	2003-2010	111	1,110	83	135	507
-014C[4] 303d	2005-2008	8	131	96	120	160
-014CTributaries	2005-2025	114	166	29	81	168
Arnett[5] 303d	2005-2014	15	222	94	129	221
Arnett Tributaries	2006-2016	40	261	130	205	323
UQ3[6] 303d	2010-2010	3	29	20	23	35
Total Suspended Solids						
-014A 303d	2001-2023	17	13	4	6	10
-014A Tributaries	2002-2023	---	---	---	---	---
-014B 303d	2003-2023	9	234	2	2	26
-014B Tributaries	2005-2024	12	13	3	5	22
-014C 303d	2005-2025	2	49	27	49	71
-014CTributaries	2003-2014	19	32	5	5	5
Arnett Creek 303d	2004-2004	20	10	3	5	6
Arnett Tributaries	2001-2023	2	3	3	3	3
UQ3 303d	--	--	--	--	--	--

1 Data may not be available for all years in range
2 Queen Creek from headwaters to Superior WWTP outfall
3 Queen Creek from Superior WWTP outfall to Potts Canyon
4 Queen Creek from Potts Canyon to Whitlow Dam
5 Arnett Creek from headwaters to confluence with Queen Creek
6 Unnamed Tributary to Queen Creek

5.2 Soil Chemistry Data

Measured copper concentrations in soil samples surrounding select receiving waters are shown in Figure 6. The magnitude of the measurements is shown graphically by the size of the symbol. The lead concentrations in soils are shown in Figure 7. As will be discussed in the parameterization (Section 8.1), these soil measurements are used to set the HSPF model potency factors.

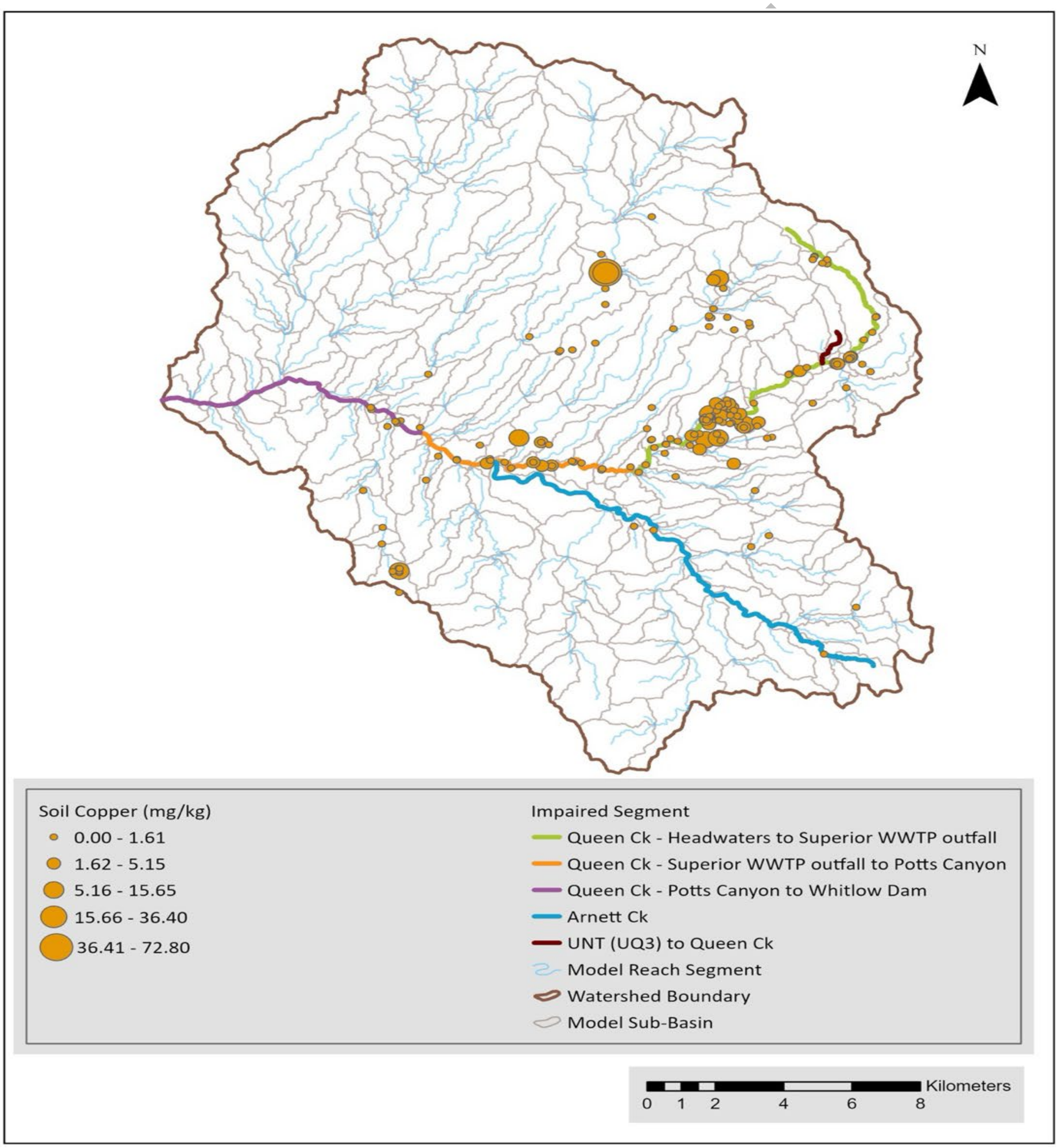

Figure 6. Soil copper measurements in the UQCW.

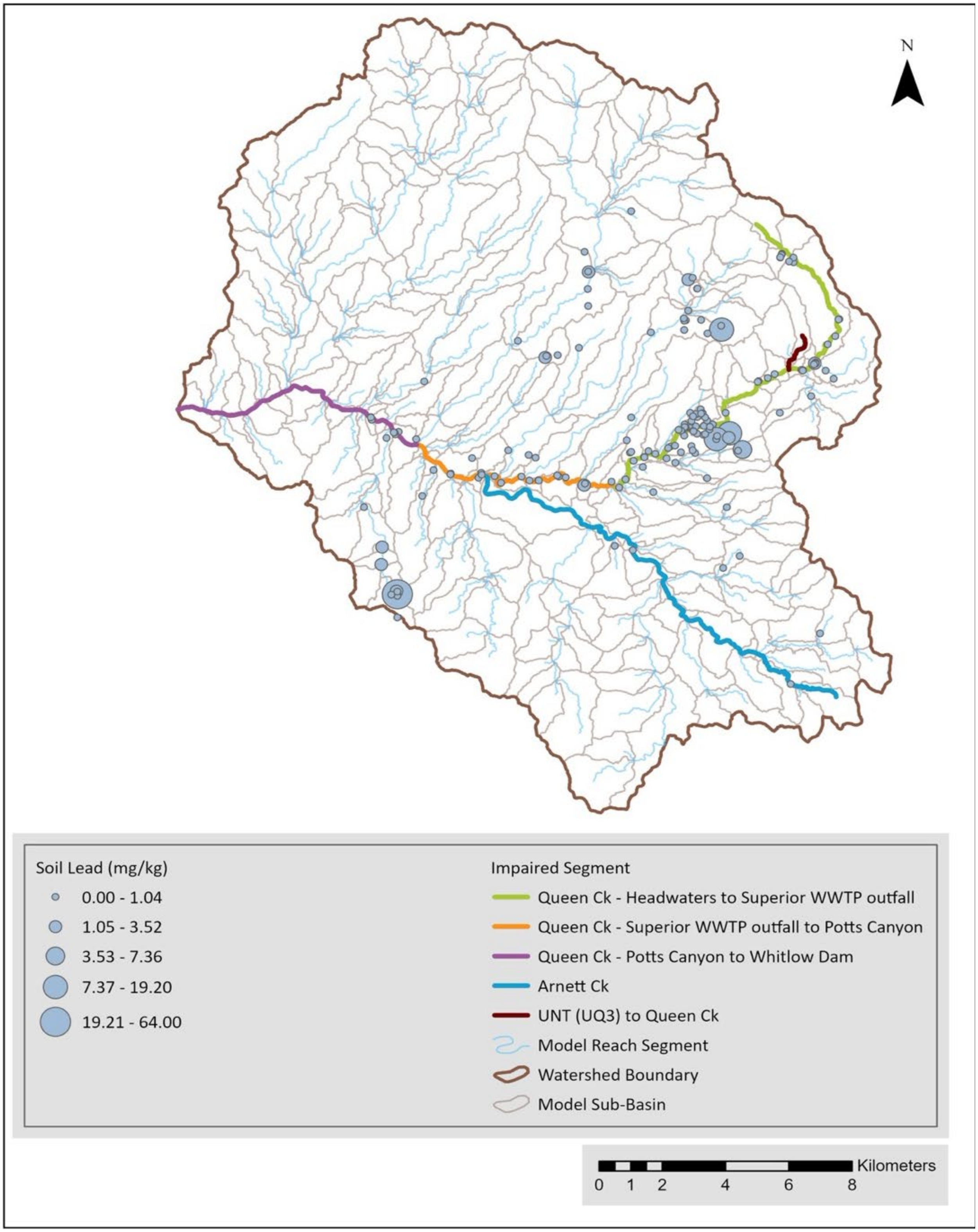

Figure 7. Soil lead measurements in the UQCW.

5.3 SEDIMENT DATA

Instream sediment data were not available for this TMDL effort. To refine the in-stream sediment transport mechanisms in the model, an additional study would be necessary to evaluate the shear stress and deposition in the waterbodies. Additionally, the partitioning between dissolved and particulate metals is not well studied in the watershed. Limited data exists to evaluate the partitioning coefficient which is a function of specific soil types and organic content/functional groups in the sediment. The modeling performed for the TMDL analysis used literature values for these parameters (ADEQ, 2026). As these mechanisms affect the instream water column concentration of metals, the model was limited to evaluating the source contributions from the land areas, and not to assess the effect of landscape restoration.

5.4 SUMMARY OF FINDINGS

Available water quality data demonstrates that the dissolved copper and total lead impairments in the UQCW, as shown in the median measurements, are generally above the respective TMDL concentration targets. The mean total metal concentration is significantly greater than the corresponding median values for most reaches in the watershed indicating there are large peak concentrations that occur, presumably during large storm events.

Section 6 SOURCE ASSESSMENT

A key component of a TMDL evaluation is the determination of known and potential sources of contamination to the watershed. Source assessment analyses are used to evaluate the type, magnitude, timing, and location of pollutant loading to a waterbody (EPA, 1999). Source assessment methods vary widely with respect to their applicability, ease of use, and acceptability. This section presents potential sources of pollutants throughout the UQCW that may contribute loads of the pollutants of concern, as well as the mechanisms by which pollutants can reach the waterbody, both of which can be useful in determining applicable implementation efforts.

Contaminant sources can include point sources and nonpoint sources. Point sources of pollutants are regulated under the Arizona Pollutant Discharge Elimination System (AZPDES) permitting program. Point sources may include discharges from municipal or industrial wastewater treatment plants, general stormwater permits, and AZPDES regulated MS4 urban stormwater runoff, as well as other AZPDES regulated discharges. Nonpoint sources are pollutant sources that reach the receiving water via indirect mechanisms not regulated under the AZPDES program, like historic mining, atmospheric deposition, unregulated stormwater runoff, geologic and soil sources, and groundwater upwelling.

6.1 POINT SOURCES

Several point sources discharge to surface waters in the UQCW, including water treatment plants, Municipal Separate Storm Sewer Systems (MS4), and industrial facilities subject to the Multi-Sector General Permit (MSGP). Table 10 lists and describes the point sources and their locations. Figure 8 illustrates the point sources locations and the relative drainage area for each of the impaired surface waters in the UQCW. Of the facilities with individual AZPDES permits, only Superior WWTP Outfall 001 is currently discharging to the UQCW and is present in the model discussed in Sections 7 and 8. Superior WWTP Outfall 002 is not currently operational. The Resolution Copper Mining LLC- Superior Mine facility has two permitted surface water discharge outfalls, Outfall 001 and Outfall 002. Outfall 001 is the discharge point for the CP-105 storm water collection pond, which is used for collecting storm water at the West Plant site. The water collected in CP-105 can be pumped to the facility's Mine Water Treatment Plant (MWTP) for treatment and reuse. Discharges resulting from less than a 10-year, 24-hour storm event are prohibited through Outfall 001. Outfall 002 is for the discharge of water treated at the MWTP. Neither of the Resolution Copper Mining outfalls are included in the model used for the TMDL analysis because they have not discharged for more than 10 years from either of the two outfalls. Instead of discharging at 002, treated water from this plant is pumped outside the watershed for irrigation purposes.

AZPDES facilities identified in Table 10 will receive WLAs in the TMDL based on their currently permitted water quality-based effluent limitations (WQBEL) and design flow for the WWTP effluent or storm flows for the others. MSGP facilities in Table 10 will receive WLAs based on the applicable TMDL target and the model calculated storm flow.

Table 10. AZPDES Point source dischargers in the UQCW.

Permit ID	Facility Name	Permit Type	Outfall	Receiving Water
Individual Permit				
AZ0021199	Superior WWTP	Minor WWTP	001	Queen Creek (-014B)
			002[1]	Queen Creek (-014A)
AZ0020389	Resolution Copper Mining	Major Industrial	001[2]	Queen Creek (-014A)
			002[2]	Queen Creek (-014A)
MSGP General Permit				
--	Gila Rock Products	MSGP	No name[3]	Reymert Wash (to QC -014C)
--	Kalamazoo Materials	MSGP	Superior KMI[3]	Unnamed Trib to Arnett Creek
AZI107055	OMYA Limestone Quarry	MSGP	Outfall 1	Queen Creek (-014A)
			Outfall 2	Queen Creek (-014A)
AZI107056	OMYA Processing Facility	MSGP	Outfall 1	Unnamed Trib (UQ1) to QC
			Outfall 2	Unnamed Trib (UQ1) to QC
			Outfall 3	Unnamed Trib (UQ1) to QC
AZI106994	Imerys Perlite USA Inc.	MSGP	Outfall 1	Unnamed Trib (UQ1) to QC
			Outfall 2	Unnamed Trib (UQ1) to QC
			Outfall 3	Unnamed ephemeral tributary
AZI108987	Resolution Copper Mining (East Plant)	MSGP	EP-SW-01	Unnamed ephemeral tributary
			EP-SW-03	Unnamed ephemeral tributary
AZI108986	Resolution Copper Mining (West Plant)	MSGP	WP-SW-03	Unnamed ephemeral tributary
MS4 Municipal Stormwater Permit				
AZS000018	ADOT MS4 2021	MS4	Superior Office	Unnamed Trib (UQ8) to Queen Creek
			Superior Fuel	Unnamed ephemeral tributary

1 Outfall permitted, but it is not currently operational.
2 No discharge since 2016.
3 Outfall does not discharge to a regulated water and will not receive a TMDL allocation.

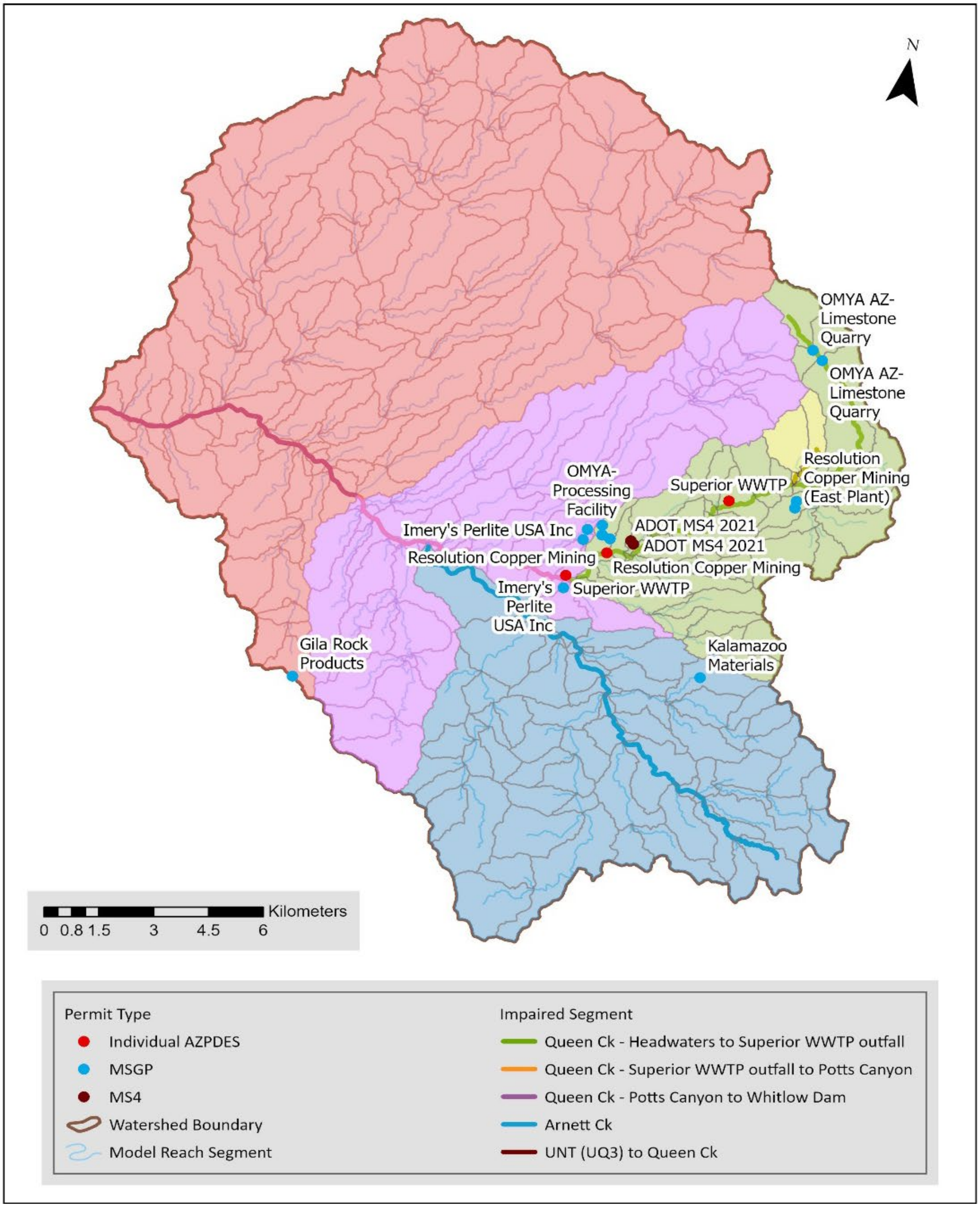

Figure 8. Locations of AZPDES permitted discharges within the UQCW.

6.2 Nonpoint Sources

Nonpoint sources of pollution originate from non-permitted areas which are conveyed to waterways in the watershed via surface water runoff or groundwater transport. Nonpoint sources may be intermittent in nature and difficult to quantify. Identified nonpoint sources which are known or thought to contribute pollutant loadings to the impaired waterbodies are identified below. Available soil measurements of copper and lead (see Figure 6 for copper and Figure 7 for lead) over the watershed are used to characterize the nonpoint sources and parameterize their behavior in the TMDL model (see Section 7 and Section 8).

6.2.1 Mined Lands

The UQCW has a long history of mining. The Silver King and Silver Queen mines began in 1875, with depletion of silver resulting in mine closures in the 1890s. The Silver Queen was reopened as the Magma Copper Company in 1910 with a metals smelter beginning operation in 1924. The Magma Copper Company ceased operations in 1996. Based on prevailing wind direction and soil sampling studies, the impact of the smelter emissions was most concentrated in the east and east-northeast of the smelter stack. This impact was mainly recognized in developed areas of the town of Superior (Haley-Aldrich 2025, p.4; heat-maps in Attachment A-5 for copper and lead).

Industrial mining operation locations in the watershed are shown on Figure 2. These mining activities have left a legacy of contamination, with historic mine sites and tailings piles. Surface runoff and erosion at these disturbed sites transport the metals to the waterbodies impacting their water quality. Remediation efforts that have been completed or are in progress are addressed in Section 10.2.2.

6.2.2 Undeveloped Land

The land areas around the watershed are naturally rich in metals due to the mineral content of the underlying geology and its overlying weathered soils. Natural erosion of the soils carries the sediment and metals to waterbodies during precipitation events.

There are several major lithological groups in the watershed. Within the Superior Mining District are complex hydrothermal porphyry deposits, vein systems, and fractured metamorphic and igneous rocks. Two well-known geological units in the watershed are the Apache Leap Tuff and the Pinal Schist. Fractures and faults are found throughout the eastern portion of the watershed at and near the Apache Leap Tuff. These breaks allow for exposure and daylighting of copper and lead-concentrated deposits including Chalcopyrite, Chalcocite, Galena, Pyrite, and other metal-rich minerals.

The exposed rock may undergo both mechanical and chemical weathering that can cause metals to be transported directly to surface waters through runoff. Chemical weathering occurs when these rock units react with oxygen and water. This causes the minerals to undergo oxidation and leach metals including dissolved copper and lead from the protolith into storm runoff, which then carries the metals through hydrological channels to surface waters. Erosion may also occur when short, intense monsoon storms or flash floods physically erode the rock units, mobilizing minerals from the units and surrounding mineralized soils. These stormflows transport metals concentrated water downstream to Queen Creek and its tributaries. This process is mostly frequently seen in Queen Creek segment -014A where exposed bedrock outcroppings are the primary terrain for stormflow runoff. Figure 9 shows the exposed bedrock facade found in the Queen Creek canyon in the upstream portion of the watershed. Stormflow on the north face of the canyon runs over the rocky facade to Queen Creek below. UQ2, UQ3 and several other unnamed tributaries drain to Queen Creek from these outcroppings.

Figure 9. Water flow path of UQ3 from the exposed bedrock to Queen Creek below.

6.2.3 Stormwater Nonpoint Sources

The town of Superior is not subject to a Phase II MS4 permit. Even though the Town's stormwater is not regulated, it can still contribute to metal pollution in surface waters. When precipitation falls on impervious surfaces such as roads, parking lots, and rooftops, it collects pollutants, including metals, and transports them to surface water bodies. This runoff can carry metals such as copper, lead, and zinc from automotive fluids, brake dust, and roofing materials. Construction activities can accelerate runoff by disturbing the soil and increasing sediment transport to water bodies. Construction stormwater runoff is regulated under the AZPDES Construction Activity General Permit (CGP) to ensure erosion controls measures are implemented during certain construction projects. Outside of the town of Superior, there are only sparsely developed areas, and stormwater runoff is minimal.

6.2.4 Atmospheric Deposition Sources

Metal particulate deposition can be both naturally occurring or through human sources. Wind gusts naturally transport metal concentrated dust across the watershed. Anthropogenic atmospheric deposition sources include motor vehicle recreation, exposed AML waste, and current and historic industrial processes.

The historic Magma Copper Smelter emitted metal-rich flue gas from its ~300 ft smokestack for nearly 50 years beginning in the 1920s. These emissions accumulated in the soils of the watershed and were transported after storm events. This smelter and the nearby contaminated soil on the Resolution Copper property have been fully remediated, but the total area that may have been affected in the watershed has not been determined.

Open pit mining operations in the watershed include the Omya limestone quarry, Imerys perlite mine, Kalamazoo landscaping rock quarry, and the Gila Rock Products sand and gravel quarry. Dust and airborne particulate emissions are regulated at these quarries to control and reduce but not eliminate dust emissions from facility operations and materials transport.

Unmaintained unpaved roadways and recreational motor vehicles also produce dust and deposit across the landscape. Off Highway Vehicles (OHVs) on dirt trails kick up dust while in use. Unpaved roads that are not well-maintained face issues of gullying and erosion that allow soils to be readily available during wind gusts. The Tonto National Forest allows for a variety of recreational activities on trails in the UQCW.

6.3 Source Assessment Summary

The available data to characterize source contributions (see Section 5) were integrated into the HSPF model (see Section 7) which was used to evaluate the relative metals contribution of land use categories to the impaired reaches. To evaluate the loading of sources in the watershed, a modeled day of the year corresponding to the 95th percentile calculated load was selected. A high percentile loading captures the storm loading to the waterbodies. Further, MSGP facilities would not discharge during small storms or dry weather. AZPDES permittees are allocated the TMDL target at their design flow rate, to ensure that they discharge in compliance with water quality objectives.

The relative land area of sources contributing metals and pollutant loading sources to Queen Creek and Arnett Creek are shown in Figures 10-14. The developed, mined, and undeveloped land areas were calculated with the model, whereas the MSGP discharge loads were estimated by their TMDL allocation (TMDL water quality target multiplied by facility flow). Outfalls that are currently not discharging are set to zero load in the load-based charts, which include the

Superior WWTP Outfall 002, and the Resolution Copper Mining AZPDES Outfalls 001 and 002. Note for all pie charts (Figures 10-14), individual permittees are not included in the area plot as they are point source discharges and have no associated watershed area contribution. The area of MSGP permitted facilities contributes loading, so they appear in both the area and loading figures. Relative contributions for the unnamed tributary to Queen Creek (UQ3, 15050100-1843) are not shown in this report as that watershed is 100 percent undeveloped land.

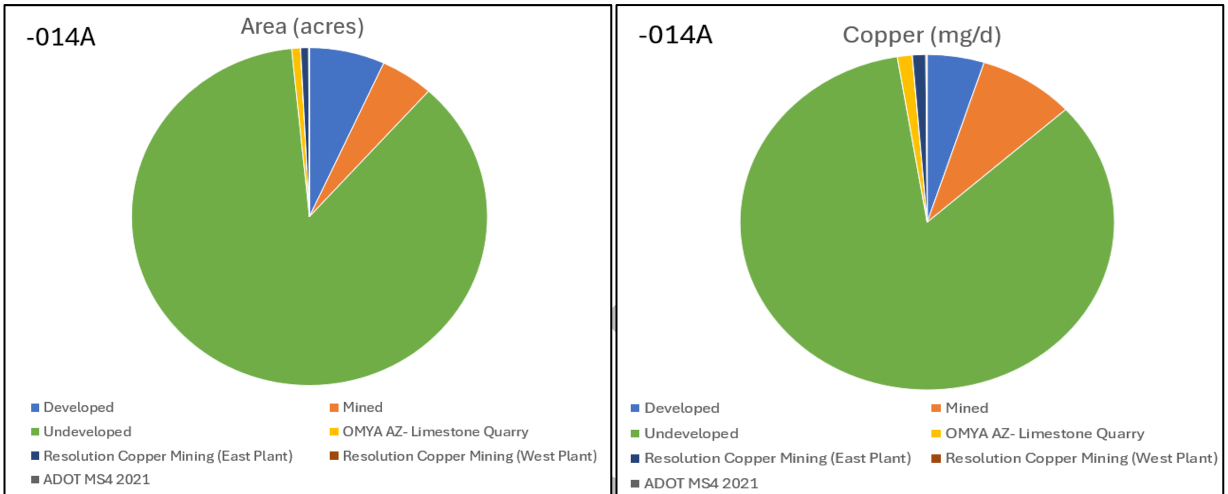

Figure 10. Relative area and copper loading contribution to Queen Creek (-014A).

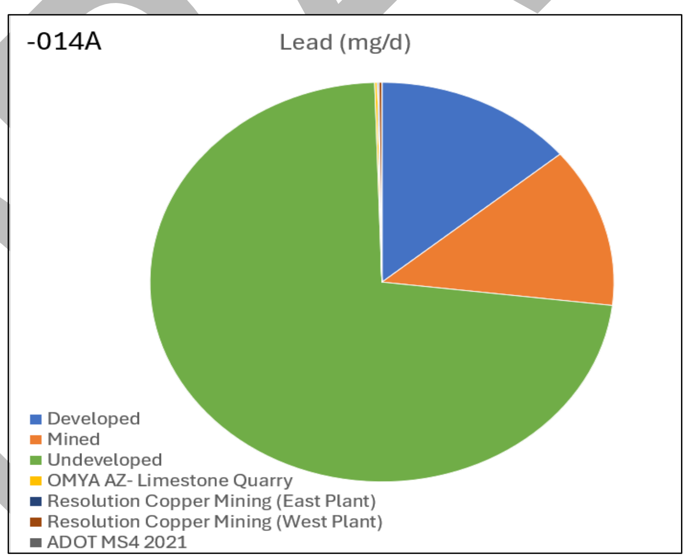

Figure 11. Relative lead loading to Queen Creek (-014A).

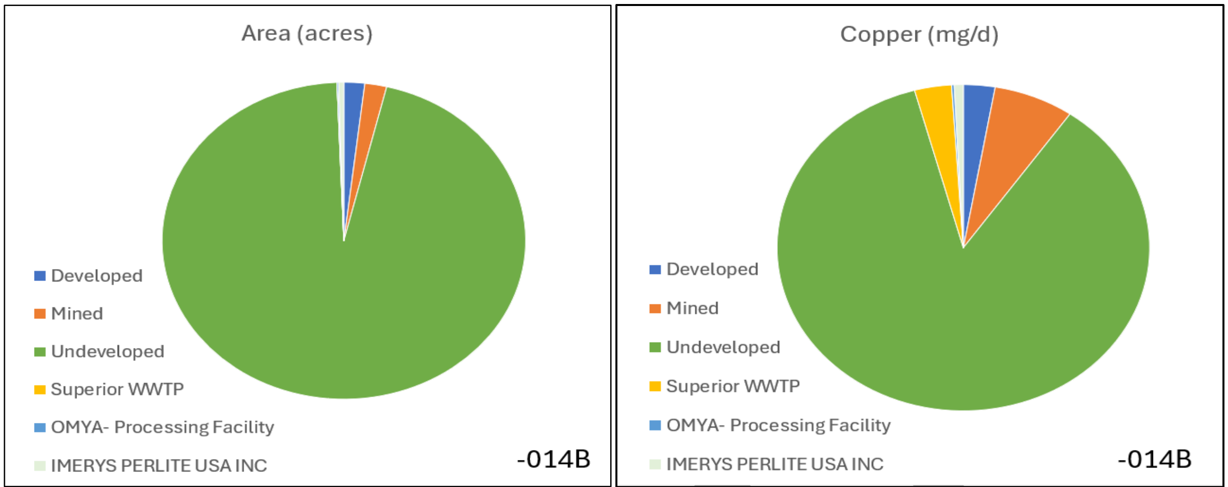

Figure 12. Relative area and copper loading contribution to Queen Creek (-014B).

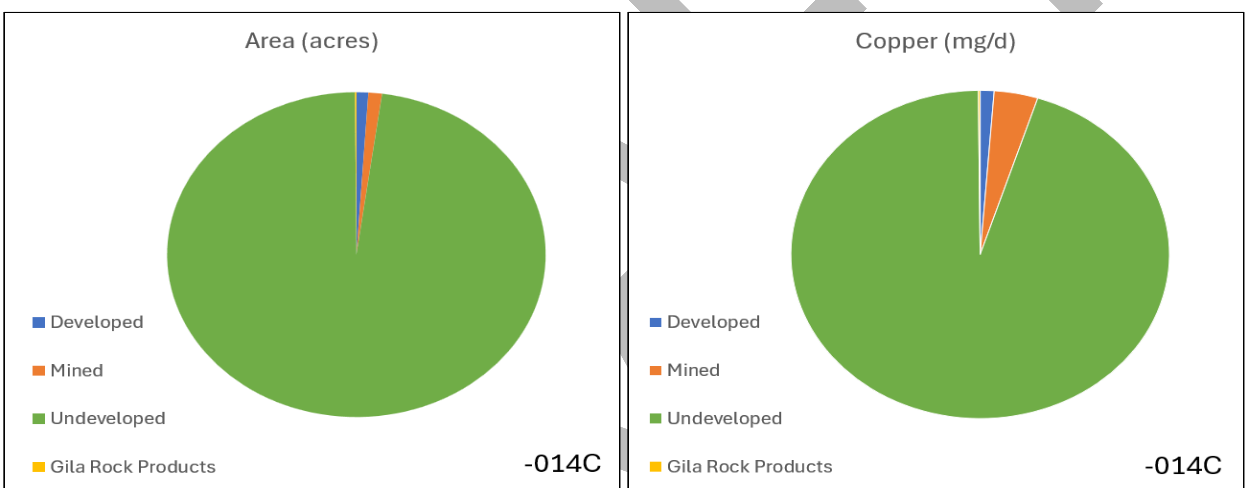

Figure 13. Relative area and copper loading contribution to Queen Creek (-014C).

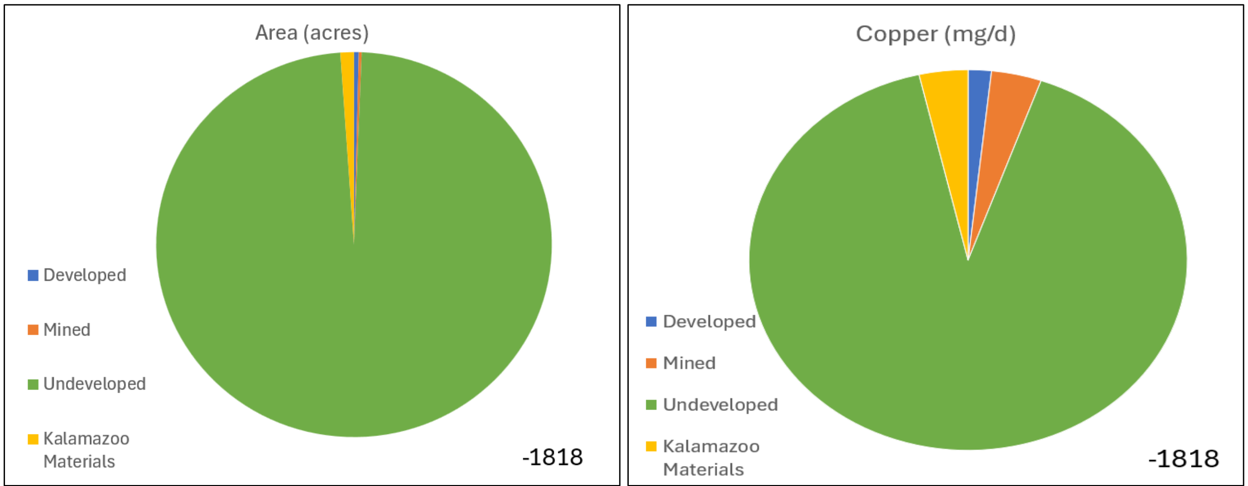

Figure 14. Relative area and copper loading contribution to Arnett Creek (15050100-1818).

Section 7 TECHNICAL APPROACH

7.1 TECHNICAL APPROACHES CONSIDERED

Two distinct modeling pathways were considered to inform TMDL development. The first pathway would employ the Hydrological Simulation Program–FORTRAN (HSPF) model to simulate the watershed processes that affect dissolved copper and total lead transport from sources to waterbodies. The second approach was an empirical approach, Load Duration Curves (LDC), developed from the data collected in the watershed. The HSPF approach would provide insight into specific sources and better evaluate the effectiveness of management actions; however, there may not be sufficient data available to fully calibrate and validate this model. The LDC approach is better suited to sparsely available data but comes at the expense of not being able to simulate specific sources in the watershed, nor evaluate the control measures that could be implemented.

Two recent memorandums were produced for ADEQ describing the available data in the watershed and evaluation of modeling approaches (SWCA Environmental Consultants; 2025a, 2025b). These memos detail the data available in the watershed and the pros and cons of HSPF and LDCs.

7.2 SELECTED APPROACH

After reviewing the potential modeling approaches for the watershed, ADEQ sought EPA technical feedback on the TMDL modeling approaches. ADEQ subsequently selected the HSPF modeling approach. The group acknowledged that the data limitations may require a simplified approach to the HSPF model development; however, that model would serve as the backbone for future enhancement in the event additional watershed data became available. The model selection was also, in part, due to the history of HSPF modeling efforts in the watershed. These efforts are described below.

During initial TMDL development in 2010, ADEQ staff calibrated and validated an HSPF model for dissolved copper in the Queen Creek watershed (ADEQ, 2010). In support of this initial modeling effort, ADEQ implemented a comprehensive and extensive sampling and analysis plan, using automated instrumentation, geared towards developing the needed parameters to populate the HSPF model. ADEQ collected numerous water quality grab samples across the watershed to characterize water quality from various sources, land use types, and bedrock lithologies. The HSPF model was calibrated for streamflow at numerous stations within the watershed. The water quality monitoring data was used to develop the HSPF copper loading factors along with the calibration of the water quality component of the model.

However, data limitations did not allow the model to resolve copper loading from various sources in the watershed. To address these issues and to further understand and discern between natural and anthropogenic sources of dissolved copper and total lead in the Queen Creek watershed, ADEQ implemented a supplemental and extensive monitoring program and collected additional copper and lead water quality and lithologic data. These additional data were incorporated into the HSPF model (ADEQ, 2013). A third-party evaluation of the modeling and TMDL for the Queen Creek watershed identified several recommended model modifications and loading calculation methodologies (RESPEC, 2017). Table 11 outlines the comments from the 2013 modeling approach and improvements made in the 2026 model.

Table 11. Current Queen Creek model enhancements as compared to RESPEC 2017 identified limitations of the 2013 model.

RESPEC Comment on 2013 HSPF Model	Limitation Identified	Improvement Made in Current Model
Three-month modeled time span too short	No time for spin up and too short for calibration	Modeled time period from Oct 1, 2001, through September 29, 2025, a 24-year simulation period. While additional calibration data are not available for all parameters, a several-year model spin- up is created.
Extend the model domain to Whitlow Dam	Watershed domain truncated misses downstream 303(d) reach	Modeled domain now includes Whitlow Dam.
Sediment parameterization from land to stream requires additional investigation and elaboration	May lead to inaccurate sediment loading	Modeled sediment parameters now based on SSURGO dataset and then calibrated. Additionally, these parameters vary by soil type and location in the watershed. An additional watershed sediment yield study would be required to refine the calibration.
Certain hydrologic parameters, interception storage and land slope, were not adequately parameterized	May lead to inaccurate watershed response	Initial model parameters are based on available data and recommended estimation practices. A sensitivity analysis was used to determine which parameters were then calibrated. Additionally, parameters may vary by watershed location and underlying soil type.
Hydrologic and sediment parameters were not varied over different land uses or cover categories	May lead to inaccurate watershed response	The watershed was separated into 10 zones each containing up to 15 land-use soil combinations where they were present. Uncorrelated parameters for each combination of watershed zone and land-use soil type found to be sensitive to model results were calibrated as data allowed.
Instream sediment parameters were not investigated	May lead to inaccurate modeled stream bed depths	Data to robustly estimate the instream sediment parameters are not currently available. The bed-depths may be inaccurate. However, the steep nature of the watershed leads to incising streams with generally high levels of scour. The model *does behave consistently* with the watershed processes.
Loading calculations in the model were not implemented correct	The calculated loadings were incorrect	Loadings calculations were corrected.

The 2026 HSPF model utilized in the report leverages the available data and watershed information to address the concerns identified in RESPEC 2017. Data limitations required the complex HSPF model to be used simply. Acknowledgement is given to the fact that limited data exists to fully parameterize the HSPF model. This suggests where parameter effects are correlated, they are fixed in relation to each other and only one value is calibrated. The benefit of selecting HSPF over a Load Duration Curve approach is that with additional data collection, the 2026 HSPF model can be updated and refined, allowing more of the functionality to be utilized. This approach allows the model to inform the current state of the watershed TMDL and facilitates future enhancement of the model as additional data becomes available. The model development is detailed in the 2026 Queen Creek watershed HSPF Modeling Report (ADEQ, 2026).

The calibration process followed best practices to leverage available data and ensure the model was not being over parameterized. The approach followed two guiding principles. The first was to only calibrate sensitive parameters which include those with a composite sensitivity (CS) greater than 0.5 percent of the most sensitive parameter. Limiting the parameters ensures the automatic calibration tool would be able to find real endpoints (Doherty, 2025). The second was in relation to how to treat correlated parameters. In a complex model like HSPF there are parameters representing different mechanistic processes that can have a similar effect on model output. The correlation of the parameters in HSPF were determined with the calibration tool and those related by 95 percent or greater were held constant and only the most sensitive of that group was calibrated. Calibrating only one parameter in a correlated group while holding the others constant to literature or best estimates has been shown to result in all parameters estimated uniquely (Hill and Tiedeman, 2007). Following this approach, the model is giving mechanistic results based on the available data, instead of trying to calibrate every parameter that would result in a model that fits the data but would not necessarily respond to changes in the watershed conditions as the actual watershed. With a richer set of data, the model could be recalibrated to refine the performance.

Section 8 LINKAGE ANALYSIS

The purpose of the linkage analysis is to establish the connections or linkages between the loadings to waterbodies (i.e., the causes of impairment) and the water quality response within the receiving waters. This section describes the approach used to characterize waterbody response to pollutant loadings from the watershed.

8.1 METALS TRANSPORT MECHANISMS CONCEPTUAL MODEL

The developed HSPF model is designed to simulate the fate and transport of metals from the watershed land areas to the waterbodies. Once the metal reaches the waterbody, the model calculates the fraction dissolved in the water column and the amount adsorbed onto suspended sediment. The model then simulates the transport of metals downstream and is designed to calculate deposition and scouring of bed sediments. The schematic of the conceptual model is presented in Figure 15. Each of the arrows in the figure denotes a mechanism in the HSPF model that was defined with watershed data, literature values, or determined via calibration.

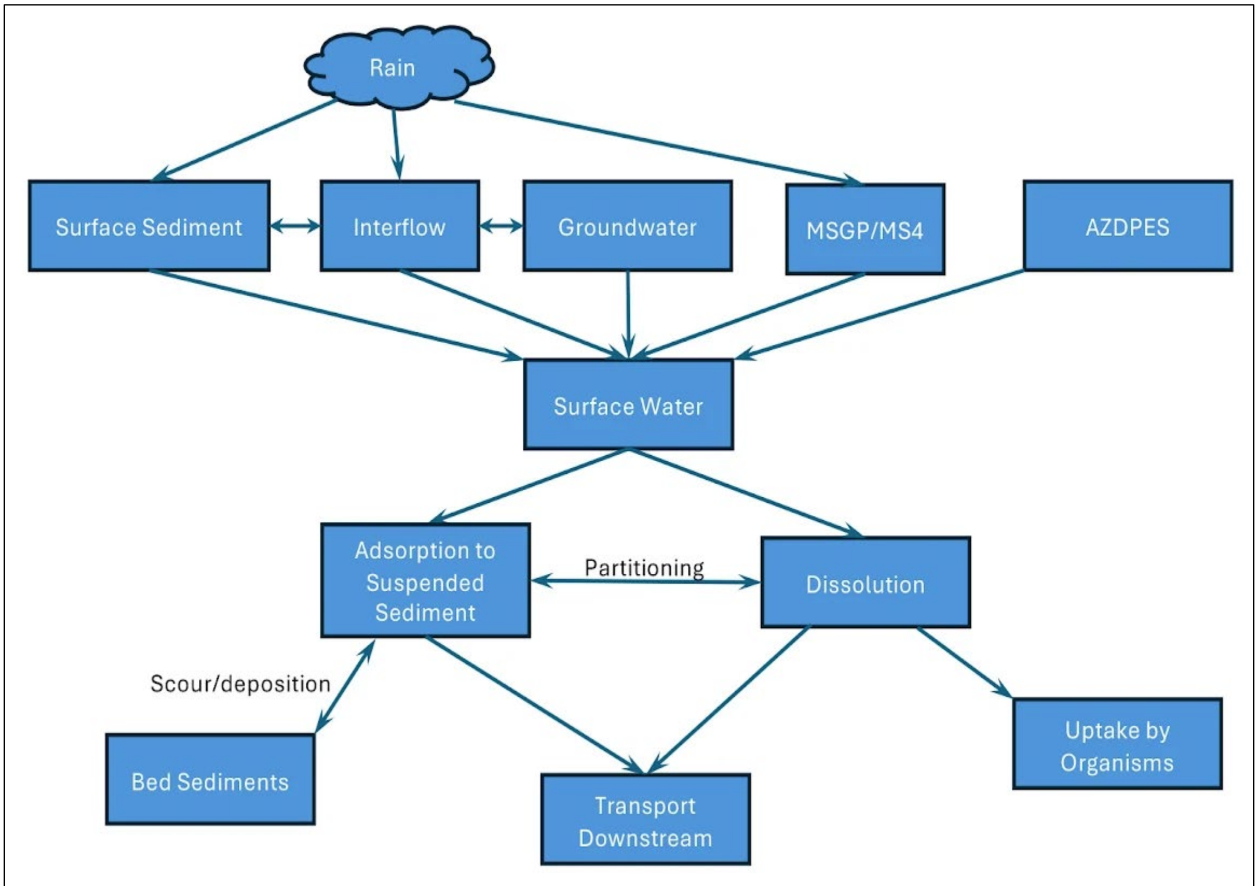

Figure 15. Conceptual model of metals transport adopted for the Queen Creek watershed system

8.1.1 Watershed Segmentation

The watershed domain for the HSPF model extends from the headwaters of Queen Creek to Whitlow Dam, allowing simulation of all three impaired reaches of Queen Creek and associated tributaries. The size of the subbasins was refined to encapsulated mined areas, where they exist, and balanced by limiting the total number operations to within the hard-coded limit of HSPF. The final model contained 296 subbasins.

8.1.2 Meteorological data

The Parameter-elevation Regressions on Independent Slopes Model[3] (PRISM) data were used to define the meteorological data for the watershed due to limited meteorological gauge data available. Measured precipitation data was extremely limited in the UQCW and limited data was available for the majority of the simulation period. Only two gauge stations were available in the watershed that overlapped with streamflow observations. The default resolution of PRISM is 800 m cells, resulting in 588 cells intersecting the model subbasins. Since the disaggregation tool in BASINS (the HSPF modeling software framework) allows for processing only one node at a time, the grid was up-sampled to 6,400 m (1/64th of the original resolution) to provide a manageable number of cells for a manual disaggregation workflow. Evaporation and

[3] PRISM Group, Oregon State University, https://prism.oregonstate.edu.

temperature were similarly disaggregated using their parameter specific routines in BASINS. The meteorological inputs drive the HSPF model hydrology.

8.1.3 Streamflow Data

The lack of USGS-maintained stream gaging stations within the project watershed represented a significant data gap. ADEQ had installed eight electronic stage recorders (four on Queen Creek and four on selected tributaries) to collect stage data at 15-minute intervals from October 2006 through February 2008. Continuous stream discharge records were then calculated from rating curves established through manual flow measurements, surveyed cross sections, and the WinXSPro program. Additional data was taken for the 2023 to 2024 sampling effort, however, the data was not used due to not meeting QA/QC criteria. The streamflow data are used to calibrate the watershed parameters so that the model response matches observations.

8.1.4 Pervious and Impervious Land

The HSPF parameterization of pervious lands determines the behavior of runoff, determining the amount running off the surface, the fraction that infiltrates and moves through the soil, and that fraction interacting with active groundwater. The land use/land cover and SSURGO soil mapping discussed in Section 3.1 were used in the initial parameterization.

Where possible the model parameters were set through measured values, published data, and literature estimates appropriate for the specific soil type and location within the watershed. The approach to determining select parameters is as follows:

- Infiltration (INFILT) from SSURGO Hydrologic Group
- Lower zone nominal storage (LZSN) estimated as 1/4 mean annual rainfall + 4 inches for arid regions from BASINS Technical Note 6 (US EPA 2000)
- Upper zone nominal storage (UZSN) calculated from land slope, curvature, and vegetation density (US EPA 2000)
- Lower zone E-T parameter (LZETP) set to sinusoidal function within barren land range
- Coefficient in the soil detachment equation (KRER) from SSURGO erodibility
- Wash-off potency factors (POTFW) based on sequential extractions and soil samples for metals
- Concentration of the constituents in interflow outflow (IOQC) and active groundwater outflow (AOQC) based on sequential extractions and soil samples for metals and water quality observations
- Initial sediment concentrations for constituents (SQUAL) based on sequential extractions and soil samples
- Leakage to mine from Queen Creek upstream of Superior (Reach 244) based on GeoSystems 2022

Many of the model parameters required calibration. The approach and results of the calibration are described in the companion modeling report to this TMDL (ADEQ, 2026).

- Precipitation and ET_o multipliers to refine the mapping of PRISM data to the watershed
- Interflow inflow (INTFW)
- LZSN the estimated values are calibrated
- UZSN the estimated values are calibrated
- LZETP the estimated values are calibrated
- IOQC the estimated values are calibrated
- AOQC the estimated values are calibrated
- SQUAL the estimated values are calibrated
- Interflow recession parameter (IRC)
- Remaining potential that can be satisfied with baseflow (BASETP)
- Coefficient in the soil detachment equation (KSER)
- Coefficient in the rate of wash-off equation (KEIM)
- Solids accumulation rate (ACCSDP)
- Fraction of solids storage removed per day (REMSDP)
- Coefficient defining a reach carrying capacity for sand (KSAND)
- Exponent of the sand-load power function (EXPSND)
- Critical erodibility coefficient (KRER)
- Coefficient for rate of compaction (AFFIX)
- Metals partitioning coefficients (KD)
- Stream leakage at reach 244 the estimated values are calibrated

Many of the parameters requiring calibration relate to sediment transport. SSURGO can provide estimates for erodibility and sorting fraction. However, a dedicated sediment study of the watershed would better inform these model parameters. Additionally, a sediment study would estimate the watershed yield and streambed scour and deposition, allowing better calibration targets than the total suspended solids used here.

8.1.5 Calibration Approach

The model was sequentially calibrated first for hydrology, followed by sediment, and finally metals. Additionally, the calibration generally proceeded from upstream to downstream. As the calibration proceeded downstream, the upstream parameters were further refined for improved balance of model performance. While the annual flow volumes for the watershed were a component of the calibration process, the watershed parameterization was weighted to match storm volumes. This process leveraged available data to refine the model simulation during periods of significant metals transport within the watershed.

The calibrated HSPF model of the UQCW simulates receiving water flow rate, total suspended solids, dissolved copper, and total recoverable lead. The model simulations capture the dynamics and order of magnitude observed in the data measured in the watershed. A refined calibration is currently limited by the available data in the watershed. The model utilizes the existing data to allow watershed simulations and source loading calculations. Due to data limitations, the model cannot take advantage of the full power of the HSPF modeling system. However, as additional data are collected and sediment studies performed in the watershed the model can be refined and HSPF features implemented fully. The calibration methodology is discussed further in Section 7.2 and ADEQ (2026). The UQCW model was built and calibrated around the limited parameter data available in the watershed. Due to the limited data, calibration efforts relied on best practices for calibrating parameters based on correlation and sensitivity of parameters. Model re-calibration should be performed once additional modeling parameter data is collected.

8.2 Spatial Patterns

HSPF model simulations were performed with meteorology from October 1, 2001, to September 30, 2025. Model output for the last five years was analyzed to determine the 95^{th} percentile loads to evaluate the waterbodies under storm and post-storm conditions as these were determined to be the critical conditions for this watershed.

8.2.1 Dissolved Copper

Model results for the 95^{th} percentile dissolved copper loading in the watershed is presented in Figure 16. The corresponding 95^{th} percentile concentration of dissolved copper in the receiving water is shown in Figure 17. While the tributary copper concentrations increase in the vicinity of higher soil concentrations, the tributary flow rates appear to be low enough to result in significant load increases.

HSPF results were used to evaluate the relative contribution to dissolved copper load by land sources and upstream reaches. The analysis was performed for February 25, 2023, the date corresponding to the 95^{th} percentile load in Queen Creek reach -014A. This date was used as it was determined to be a high magnitude event because pollutant transport, from overland to the receiving channel, only occurs during wet weather. Other reaches may have 95^{th} percentile loads occurring on different days; however, this analysis requires selecting a day so the loads flowing through the watershed will sum. The in-stream load weighted percent contribution of dissolved copper for each impaired reach is presented in Table 12. This analysis is simplified by not considering the scour/deposition in the stream bed and changes due to partitioning. Each row in Table 12 lists the percent contribution of dissolved copper in that specific impaired reach, for example of the dissolved copper load at Whitlow Ranch Dam (Queen Creek Reach -014C), 57 percent is from the upstream impaired reaches, and 42 percent is from undeveloped lands draining to -014C. The cumulative load weighted percent contribution of dissolved copper is presented in Table 13 which carries the source information downstream. For example, for the load in Queen Creek reach -014C, mined areas generated 4 percent, developed areas produced 2 percent, undeveloped areas produced 92 percent, and 2 percent from AZPDES permit holders. Note in both Tables 12 and 13 the rows may not add to 100 due to rounding.

As was illustrated in the source assessment summary (Section 6.3) while mined and developed areas may have higher loads per acre, their size is dwarfed by the surrounding undeveloped lands in the watershed. Most of the copper loading for each of the impaired reaches is undeveloped lands.

Table 12. Load weighted percent contribution of in-stream dissolved copper load to the outlet of each impaired watershed.

Impaired Reach	Load Weighted Percent Contribution of Total Reach Load[1] (%)					
	Reach Contribution					Upstream Contributions
	Mined	Developed	Undeveloped	MSGP[2]	Individual	
UQ3	0	0	100	0	0	0
Arnett Creek	4	2	91	4	0	0
Queen Creek (-014A)	8	5	84	1	0	2[3]
Queen Creek (-014B)	5	2	57	0	2	34[4]
Queen Creek (-014C)	0	0	42	0	0	57[5]

1 Ignoring stream bed scouring and deposition. Loading from simulation of February 25, 2023.
2 Loading estimated by TMDL target concentration multiplied by calculated flow rate.
3 UQ3.
4 UQ3, Queen Creek 014A, and Arnett Creek.
5 UQ3, Queen Creek 014A, Arnett Creek, and Queen Creek 014B.

Table 13. Cumulative load weighted percent contribution of in-stream dissolved copper load to the outlet of each impaired watershed.

Impaired Reach	Cumulative Load Weighted Percent Contribution[1] (%)					Upstream Contributions
	Mined	Developed	Undeveloped	MSGP[2]	Individual	
UQ3	0	0	100	0	0	Headwater
Arnett Creek	4	2	91	4	0	Headwater
Queen Creek (-014A)	8	5	86	1	0	Headwater and UQ3
Queen Creek (-014B)	6	3	88	1	2	UQ3, 014A, and Arnett Creek
Queen Creek (-014C)	4	2	92	1	1	UQ3, 014A, 014B, and Arnett Creek

1 Ignoring stream bed scouring and deposition. Loading from simulation of February 25, 2023.
2 Loading estimated by TMDL target concentration multiplied by calculated flow rate.

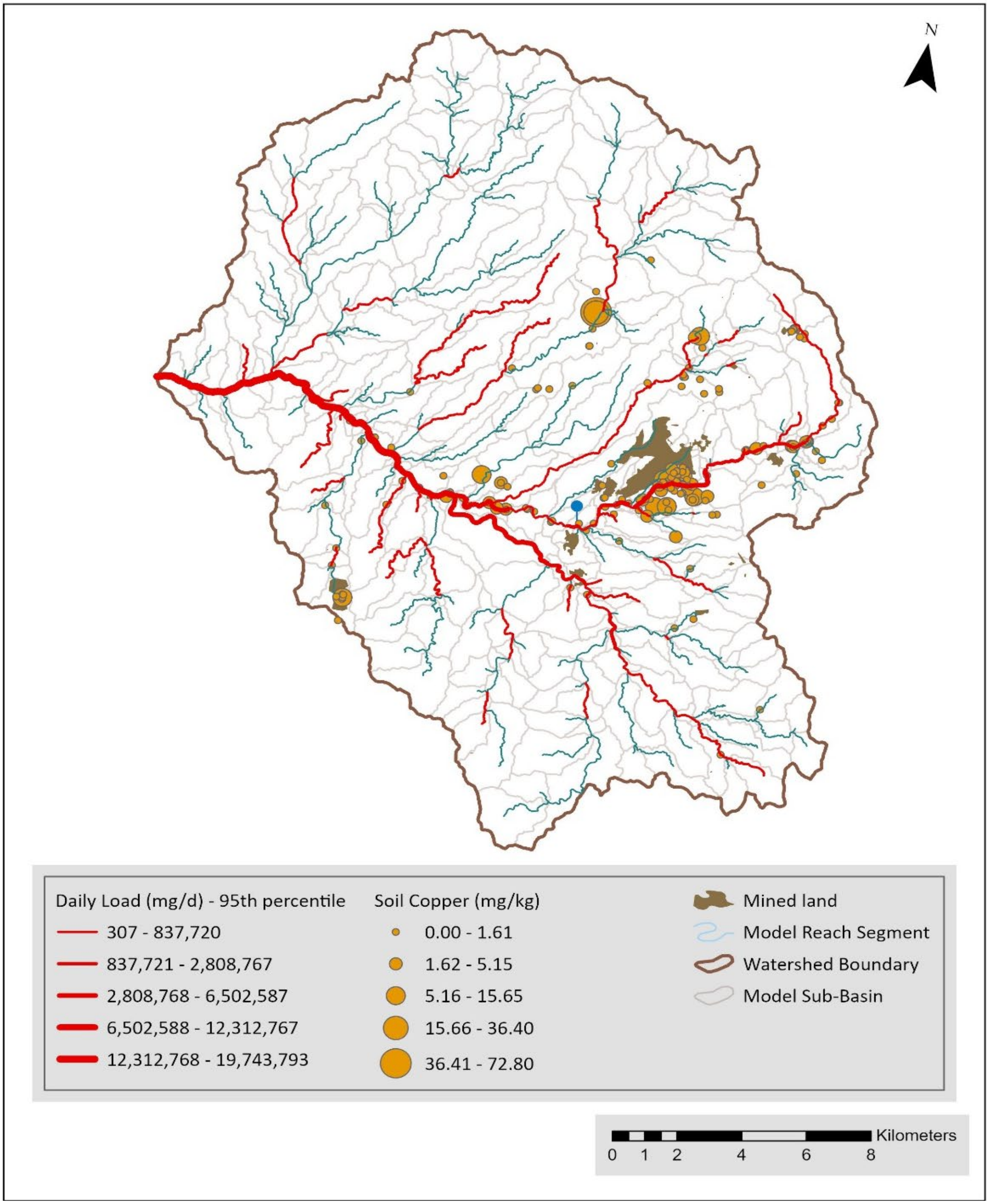

Figure 16. HSPF-modeled dissolved copper daily load (mg/d) for UQCW. Value represents 95th percentile from distribution of daily values for 2021-2025.

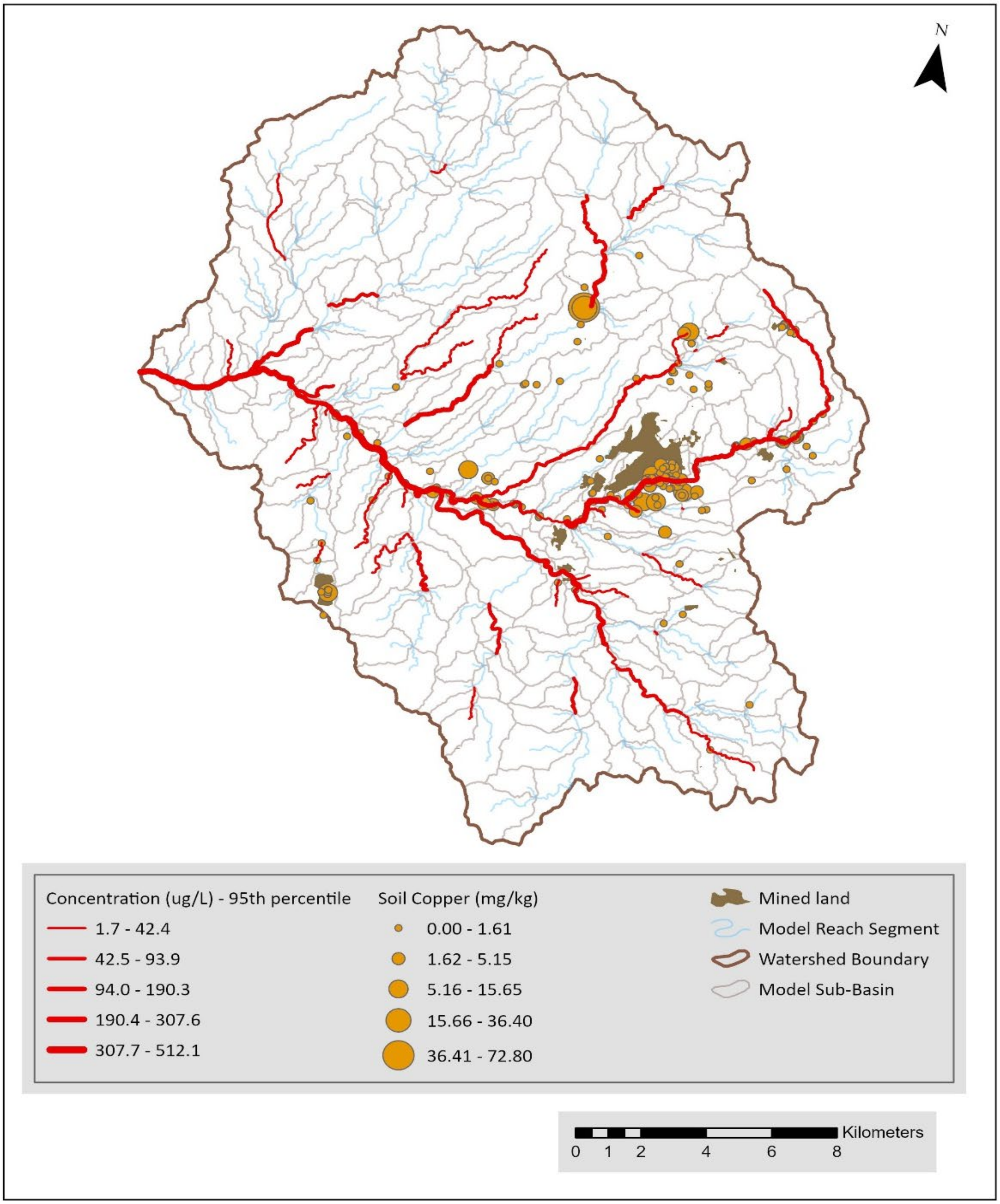

Figure 17. HSPF-modeled dissolved copper concentration (µg/L) for the UQCW watershed. Value represents 95th percentile from distribution of daily values for 2021-2025.

8.2.2 Total Lead

Modeled 95th percentile results for total lead loading are presented in Figure 18, and the corresponding modeled total lead concentration is shown in Figure 19. As with copper, the concentration of lead appears to increase near land areas with high soil concentrations. However, the flow rate in those tributaries appears to be low enough to prevent significant increases in loading of total lead. The source contributions of total lead to Queen Creek -014A are listed in Table 14. The reach UQ3 contributes a negligible load of lead, so the cumulative percent contribution by source to Queen Creek -014A presented in Table 15 is within rounding to those listed in Table 14.

Table 14. Load weighted percent contribution of in-stream total lead load to the outlet of impaired watershed (-014A).

Impaired Reach	Load Weighted Percent Contribution of Total Reach Load[1] (%)					
	Reach Contribution					Upstream Contributions
	Mined	Developed	Undeveloped	MSGP[2]	Individual	
Queen Creek (-014A)	13	14	73	<1	0	<1[3]

1 Ignoring stream bed scouring and deposition. Loading from simulation of February 25, 2023.
2 Loading estimated by TMDL target concentration multiplied by calculated flow rate.
3 UQ3.

Table 15. Cumulative load weighted percent contribution of in-stream total lead load the outlet of impaired watershed (-014A).

Impaired Reach	Cumulative Load Weighted Percent Contribution[1] (%)					Upstream Contributions
	Mined	Developed	Undeveloped	MSGP[2]	Individual	
Queen Creek (-014A)	13	14	73	<1	0	Headwater and UQ3

1 Ignoring stream bed scouring and deposition. Loading from simulation of February 25, 2023.
2 Loading estimated by TMDL target concentration multiplied by calculated flow rate.

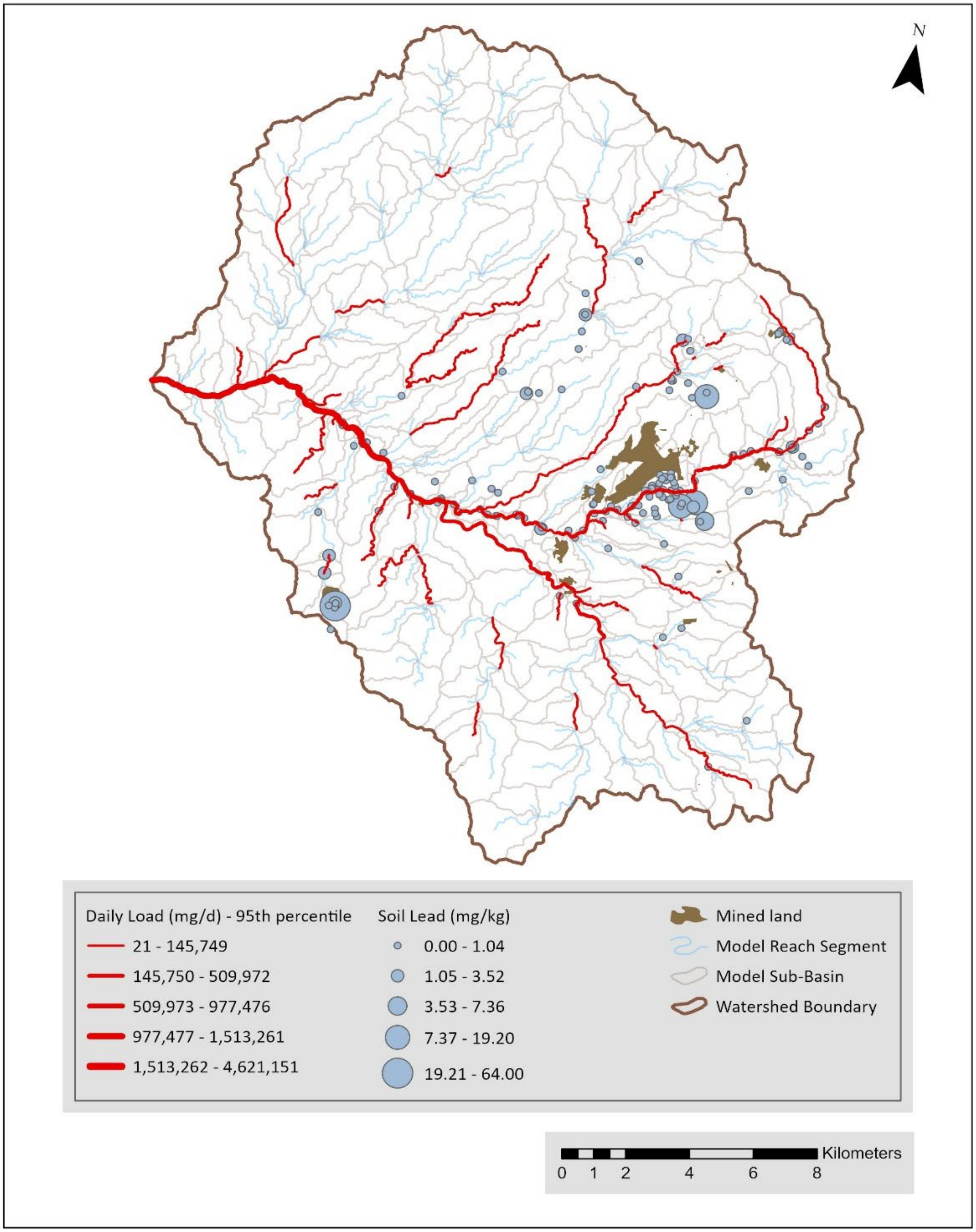

Figure 18. HSPF-modeled total lead daily load (mg/d) for the UQCW. Value represents 95th percentile from distribution of daily values for 2021-2025.

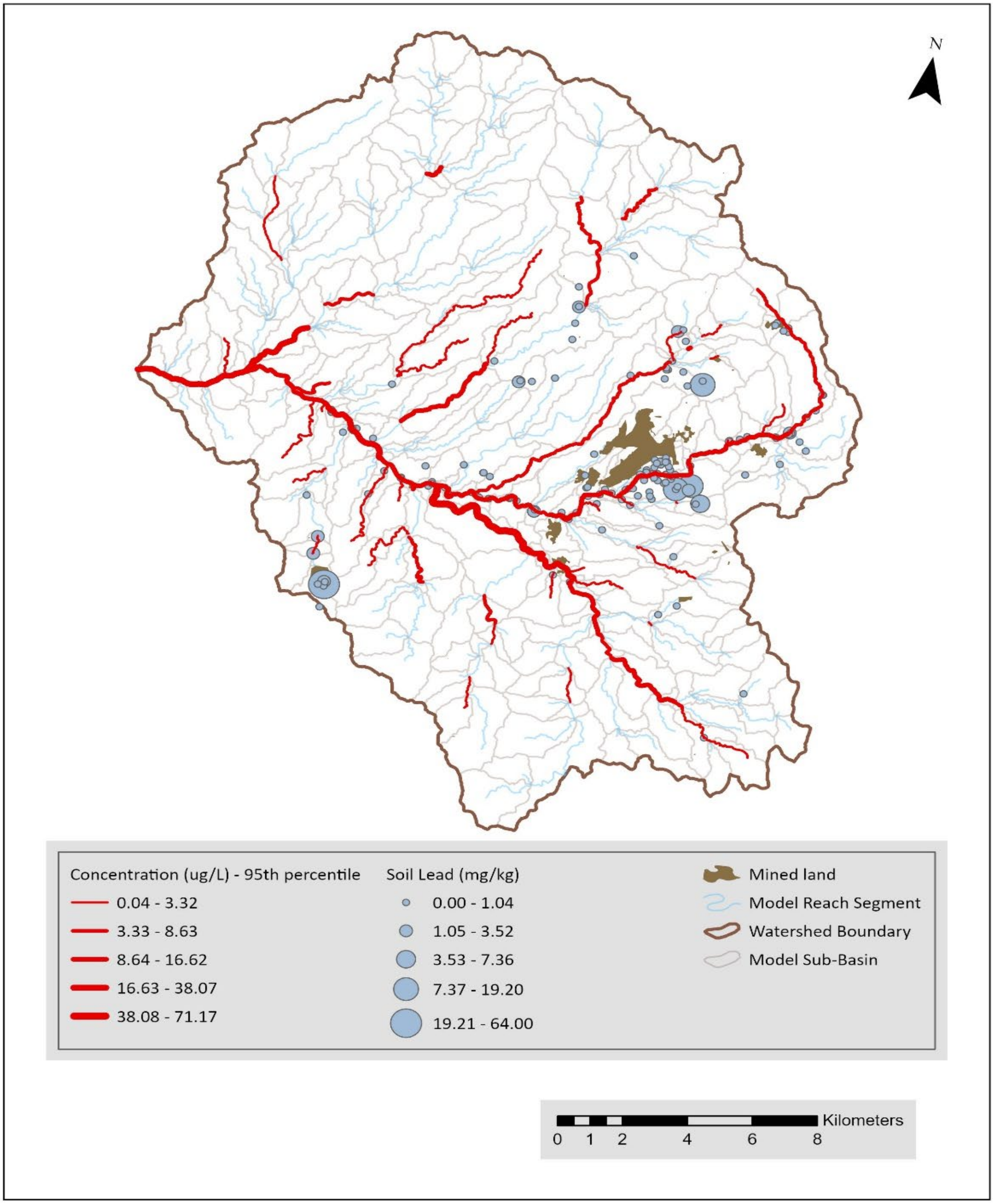

Figure 19. HSPF-modeled total lead concentration for the UQCW. Value represents 95th percentile from distribution of daily values for 2021-2025.

8.3 Seasonal Patterns

As is noted in Table 2, there are few large storms in each of the summer monsoon and winter wet seasons. During these storms, metals and the sediments they are associated with are washed into the waterbodies in the watershed. These are the critical conditions considered in the TMDL development in the next section. Many waterbodies are ephemeral or intermittent, and those that are perennial have greatly reduced flows during inter-storm and dry seasons. The MSGP facilities will not discharge during non-storm conditions, and AZPDES individual permittees will be held to their permitted water quality-based effluent limitations protecting the beneficial uses of the reaches.

Section 9 TMDL Development

A TMDL is defined as the sum of the WLAs for point sources, plus the sum of the LAs for nonpoint and natural background sources, plus a MOS. This loading budget, with an appropriate MOS, will result in a pattern of loading that the waterbody can process with its available assimilative loading capacity without exceeding water quality standards, as shown in the following equation:

$$\text{TMDL} = \sum \text{WLA} + \sum \text{LA} + \text{MOS}$$

Where,

$\sum$WLA = Sum of all individual point source WLAs

$\sum$LA = Sum of all nonpoint source and natural background LAs

MOS = Margin of safety

The TMDL identifies allowable loadings for point and nonpoint sources discharging into each impaired water body.

9.1 Loading Capacity and Allocations

The loading capacity of the waterbody is defined as the quantity of a pollutant or other waterbody constituent which can be absorbed without exceeding applicable water quality standards.

The loading capacity of each impaired waterbody was defined by the 95th percentile flow (from a distribution of daily values for the period 2021–2025) and a concentration determined by Arizona’s water quality criteria for a particular use designation (Table 3). The 95th percentile flow occurs during storm events which is the critical condition for this TMDL as described in Section 9.2 below. The loading capacity is reduced by the margin of safety, a 10 percent set-aside (see Section 9.3 below), to yield an allowable load.

A summary of the impaired waterbodies and the required load reduction to achieve TMDL targets is presented in Table 16. Additionally, Table 16 references further information concerning the allowable loading and required reductions for each waterbody and impairment. The referenced tables (Tables 17–22) provide specific values of existing load, allowable load (the TMDL), explicit margin of safety (MOS), and remaining allowable load. The current modeling effort showed reductions ranging from 48.1 to 92.0 percent for dissolved copper and 71.2 percent for total lead.

From the remaining allowable load, allocations are given to wasteload allocations (WLA) and load allocations (LA). Wasteload allocations include those point discharges from AZPDES individual permitted facilities, permitted non-municipal stormwater discharges (Multi-Sector General Permit or MSGP), and municipal stormwater discharges (Municipal Separate Storm Sewer System or MS4).

Table 16. Summary of impaired waterbodies and their needed reductions (before 10 percent MOS allowance calculation) along with specific table references to allocations.

Waterbody ID	Waterbody Name	Impairment	Reduction Needed (before MOS removed)	Table Reference
15050100-1843	Unnamed Tributary (UQ3) to Queen Creek	Copper, dissolved	62.3	Table 17
15050100-014A	Queen Creek - Headwaters to Superior WWTP Outfall	Copper, dissolved	48.8	Table 18
		Lead, total	71.2	Table 19
15050100-1818	Arnett Creek	Copper, dissolved	90.9	Table 20
15050100-014B	Queen Creek - Superior WWTP Outfall to Potts Canyon	Copper, dissolved	92.0	Table 21
15050100-014C	Queen Creek - Potts Canyon to Whitlow Dam	Copper, dissolved	91.2	Table 22

9.1.1 Wasteload Allocations

The total allowable load was first distributed to the WLA, and based on permit allowances for flow and concentrations, an allowable load was assigned. For individual AZPDES permittees, the design flow and allowable concentration for copper and lead were used to compute an allowable load. For Superior WWTP Outfall 001 (Table 1.a. in the facility's permit), concentrations for metals were reported as total recoverable with a metals translator of 0.96 (A.A.C. R18-11: Appendix A, Table 5) for dissolved copper.

Overall, no load reductions were assigned to the permittees because available data indicates that potential discharges remain below the target limits. All permittees—including individual AZPDES permittees, MSGP facilities, and MS4 entities—were assigned allowable loads based on their permit-documented flows and concentrations. For Resolution Copper's Individual Permit Outfall 001, which discharges only during precipitation events exceeding a 10-year, 24-hour storm, discharges will be regulated using concentration-based target limits set equal to the water quality standards. This guarantees that stormwater entering Queen Creek will not violate surface water standards.

9.1.2 Load Allocations

Because of comparatively enormous contribution of loading from non-permitted, nonpoint sources, as shown in the HSPF modeling effort, the focus and responsibility of load reduction mainly rests with this sector of pollutant source. Hence, the remaining allowable load was assigned to the LA and based on existing load, significant reductions were needed. These reductions ranged from 49.4 to 99.5 percent for dissolved copper (Tables 16 to 17, and Tables 19 to 21), and 70.7 to 90.5 percent for total lead (Table 18).

The LA sector was classified into three groups where distinctions were useful: mined land, developed land, and undeveloped land (see also Section 6.2 Nonpoint Sources). Groupings were based on the HSPF model segment designations for land cover and mined land which made use of NLCD, SSURGO, and SWCA Environmental Consultants (2025a). A source distribution factor was constructed from the ratio of the load produced by a specific group to the total load produced by all groups (see Tables 16 to 21). Existing loads for each group were based on the product of its distribution factor and the total existing load in the non-permitted, nonpoint source sector.

Additionally, the potency of mined land was compared to developed and undeveloped land for each watershed of an impaired waterbody. If potency was found to be significantly higher for mined land, then a multiplier much larger than a value of 1.0 would be used in the computation of allocated load for each group. Allocated load would then be found by the product of this multiplier and the relative area occupied by the specific group to the total area of the impaired watershed. This multiplier, however, was not used in the analysis as the potency for mined land was not significantly higher than developed or undeveloped groups so the multiplier remained at 1.0 for all impaired waterbodies.

In reviewing the Load Allocations (LAs) in Tables 17 through 22, the majority of the allocation is assigned to undeveloped land. Given the vast extent of these undeveloped areas, mined land or developed areas are unlikely to become the dominant sources within the LA. Source contribution percentages supporting this conclusion are provided in Tables 11 and 12 of Section 8.2 (Spatial Patterns) for dissolved copper, and similarly in Tables 16 and 17 for total lead. Nevertheless, the largest percentage of load reduction was assigned to mined land due to its higher localized source contribution.

9.2 Seasonality and Critical Conditions

The critical condition for this TMDL are rainfall events of significant magnitude to produce surface runoff and mobilize metals from sediment deposits on the uplands and in their collecting channels and streams. A high-flow (storm event) can be defined by various metrics; the 95th percentile flow was applied here. In examining a few storms, this flow magnitude exists on the storm hydrograph, though not necessarily the peak of stormflow. At this flow magnitude, both entrainment of particulate and dissolved metals from uplands through surface runoff and in-channel scour and entrainment occur. Outside of storm events, sediment is deposited in channels for subsequent entrainment from the next storm event.

Seasonal patterns of precipitation, runoff, and streamflow were discussed in Section 8.3. Stormflow events, the critical condition, control pollution episodes that lead to impairment. Seasonality was hard to assess because the reliable streamflow record was short (10/1/2006 to 2/29/2008) for this watershed. During this period, four storms were identified (one in August and three in December). One could reason that seasonality exists when storms are more likely at certain times of the year. The monsoon, for example, can bring very large storms to Arizona during summer months (see Section 3.2). However, the largest storm in 2007–2008 occurred in December, which belongs to the winter wet season. Hence, no reliable definition of seasonality can be proposed other than to say that summer monsoon and winter wet season are pollutant-generating seasons.

9.3 MARGIN OF SAFETY

The Margin of Safety (MOS) is included in the TMDL to account for uncertainty regarding the relationship between pollutant loads and the water quality response of receiving waterbodies. The MOS may be formulated implicitly, using conservative assumptions or analytical techniques, or explicitly by reserving a portion of the loading capacity as an unallocated load.

The allocations developed for this TMDL incorporate an explicit 10 percent MOS. In addition, the model development was conducted to provide conservative results as an extra, implicit MOS. It is presumed that many of the waterbodies are losing reaches; however, available information (GeoSystems Analysis, 2022) enumerates leakage in one reach of Queen Creek. The modeling considered leakage only in a short reach upstream of Superior. Because critical conditions were categorized as high-flow events, it was determined this stream leakage minimally impacts the TMDL load at this location. Future modeling updates should better understand watershed-wide stream leakage to better assess the annual water budget analysis.

While metals data were available for some mined areas and were used to parameterize those specific locations, the average of the mined areas were used to set model parameters for the mined areas without data. Where receiving water data was available downstream of the mined lands, calibration was used to refine the model parameterizations. The calibration approach followed best practices to maximize the utility of available data without over parameterizing the model (see Section 7.2). As the complex HSPF model is used in a simplified way, the model results are reflective of mechanics and not a result of “curve fitting.”

Table 17. Mass balance of existing, allowable, and allocated dissolved copper load (WLA and LA) for WBID 15050100-1843.

Parameter: Dissolved Copper	WBID: 15050100-1843	Reach Name: Unnamed Tributary (UQ3) to Queen Creek					
	Value	Units					
Existing Load	125,288	mg/d					
Allowable Load (TMDL)	47,194	mg/d					
Reduction Needed (before MOS)	62.3	%					
MOS (10%)	4,719	mg/d					
Remainder Allowable Load (after MOS)	42,475	mg/d					
Reduction Needed (after MOS)	66.1	%					
Wasteload Allocations					Existing Load (mg/d)	Allocated Load (mg/d)	Percentage Reduction
	Permit #	Name	Outfall #				
	AZPDES Individual Permit						
	None present	-	-		-	-	-
	Multi-Sector General Permit (MSGP)						
	None present	-	-		-	-	-
	Municipal Separate Storm Sewer System (MS4)						
	None present	-	-		-	-	-
			Subtotal		**0**	**0**	**0.0**
Load Allocations					Existing Load (mg/d)	Allocated Load (mg/d)	Percentage Reduction
	Land Use/ Cover Group	Source Distribution Factor	Multiplier over Undeveloped (background) Target	Cumulative acreage at pour point (ac)			
	Mined Land	0.000	1.0	0	0	0	0.0
	Developed Land	0.000	1.0	0	0	0	0.0
	Undeveloped Land	1.000	1.0	710	125,288	42,475	**66.1**
			Subtotal		**125,288**	**42,475**	

Table 18. Mass balance of existing, allowable, and allocated dissolved copper load (WLA and LA) for WBID 15050100-014A.

Parameter: Dissolved Copper	WBID: 15050100-014A	Reach Name: Queen Creek - Headwaters to Superior WWTP Outfall					
	Value	**Units**					
Existing Load	789,652	mg/d					
Allowable Load (TMDL)	404,423	mg/d					
Reduction Needed (before MOS)	48.8	%					
MOS (10%)	40,442	mg/d					
Remainder Allowable Load (after MOS)	363,980	mg/d					
Reduction Needed (after MOS)	53.9	%					
Wasteload Allocations					**Existing Load (mg/d)**	**Allocated Load (mg/d)**	**Percentage Reduction**
	Permit #	**Name**	**Outfall #**				
	AZPDES Individual Permit						
	AZ-0021199	Superior WWTP	002		Not built	0	Not built
	AZ-0020389	Resolution Copper Company	001		6,714	6,714	0.0
		Resolution Copper Company	002		94,760	94,760	0.0
	Multi-Sector General Permit (MSGP)						
	AZ-I107055	OMYA AZ- Limestone Quarry	Outfalls 1,2		1,661	1,661	0.0
	AZ-I108987	Resolution Copper Mining (East Plant)	EP-SW-01, -03		1,477	1,477	0.0
	AZ-I108986	Resolution Copper Mining (West Plant)	WP-SW-03		222	222	0.0
	Municipal Separate Storm Sewer System (MS4)						
	AZ-S000018	ADOT	Superior Office		47	47	0.0
	AZ-S000018	ADOT	Superior Fuel		31	31	0.0
			Subtotal		**104,912**	**104,912**	**0.0**
Load Allocations					**Existing Load (mg/d)**	**Allocated Load (mg/d)**	**Percentage Reduction**
	Land Use/ Cover Group	**Source Distribution Factor**	**Multiplier over Undeveloped (background) Target**	**Cumulative acreage at pour point (ac)**			
	Mined Land	0.086	1.0	536	67,617	12,684	**81.20**
	Developed Land	0.050	1.0	763	39,871	18,050	**54.70**
	Undeveloped Land	0.864	1.0	9,655	682,164	228,334	**65.66**
			Subtotal		**789,652**	**259,068**	

Table 19. Mass balance of existing, allowable, and allocated total lead load (WLA and LA) for WBID 15050100-014A.

Parameter: Total Lead	WBID: 15050100-014A Reach Name: Queen Creek - Headwaters to Superior WWTP Outfall						
	Value	**Unit**					
Existing Load	2,011,149	mg/d					
Allowable Load (TMDL)	579,648	mg/d					
Reduction Needed (before MOS)	71.2	%					
MOS (10%)	57,965	mg/d					
Remainder Allowable Load (after MOS)	521,683	mg/d					
Reduction Needed (after MOS)	74.1	%					
Wasteload Allocations					**Existing Load (mg/d)**	**Allocated Load (mg/d)**	**Percentage Reduction**
	Permit #	**Name**	**Outfall #**				
	AZPDES Individual Permit						
	AZ-0021199	Superior WWTP	002		Not built	0	Not built
	AZ-0020389	Resolution Copper Company	001		2,208	2,208	0.0
		Resolution Copper Company	002		31,165	31,165	0.0
	Multi-Sector General Permit (MSGP)						
	AZ-I107055	OMYA AZ- Limestone Quarry	Outfalls 1,2		2,381	2,381	0.0
	AZ-I108987	Resolution Copper Mining (East Plant)	EP-SW-01, -03		2,117	2,117	0.0
	AZ-I108986	Resolution Copper Mining (West Plant)	WP-SW-03		317	317	0.0
	Municipal Separate Storm Sewer System (MS4)						
	AZ-S000018	ADOT	Superior Office		67	67	0.0
	AZ-S000018	ADOT	Superior Fuel		45	45	0.0
			Subtotal		**38,300**	**38,300**	**0.0**
Load Allocations					**Existing Load (mg/d)**	**Allocated Load (mg/d)**	**Percentage Reduction**
	Land Use/ Cover Group	**Source Distribution Factor**	**Multiplier over Undeveloped (background) Target**	**Cumulative acreage at pour point (ac)**			
	Mined Land	0.126	1.0	536	254,188	23,666	**90.7**
	Developed Land	0.136	1.0	763	273,408	33,679	**87.7**
	Undeveloped Land	0.738	1.0	9,655	1,483,554	426,038	**71.3**
			Subtotal		**2,011,149**	**483,383**	

Table 20. Mass balance of existing, allowable, and allocated dissolved copper load (WLA and LA) for WBID 15050100-1818.

Parameter: Dissolved Copper	WBID: 15050100-1818	Reach Name: Arnett Creek				
	Value	Units				
Existing Load	3,031,272	mg/d				
Allowable Load (TMDL)	274,340	mg/d				
Reduction Needed (before MOS)	90.9	%				
MOS (10%)	27,434	mg/d				
Remainder Allowable Load (after MOS)	246,906	mg/d				
Reduction Needed (after MOS)	91.9	%				
Wasteload Allocations				Existing Load (mg/d)	Allocated Load (mg/d)	Percentage Reduction
	Permit #	Name	Outfall #			
	AZPDES Individual Permit					
	None present	-	-	-	-	-
	Multi-Sector General Permit (MSGP)					
	NA	Kalamazoo Materials	Outfalls 1,2	3,053	3,053	0.0
	Municipal Separate Storm Sewer System (MS4)					
	None present	-	-	-	-	-
			Subtotal	**3,053**	**3,053**	**0.0**
Load Allocations				Existing Load (mg/d)	Allocated Load (mg/d)	Percentage Reduction
	Land Use/ Cover Group	Source Distribution Factor	Multiplier over Undeveloped (background) Target / Cumulative acreage at pour point (ac)			
	Mined Land	0.038	1.0 / 47	116,207	577	**99.5**
	Developed Land	0.018	1.0 / 78	53,789	962	**98.2**
	Undeveloped Land	0.944	1.0 / 19,731	2,861,276	242,313	**91.5**
			Subtotal	**3,031,272**	**243,852**	

Table 21. Mass balance of existing, allowable, and allocated dissolved copper load (WLA and LA) for WBID 15050100-014B.

Parameter: Dissolved Copper	WBID: 15050100-014B	Reach Name: Queen Creek - Superior WWTP Outfall to Potts Canyon					
	Value	**Unit**					
Existing Load	13,395,268	mg/d					
Allowable Load (TMDL)	1,070,967	mg/d					
Reduction Needed (before MOS)	92.0	%					
MOS (10%)	107,097	mg/d					
Remainder Allowable Load (after MOS)	963,870	mg/d					
Reduction Needed (after MOS)	92.8	%					
Wasteload Allocations					**Existing Load (mg/d)**	**Allocated Load (mg/d)**	**Percentage Reduction**
	Permit #	**Name**	**Outfall #**				
	AZPDES Individual Permit						
	AZ-0021199	Superior WWTP	001		6,390	21,804	0.0
	Multi-Sector General Permit (MSGP)						
	AZ-I107056	OMYA- Processing Facility	Outfalls 1,2,3		490	490	0.0
	AZ-I106994	Imery's Perlite USA Inc	Outfalls 1,2,3		1,671	1,671	0.0
Allocation from Upstream Impaired Reach (15050100-014A)							
	AZPDES Individual Permit						
	AZ-0021199	Superior WWTP	002		Not built	0	Not built
	AZ-0020389	Resolution Copper Company	001		6,714	6,714	0.0
		Resolution Copper Company	002		94,760	94,760	0.0
	Multi-Sector General Permit (MSGP)						
	AZ-I107055	OMYA AZ- Limestone Quarry	Outfalls 1,2		1,661	1,661	0.0
	AZ-I108987	Resolution Copper Mining (East Plant)	EP-SW-01, -03		1,477	1,477	0.0
	AZ-I108986	Resolution Copper Mining (West Plant)	WP-SW-03		222	222	0.0
	Municipal Separate Storm Sewer System (MS4)						
	AZ-S000018	ADOT	Superior Office		47	47	0.0
	AZ-S000018	ADOT	Superior Fuel		31	31	0.0
Allocation from Upstream Impaired Reach (15050100-1818)							
	Multi-Sector General Permit (MSGP)						
	NA	Kalamazoo Materials	Outfalls 1,2		3,053	3,053	0.0
			Subtotal		**116,516**	**131,930**	**0.0**
Load Allocations					**Existing Load (mg/d)**	**Allocated Load (mg/d)**	**Percentage Reduction**
	Land Use/ Cover Group	**Source Distribution Factor**	**Multiplier over Undeveloped (background) Target**	**Cumulative acreage at pour point (ac)**			
	Mined Land	0.073	1.0	940	973,000	16,263	**98.3**
	Developed Land	0.029	1.0	894	383,526	15,467	**96.0**
	Undeveloped Land	0.899	1.0	46,243	12,032,352	800,210	**93.3**
			Subtotal		**13,388,878**	**831,940**	

Table 22. Mass balance of existing, allowable, and allocated dissolved copper load (WLA and LA) for WBID 15050100-014C.

Parameter: Dissolved Copper	WBID: 15050100-014C	Reach Name: Queen Creek - Potts Canyon to Whitlow Dam					
	Value	**Units**					
Existing Load	19,051,878	mg/d					
Allowable Load (TMDL)	1,679,169	mg/d					
Reduction Needed (before MOS)	91.2	%					
MOS (10%)	167,917	mg/d					
MOS)	1,511,252	mg/d					
Reduction Needed (after MOS)	92.1	%					
Wasteload Allocations					**Existing Load (mg/d)**	**Allocated Load (mg/d)**	**Percentage Reduction**
	Permit #	**Name**	**Outfall #**				
	Multi-Sector General Permit (MSGP)						
	NA	Gila Rock Products	Not designated		1,988	1,988	0.0
Allocation from Upstream Impaired Reach (15050100-014B)							
	AZPDES Individual Permit						
	AZ-0021199	Superior WWTP	001		6,390	21,804	0.0
	Multi-Sector General Permit (MSGP)						
	AZ-I107056	OMYA- Processing Facility	Outfalls 1,2,3		490	490	0.0
	AZ-I106994	Imery's Perlite USA Inc	Outfalls 1,2,3		1,671	1,671	0.0
Allocation from Upstream Impaired Reach (15050100-014A)							
	AZPDES Individual Permit						
	AZ-0021199	Superior WWTP	002		Not built	0	Not built
	AZ-0020389	Resolution Copper Company	001		6,714	6,714	0.0
		Resolution Copper Company	002		94,760	94,760	0.0
	Multi-Sector General Permit (MSGP)						
	AZ-I107055	OMYA AZ- Limestone Quarry	Outfalls 1,2		1,661	1,661	0.0
	AZ-I108987	Resolution Copper Mining (East Plant)	EP-SW-01, -03		1,477	1,477	0.0
	AZ-I108986	Resolution Copper Mining (West Plant)	WP-SW-03		222	222	0.0
	Municipal Separate Storm Sewer System (MS4)						
	AZ-S000018	ADOT	Superior Office		47	47	0.0
	AZ-S000018	ADOT	Superior Fuel		31	31	0.0
Allocation from Upstream Impaired Reach (15050100-1818)							
	Multi-Sector General Permit						
	NA	Kalamazoo Materials	Outfalls 1,2		3,053	3,053	0.0
			Subtotal		**118,505**	**133,919**	**0.0**
Load Allocations					**Existing Load (mg/d)**	**Allocated Load (mg/d)**	**Percentage Reduction**
	Land Use/Cover Group	**Source Distribution Factor**	**Multiplier over Undeveloped (background) Target**	**Cumulative acreage at pour point (ac)**			
	Mined Land	0.037	1.0	1062	712,907	16,032	**97.8**
	Developed Land	0.012	1.0	926	226,383	13,991	**93.8**
	Undeveloped Land	0.951	1.0	89,213	18,106,198	1,347,310	**92.6**
			Subtotal		**19,045,488**	**1,377,333**	

Section 10 Implementation Planning

TMDL implementation plans are required by A.R.S § 49-234(G), (H), & (J); requiring they be developed for those waters listed as impaired and for which a TMDL has been completed pursuant to CWA § 303(d). Implementation plans provide a strategy that explains "how the allocations in the TMDL and any reductions in existing pollutant loadings will be achieved and the time frame in which attainment of applicable surface water quality standards is expected to be achieved".

The UQCW Implementation Plan establishes a flexible, adaptive framework for supporting stakeholder-led initiatives and tracking progress. The plan is organized around four core objectives:

1. Provide a non-binding technical reference guide of illustrative monitoring parameters to support future point source permitting evaluations;
2. Compile a menu of voluntary BMPs and catalog past and ongoing NPS remediation efforts in the UQCW;
3. Outline collaborative frameworks for voluntary stakeholder partnerships; and
4. Present a technical blueprint for future collaborative water quality monitoring, adaptive schedules, and the potential evaluation of site-specific standards.

10.1 Point Sources

Three AZPDES permit types are directly associated with surface water discharge to the UQCW: Individual, MSGP, and MS4s. CGPs were excluded due to their short-term nature.

Table 23. AZPDES surface water permits in the UQCW.

Permittee Name	AZPDES Permit Number	Permit Type	Permit Effective Date	Permit Expiration Date
ADOT	AZS0000018	Phase I MS4	6/24/2021	6/24/2026[1]
Gila Rock Products	No active permit[2]	MSGP	Not renewed for the 2025–2030	Not renewed for 2025–2030
Imery's Perlite USA Inc	AZI106994	MSGP	1/16/2025	1/15/2030
Kalamazoo Materials	No active permit[2]	MSGP	Not renewed for 2025–2030	Not renewed for 2025–2030
Omya AZ: Limestone Quarry & Processing Facility	AZI107055	MSGP	1/16/2025	1/15/2030
Omya AZ- Processing Facility	AZI107056	MSGP	1/16/2025	1/15/2030
Resolution Copper Mining LLC: Superior East & West Plant Operations	AZ0020389	Individual	12/13/2024	12/12/2029
	AZI108986	MSGP	1/16/2025	1/15/2030
	AZI108987	MSGP	1/16/2025	1/15/2030
Town of Superior WWTP	AZ0021199	Individual	4/25/2023	4/24/2028

[1] Permit in renewal as of time of TMDL development 7/31/2026.
[2] No renewal request from permittee for expired permit.

10.1.1 TMDL POINT SOURCE MONITORING PLAN AND RECOMMENDATIONS

Per CWA § 308 and 40 C.F.R. Part 122.44(i), permittees under the AZPDES program are required to conduct regular monitoring of their discharges to ensure compliance with permit-established effluent limitations and conditions. These data are critical for verifying permitted facilities are successfully meeting WLAs.

To support long-term watershed tracking while respecting established administrative boundaries, this implementation plan does not establish, schedule, or commit ADEQ to any new regulatory requirements, monitoring obligations, or permit modifications. Rather, Table 24 is provided strictly as a non-binding technical reference guide. The potential parameters compiled in the table are purely illustrative suggestions that ADEQ could choose to evaluate during future permit renewal cycles. Active permittees will continue monitoring in accordance with their current permit requirements, and any potential future adjustments—such as the technical suggestions compiled in Table 24 would be evaluated during separate, independent permitting cycles and developed in collaboration with the affected permittees to ensure technical feasibility and full regulatory alignment prior to any formal permit modifications. The recommended changes in Table 24 are for parameter sampling requirements for Mining MSGP permits in the UQCW. These sampling requirements would be used in updated pollution loading analysis and modeling revisions to the TMDL report.

Table 24. Potential TMDL permit sampling requirement changes.

PermitteeName	Permit Number	Permit Type	Current Sample Frequency	Planned Permit Parameter Requirements
ADOT	AZS0000018	Phase I MS4	2x samples/year, 1x sample/wet season[1]	No changes
Imery's Perlite USA Inc	AZI106994	MSGP	2x samples/year, 1x sample/wet season[1]	Cu, total hardness[2], Pb, pH, TSS
Omya AZ: Limestone Quarry and Processing Facility	AZI107055	MSGP	2x samples/year, 1x sample/wet season[1]	Cu, total hardness[2], Pb, pH, TSS
Omya AZ- Processing Facility	AZI107056	MSGP	2x samples/year, 1x sample/wet season[1]	Cu, total hardness[2], Pb, pH, TSS
Resolution Copper Mining LLC: Superior East and West Plant Operations	AZ0020389	Individual	1x/Month to 2x/Year Parameter dependent	No Changes
	AZI108986	MSGP	2x samples/year, 1x sample/wet season[1]	Cu, total hardness[2], Pb, pH, TSS
	AZI108987	MSGP	2x samples/year, 1x sample/wet season[1]	Cu, total hardness[2], Pb, pH, TSS
Town of Superior WWTP	AZ021199	Individual	1x/week to 1x/quarter, Parameter dependent	No Changes

[1] MSGP Winter Wet Season: November 1st – May 31st; Summer Wet Season: June 1st – October 31st.

[2] Measured as $CaCO_3$

10.1.2 New Surface Water Discharges and the Town of Superior/Resolution Copper Water Agreement

Any new or expanded point source surface water discharges initiated in the UQCW will be subject to the AZPDES program, requiring a WLA calculation to ensure that receiving WQS are fully maintained in accordance with A.A.C. R18-11-107.

A notable upcoming point source in the watershed is the planned discharge associated with the May 2026 Water Agreement between the town of Superior and Resolution Copper. Under this agreement, Resolution Copper is obligated to deliver and discharge 40 acre-feet of water per year (at a rate not to exceed 26 gallons per minute) to Queen Creek, with a planned outfall to be added near the Magma Ave Bridge on the east side of Superior. From a TMDL perspective, this new discharge is anticipated to actively support water quality improvements through two primary mechanisms: direct dilution of ambient dissolved metal concentrations during low-flow periods, and enhanced bank stabilization. Sustaining streamflow for up to ten months of the year will bolster local riparian and native vegetation, whose root networks physically bind mineralized soils, mitigating erosion and sediment transport that drives Cu and Pb loading.

Because this planned discharge is classified as a point source, it will be subject to standard AZPDES permitting requirements prior to discharge. To ensure the protection of receiving waters, any necessary scientific evaluations—such as characterizing downstream travel distances, examining seasonal mixing dynamics, or conducting localized water quality studies—will be integrated directly into the AZPDES permitting process. The administrative and technical responsibility for designing and conducting these evaluations, including any necessary flow or dilution studies, remains with the permit applicant as part of their standard regulatory obligations. This integration ensures that the discharge's in-stream behavior is scientifically verified and managed without committing ADEQ staff or financial resources to independent watershed studies.

10.2 Nonpoint Sources

NPS pollution represents the dominant driver of copper and lead loading in the UQCW, primarily driven by stormwater runoff eroding highly mineralized soils and legacy mining features over the previously documented mined land (Figure 2). In accordance with A.R.S. § 49-234(G), "any reductions in loadings from nonpoint sources shall be achieved voluntarily". As such, any management measures or BMPs outlined in this section are presented strictly for planning, public information, and funding coordination purposes. This plan does not establish new rules, regulations, or mandatory cleanup requirements for private landowners, federal land managers, or municipal entities.

10.2.1 General BMPs for the UQCW

To mitigate metal loading and stabilize mineralized soils across the UQCW, local stakeholders and land managers are encouraged to implement targeted BMPs. These voluntary structural, vegetative, and operational controls are designed to mitigate erosion, trap sediment, and reduce the transport of Cu and Pb during storm events.

Because much of the watershed area is private ownership or public land under federal management, involving local communities, federal land managers, and industry partners is essential to successfully deploying these solutions. Table 24 outlines a recommended menu of voluntary BMPs, explicitly linking each action to its targeted loading pathway and its expected physical impact on Cu and Pb mitigation.

Table 25. Voluntary BMPs for metals loading mitigation.

BMP	Targeted Source/Pathway	Expected Result
Soil Capping and Non-Mineralized Covers	Legacy tailings piles and exposed mineralized waste rock.	Reduces rainwater infiltration into mine waste, minimizes wind-driven dust, and physically prevents stormwater from eroding and transporting metal-bearing sediment into washes.
Native Vegetative Buffers and Reseedings	Exposed slopes, burn areas (Telegraph Fire), and fragile stream banks.	Native roots bind and stabilize soils. This mitigates stream bank erosion and prevents stream bed scouring that releases metal-laden sediments during storm events.
Rock Check Dams and Channel Diversions	Steep slopes, drainage gullies, and washes downstream of AML features.	Slows stormwater runoff velocities, reducing the stream's carrying capacity for metals. Traps and settles out metal-bearing sediment before it reaches the mainstem.
Invasive Species Removal	Riparian corridors and active floodplains.	Eradicating Tamarisk allows deep-rooted native vegetation to re-establish, stabilizing banks, restoring natural channel hydrology, and lower local soil salinity.
Targeted Municipal Street Sweeping	Urban roadways, pavement, and parking lots in Town of Superior.	Physically removes accumulated metals before storm events can wash them into drainages.
Physical AML Closures (Adit Backfilling & Grates)	Discharging adits, shafts, and historical mining openings.	Prevents stormwater from contacting underground mineral deposits, eliminating pathways for metal-laden discharges into adjacent washes.

10.2.2 Past and Ongoing Remediation Efforts in the UQCW

To demonstrate “reasonable assurance” to the EPA and establish a precedent for future watershed initiatives, this section catalogs previous and ongoing remediation projects in the UQCW (Table 25). Each of these efforts contributes to water quality improvements by stabilizing soils, isolating legacy mine wase, and physically reducing transport of Cu and Pb into receiving waters.

Table 26. Completed and ongoing remediation efforts in the UQCW.

Responsible Parties	Remediation Project/Activity	Year Completed	Metals Loading Mitigation Action
Resolution Copper, ADEQ VRP	West Plant Restructure Reclamation & Capping	2005–2020	Spent ~$75 million to remediate 475 acres of legacy mined land. Renovated/demolished over 30 structures, capped and recontoured tailings ponds, reseeded native vegetation.
Resolution Copper, ADEQ VRP	Historic Magma Smelter Demolition & Soil Cleanup	2018–2019	Demolished the Magma Smelter, excavated nearby contaminated soils, reseeded native vegetation.
Resolution Copper, EPA, ADEQ	Groundwater Seepage Controls and Mine Water Treatment Plant (MWTP) Operations	2008–Ongoing	Operation of Apex Trench Collection System to capture seepage and rout it to MWTP for treatment.
BHP & ADEQ VRP	Superior Soil Program (Residential Yard Cleanups)	2016–Ongoing	Ongoing residential and municipal yard investigations, following by excavation and capping in areas with elevated metal concentrations.
Town of Superior	Queen Creek Riparian Area Restoration Projects	2022–2023	Targeted removal of Tamarisk along Queen Creek and replanting of native riparian species to stabilize stream banks.
USFS	Mexican Spotted Owl Habitat Reforestation (Telegraph Fire Recovery)	2024–Ongoing	Implementation of 5-year native tree and plant seeding plan to stabilize burned mountain slopes from post-fire runoff erosion.

To guide future voluntary cleanup efforts, ADEQ completed a project in 2026 to identify potential AML features on the landscape for further investigation. The results of that project mapped more than 1,200 potential historic mining features across the watershed. This assessment is omitted from Table 26, which is reserved strictly for on-the-ground remediation projects—because it represents a planning and characterization study rather than a direct, physical load-reduction project. However, the project's outcome can aid in future remediation efforts. Local watershed groups, federal land managers, and stakeholders can utilize this database to target future soil stabilization projects and coordinate federal funding to address legacy mine features.

10.3 Stakeholder Collaboration

Because NPS control operates within a voluntary framework in Arizona under A.R.S. § 49-234(G), long-term water quality improvement in the UQCW is driven by active, local community leadership. ADEQ's primary role is to serve as a supportive technical partner, data repository, and funding facilitator, allowing local entities and land managers to take direct ownership of watershed recovery efforts.

10.3.1 Support for the Queen Creek Working Group (QCWG)

The QCWG was established by the Town of Superior in 2019 to champion local watershed restoration, focus on recovery of riparian habitat, and explore opportunities for shallow aquifer recharge. In 2024, the group secured a Phase I grant under the Bureau of Reclamation's Cooperative Watershed Management Program, funding community-led watershed restoration planning through March 2027.

ADEQ has participated in the QCWG since its inception, providing regular water quality updates, TMDL progress reports, and technical modeling insights. While ADEQ does not maintain formal voting membership, leadership status, or decision-making roles within the group, the agency strongly supports and recommends the continuation of the QCWG as an independent, stakeholder-driven forum. This collaborative effort ensures that local private landowners, industry partners, and municipal leaders can coordinate voluntary BMP implementations, share data, and leverage resources to secure funding.

10.3.2 Coordination with U.S. Forest Service (USFS) Tonto National Forest

Because the USFS administers approximately 93% of the land area within the UQCW, the agency is a critical land management partner in the watershed. Historically, ADEQ and the USFS have maintained a successful partnership to address legacy mining and nonpoint source pollution on federal lands.

To address the metal-loading risks in UQCW, ADEQ will continue to coordinate with the USFS to align agency priorities. This includes sharing water quality data, utilizing the 2026 AML database to prioritize historic mine features on USFS land, and supporting USFS efforts to implement soil-stabilization, road-decommissioning, and riparian-revegetation projects. This ongoing inter-agency alignment maximizes public resources and ensures federal restoration dollars are directed appropriately.

10.4 Future Actions and Monitoring

10.4.1 Collaborative Watershed Monitoring

Future monitoring in the UQCW is vital to tracking water quality improvements and evaluating the long-term effectiveness of voluntary BMPs. To maximize agency and stakeholder resources, ADEQ encourages a collaborative, partner-led sampling approach that coordinates efforts with the USFS, local municipal entities, and community-led watershed groups.

Rather than establishing a rigid, agency-driven monitoring schedule, ADEQ presents this section as a technical blueprint for third-party organizations and local partners looking to lead future sampling campaigns. Data collection should focus on investigating loading pathways across the five critical HUC-12 sub watersheds in the UQCW shown in Figure 20:

1. Arnett Creek (HUC 150501000401)
2. Silver King Wash (HUC 150501000402)
3. Potts Canyon (HUC 150501000403)
4. Hewitt Canyon (HUC 150501000404)
5. Alamo Canyon (HUC 150501000405)

Collecting water quality, flow, and precipitation data in these areas can aid in prioritizing site-specific remediation projects and strengthen future grant applications. Figures 21 and 22 demonstrate the modeled loading of copper and lead in each sub watershed in the UQCW. These figures may serve to help visualize where to focus data collection efforts.

Figure 20. HUC-12 Sub watersheds in the UCQW.

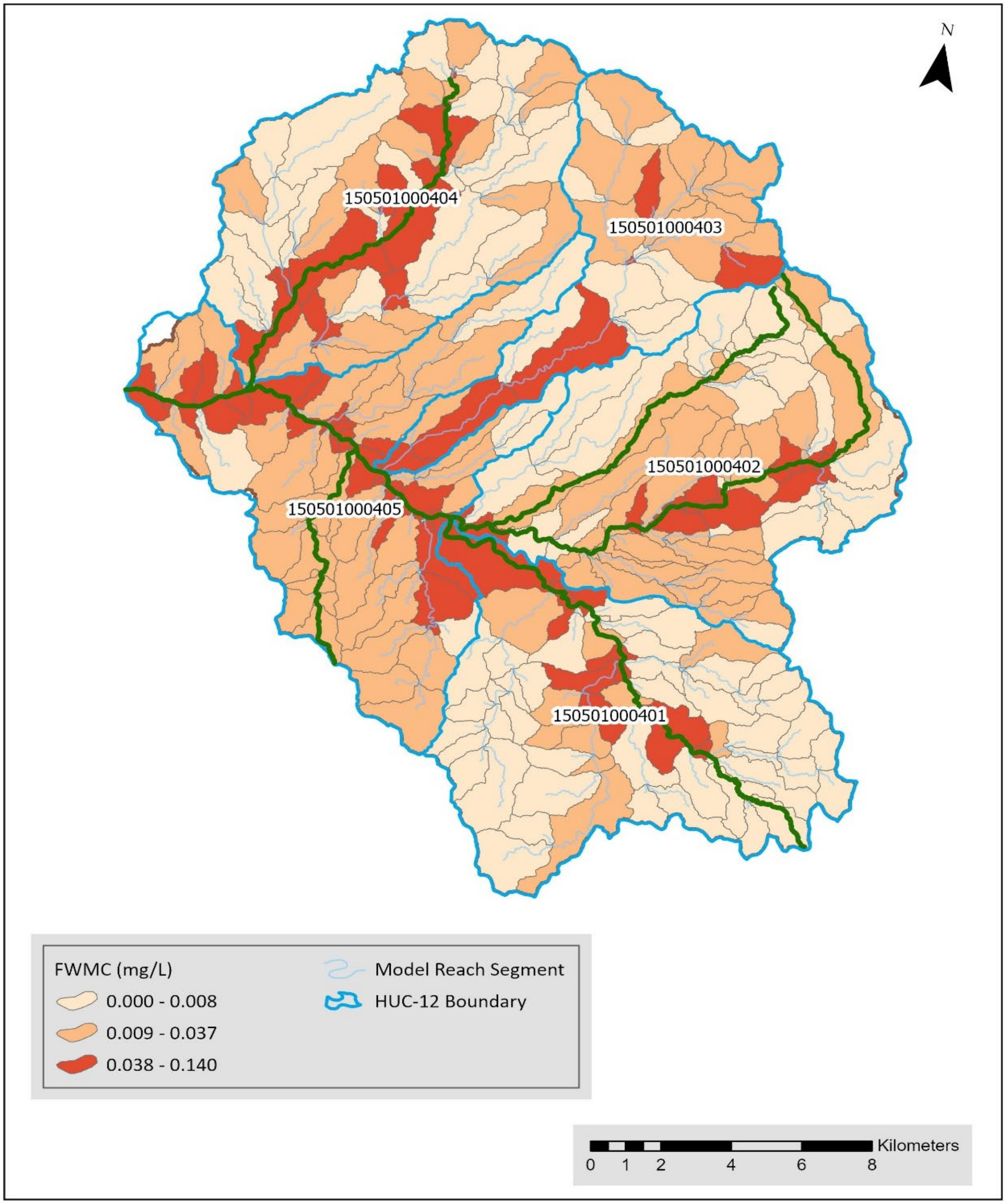

Figure 21. Flow-Weighted Mean Concentration Copper loading in the UQCW.

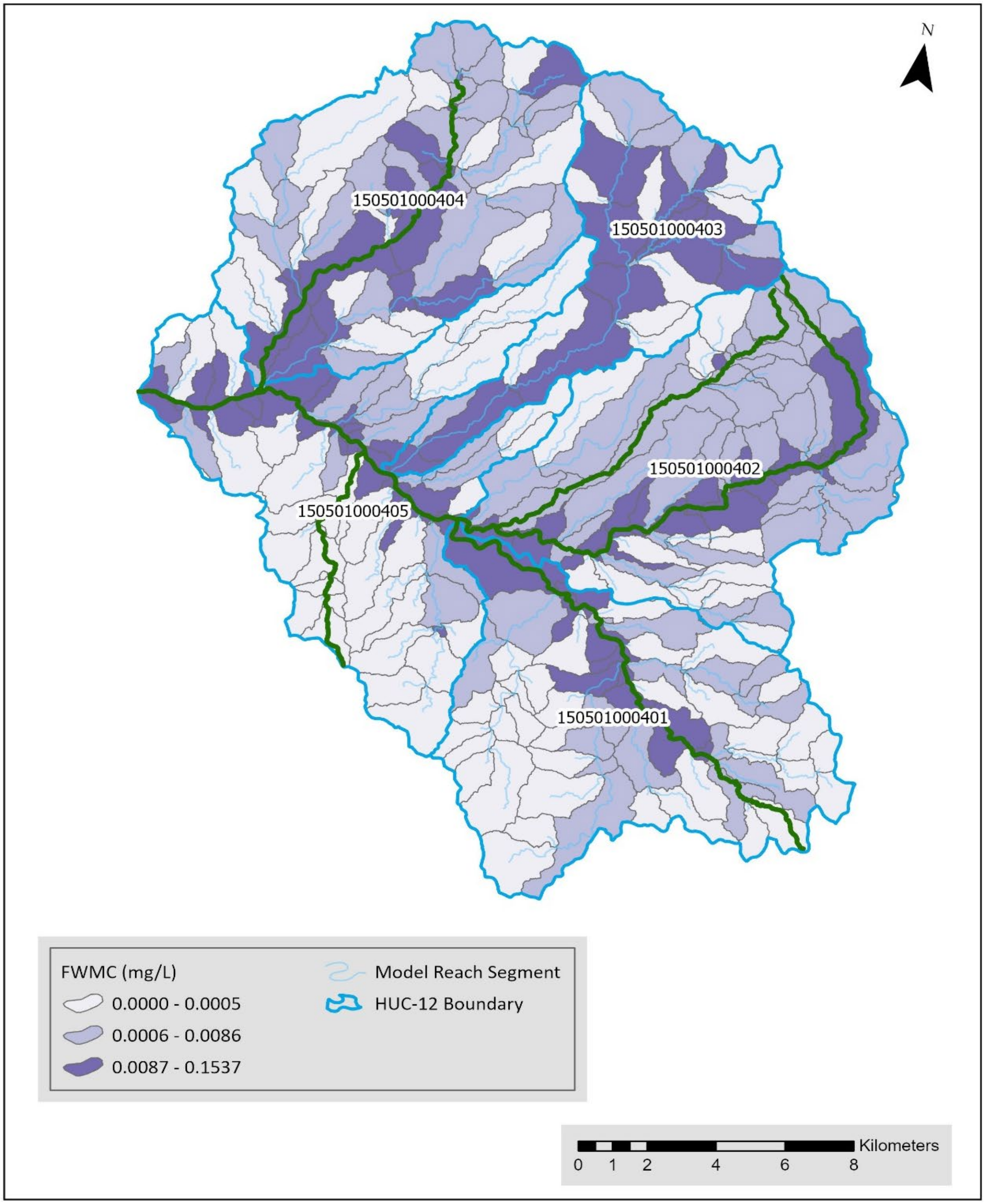

Figure 22. Flow-Weighted Mean Concentration Lead loading in the UQCW.

10.4.2 Evaluation of Site-Specific Standards (SSS)

As local natural geology significantly contributes to baseline Cu and Pb loading across the UQCW, achieving standard numeric water quality targets through voluntary NPS control measures alone may not be feasible. Pursuant to A.A.C. R18-11-115 and R18-11-119, Arizona water quality rules establish that WQS cannot be set lower than natural background conditions and allow for the development of SSS.

Currently, the UQCW features a relatively low average water hardness of approximately 120 mg/L ($CaCO_3$), which makes its default dissolved metals standards highly stringent compared to other historic mining districts in Arizona. As additional water quality and flow data are collected in the UQCW, ADEQ may evaluate whether SSS is appropriate. This evaluation would be conducted to ensure that future permit conditions and watershed goals reflect realistic, naturally occurring conditions rather than unattainable geologic baselines.

10.4.3 Adaptive Implementation Timeline & 5-Year Reviews

Achieving the load allocations set forth in this TMDL depends on active leadership from local watershed stakeholders, federal land managers, and third-party organizations. Because NPS reductions rely on voluntary participation, implementation will proceed as local partners secure funding, engage landowners, and execute targeted projects.

In accordance with A.R.S. § 49-234, ADEQ will officially review this TMDL at least once every five years to determine if attainment of applicable surface WQS has been achieved. Rather than establishing rigid agency-driven timelines or mandatory milestones, the strategy establishes a flexible 5-year adaptive horizon. During each 5-year review cycle, ADEQ will evaluate progress, review cumulative monitoring results, update the VRP soil status, and determine if adjustments to this implementation plan—or the evaluation of site-specific standards—are warranted.

Section 11 Public Participation

Since the initiation of the TMDL project, ADEQ has worked with and requested input from stakeholders in the watershed. Stakeholders' participation ranged between acknowledgement of the project to active participation including sharing data and input for use in the TMDL. The development of the TMDL would not have been possible without the participation of the public and the engagement of local interest groups. The following is a summary of public meetings held within the watershed and major topics of discussion:

- **Presentation to the San Carlos Apache Tribe:** On November 7th, 2023, ADEQ presented an overview of the ongoing Queen Creek TMDL, outlining the project plan and timeline.
- **Regenerating Sonora Presentation:** On November 7th, 2023, ADEQ presented an overview of the ongoing Queen Creek TMDL, outlining the project plan and timeline.
- **AZ Cross-Watershed Network (XWN) Presentation:** On March 5th, 2024, ADEQ presented to the XWN about the ongoing TMDLs in Arizona. This virtual presentation informed the audience of TMDLs and the TMDLs being developed by ADEQ including Queen Creek, Oak Creek, Upper Agua Fria, Statewide Mercury, and the Patagonia Mountains. Participants were encouraged to ask questions and were given a Google Forms link to request additional updates on the ongoing TMDLs.

- **ACWA 2025 Water Quality Modeling Workshop Presentation:** On September 18th, 2025, ADEQ presented the Queen Creek TMDL and its HSPF modeling approach to the attendees of the conference. This presentation was to demonstrate the complex hydrology of the UQCW and to receive comments and questions from other state and federal agencies. The group acknowledged the issues with limited data and the intermittent to ephemeral nature of the watershed. The group suggested additional data collection and to ensure a blanket MOS was implemented for the modeling results. These comments were considered during the modeling phase of the project.
- **Queen Creek Working Group (QCWG) Watershed Restoration Meetings:** Since 2023, ADEQ has been a participant in the town of Superior's QCWG. The group was created to bring watershed stakeholders together to plan watershed improvement projects in UQCW. The QCWG is open to both invited stakeholders and public participation. ADEQ has provided quarterly updates to the group, updating and requesting comments on the status of the project.

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