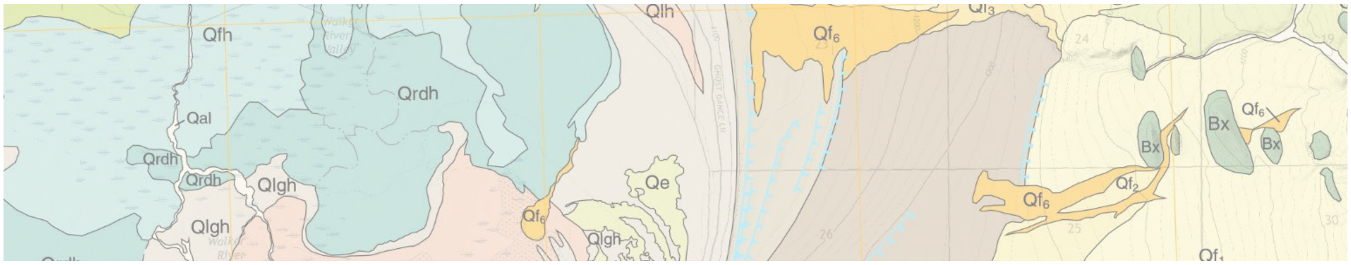


TEXT AND REFERENCES ACCOMPANYING NEVADA BUREAU OF MINES AND GEOLOGY OPEN-FILE REPORT 2026-02

# Surficial Geologic Map of the Walker Lake Area, Mineral County, Nevada

*by*

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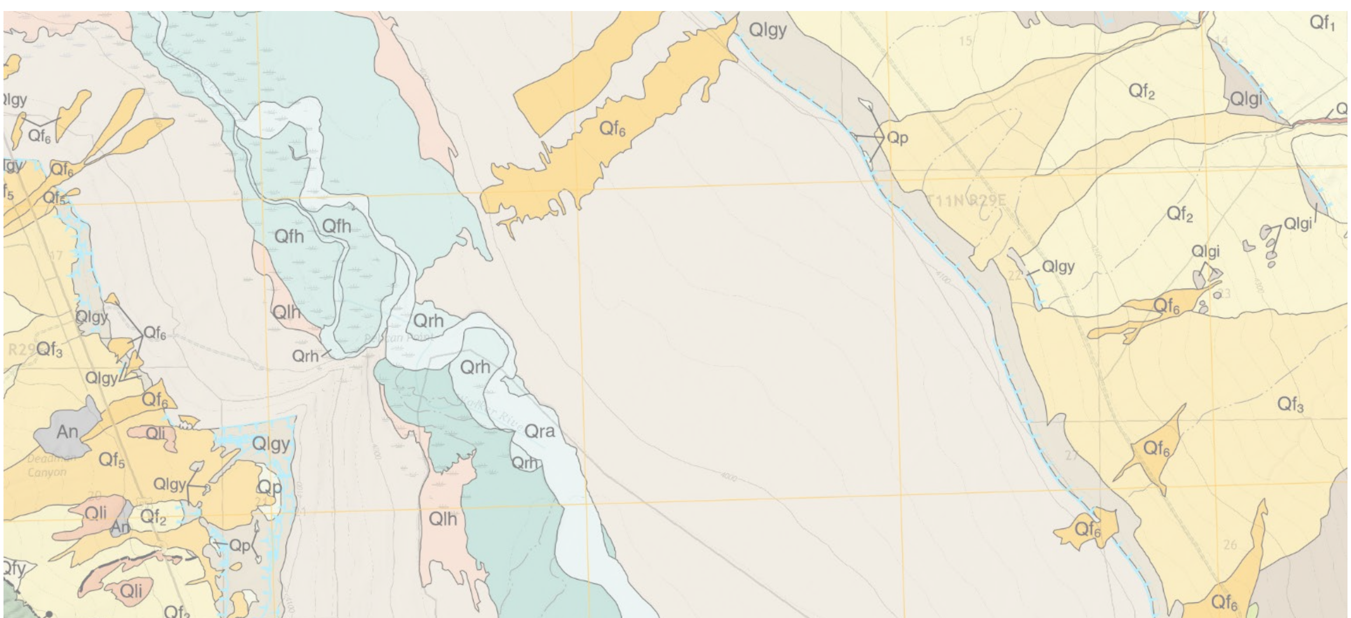

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## ABSTRACT

Walker Lake lies in a closed basin at the end of the Walker River, where water levels have been fluctuating for probably over 1 million years (Morrison, 1991; Reheis et al., 2002, 2003). In the latest Pleistocene (~15.5 ka), the basin was occupied by the southernmost arm of Lake Lahontan that reached an elevation of about 1,331 m (Adams and Wesnousky, 1998; Adams et al., 1999). After Lake Lahontan receded, there is scant evidence that a lake occupied the basin during much of the Holocene until about 3.6 ka when a lake rose to about 1,262 m (Adams and Rhodes, 2019). Over the ensuing several thousand years, lake levels fell and rose several times, creating a suite of late Holocene shorelines found between about 1,262 m and 1,252 m. More recently, the historical highstand of Walker Lake at about 1,252 m was achieved in AD 1868 (Adams, 2007). The basinwide extent of each of these dated shorelines provides horizontal chronostratigraphic markers that were used to define the ages of different alluvial fans through detailed mapping (1:5,000-scale) of the crosscutting relationships between alluvial fans and shorelines. The mapping is presented here at a scale of 1:48,000 to provide a basinwide overview.

## METHODOLOGY

This map is the result of surficial geologic mapping of ~683 km$^2$ of the Walker Lake basin, which involved classifying and delineating geomorphic surfaces and landforms at a nominal scale of 1:5,000 using a variety of aerial imagery and DEM (Digital Elevation Model) data products with 0.5 to 5-meter resolution. At the start of this study (2013), the entire mapping area was covered by 5 m LiDAR (Light Detection and Ranging) data (Lopes and Smith, 2007), while the northern part of the mapping area was also covered by 1 m LiDAR data (2009). Since that time, the Wassuk Range front fault zone was covered by 0.5 m LiDAR data sets (2015) and the entire region is now covered by 1 m LiDAR (2020). This latter dataset, downloaded from the USGS 3DEP LiDAR Explorer (https://apps.nationalmap.gov/lidar-explorer/#/), serves as the primary base for all the mapping. The 1 m LiDAR DEM has a vertical accuracy of about 15 cm and was processed into hillshade and slopeshade maps to assist in interpretation. All topographic and mapping products were cast into the NAD 83 UTM Zone 11 coordinate system using the NAVD88 vertical coordinate system. Point elevations were augmented by field surveys using a Trimble Nomad map-grade GPS surveying system with real-time corrections, which has a vertical and horizontal precision of about 30 centimeters.

The delineation of geomorphic units was performed by digitizing unit boundaries directly into an ArcGIS v 10.x and later ArcGIS Pro platform using the LiDAR data and satellite imagery as base layers. The line work was then converted to polygons, where each polygon was attributed according to its geomorphic unit. The categorization schemes of House and Adams (2009, 2010), Adams and Wesnousky (1998), and Peterson (1981) were modified slightly to accommodate the diversity and age of the different units found in the study area.

The LiDAR data, augmented by field surveys, were used to distinguish different late Holocene shorelines and to trace them laterally. Additional field activities included checking map contacts and unit designations, documenting stratigraphic and crosscutting relations between different geomorphic units, and characterizing the deposits and their surfaces. The ages of alluvial fans across the basin were constrained by the ages of the dated shorelines and other indicators of lake level that they interact with (Adams, 2007; Adams and Rhodes, 2019), either being cut by or overlying a particular shoreline or other type of lake-level indicator. Ages are variously reported as calibrated years Before Present (cal yr BP), thousands of calibrated years ago (cal ka), and Common Era years (e.g., 1868 CE).

## DESCRIPTION OF MAP UNITS

The following unit descriptions outline the morphometric, surface, and near-surface characteristics, and preliminary ages of late Quaternary to modern deposits and landforms surrounding Walker Lake. The mapping scheme was adapted from those used by Peterson (1981), Adams and Wesnousky (1998), and House and Adams (2009, 2010).

### Fluvial and Deltaic Deposits and Landforms

**Qal Active channel or wash (Historical)** Active channels represent the courses of recently active, confined stream flow during runoff events caused by rainfall or snowmelt. These channels commonly originate in mountain blocks or on alluvial fans of various ages and are sites of erosion, transport, and deposition of sediments. The floors of active channels commonly display braid-bar morphology and particle sizes ranges from sand to gravel to boulders, depending on source areas. Typically, active channels within and close to mountain blocks have coarser bedloads than do channels that are more distal to mountain blocks. Many of the smaller active channels are not mapped on the alluvial fans, but instead are included within the various alluvial-fan units.

**Qra Active channel and emergent bars of Walker River (Historical)** The Qra unit represents the active channel of the Walker River and recently active sand and fine gravel bars that were formed during recent high flows. They have all of the characteristics that would be expected of an active sand bed river.

**Qrh Channels, bars, and terraces of Walker River, undivided (Historical)** The Qrh unit represents the terraces created during the incision of the Walker River over the last 100 years or so in response to declining lake levels (Adams, 2007). Surface sediments are primarily composed of sand and fine gravel.

**Qfh Floodplains of Walker River, undivided (Historical)** Surfaces assigned to this unit are found mostly in the distal reaches of the Walker River below the historical highstand of 1,252 m (Adams, 2007). The Qfh unit is represented by broad, relatively flat surfaces adjacent to the modern channel and former channels of the Walker River, which formed as the river was extending its length as the surface of Walker Lake receded by more than 50 m over the last 100 years (Adams, 2007) and before the river had locally incised the channel. The surfaces of Qfh are composed primarily of sand and to a lesser extent silt that represent fluvial flood reworked surfaces of former fine-grained historical lake sediments.

**Qrdh Delta deposits of Walker River, undivided (Historical)** Surfaces mapped as Qrdh occur below 1,252 m and represent deposition in delta settings where the Walker River was entering Walker Lake. These relatively flat surfaces are arranged by decreasing elevation and decreasing age, moving downstream from Schurz to the distal end of the modern river where it flows into Walker Lake, although they are all grouped together on the map. Deposits consist primarily of loose sand and minor amounts of fine gravel.

**$Qty_1$ Terraces of Walker River elevated 2–3 m above modern channel (late Holocene)** Fluvial terraces adjacent to the modern Walker River channel that exhibit abandoned channels, meander scrolls and other features indicative of a former floodplain. Primarily composed of sand and fine gravel. Elevated 2–3 m above the modern channel but may have been active in the late 19th century.

**$Qty_2$ Terraces of Walker River elevated 3–5 m above modern channel (Holocene)** Similar to $Qty_1$ but surfaces are elevated 3–5 m above modern channel. The fluvial surface morphology of the $Qty_2$ surfaces are more muted because they have largely been modified by agricultural fields.

**$Qty_3$ Terraces of Walker River elevated 5–8 m above modern channel (Holocene)** Similar to $Qty_1$ and $Qty_2$ but less extensive and elevated from 5–8 m above the modern channel.

**Qt Fluvial terraces along tributary stream channels, undivided (Holocene)** This unit is represented by relatively small terrace remnants elevated above active washes in drainages in the mountain blocks and alluvial fans. The deposits are typically composed of sand through boulder-sized material, with surfaces often exhibiting braided morphology. In some drainages the terrace surfaces grade down channel to alluvial fans of different ages.

## Eolian Deposits

**Qe Eolian sediments and sand sheets (Historical to late Pleistocene)** Deposits included in this unit are composed mostly of medium to fine sand and silt arranged in broad sheets, primarily on the northeast side of Walker River east of Schurz. Although this surface is covered by desert scrub, small muted dune forms (1–2 m high) and blowouts are visible in the LiDAR imagery. Farther south along the western piedmont of the Gillis Range, broad, smooth surfaces covered with sand are also mapped as Qe.

**Qed Sand dunes (Historical to late Pleistocene)** Generally similar to Qe in terms of medium to fine sand textures, but exhibits various dune morphologies, including parabolic. Most of the dunes are less than a few meters high and show little activity because of a sparse desert scrub cover. Some of the patches of Qed occur below the historical highstand, indicating their young age.

## Alluvial-fan Deposits

The alluvial fans found in the Walker Lake basin are typical of those found in pluvial lake basins within the Great Basin and elsewhere in that they are derived from mountain drainages of various sizes, represent unconfined, divergent flow as drainages exit mountains or incised alluvial fans, and are commonly composed of poorly sorted sand to gravel to boulders. The deposits comprising the alluvial fans represent flow events ranging from relatively fine gravel slurries with occasional boulders (hyper-concentrated flows) to grossly unsorted, sandy matrix-supported gravel and boulders (debris flows). The textures of the different-aged alluvial fans are not related to age, as exposures through several alluvial fans display multiple different facies stacked in relatively thin sheets (≤1 m). The ages of the different alluvial-fan units were determined by their crosscutting relations with dated shorelines, namely the Lahontan highstand (~1,331 m; Adams and Wesnousky, 1998), late Holocene shorelines at 1,262 m, 1,257 m, and 1,255 m (Adams and Rhodes, 2019), and the historical highstand (1868 CE) at 1,252 m (Adams, 2007).

**Qfy Alluvial-fan deposits, undivided (Holocene to late Pleistocene)** Alluvial fans mapped as Qfy are younger than the Lake Lahontan highstand but cannot be specifically related to the lower, dated shorelines. Therefore, they are undifferentiated.

**$Qf_6$ Historical alluvial-fan deposits (1868 to present) (Historical)** These deposits represent deposition after the historical highstand because they cut through the 1,252 m shoreline or were observed to have occurred at some point in the last 50 years using repeat aerial imagery. Most $Qf_6$ deposits are composed of relatively fine-grained sandy slurries although some, particularly along the Wassuk Range front, are composed of more bouldery material.

**$Qf_5$ Alluvial-fan deposits (600 cal yr BP–82 cal yr BP [1868 CE]) (late Holocene)** Similar to other late Holocene fan surfaces but their distal edges are truncated by the 1,252 m shoreline.

**$Qf_4$ Alluvial-fan deposits (2,700–600 cal yr BP) (late Holocene)** Similar to other late Holocene fan surfaces, but their distal edges are truncated by the 1,255 m shoreline.

**$Qf_3$ Alluvial-fan deposits (3,600–2,700 cal yr BP) (late Holocene)** Similar to other Holocene fan surfaces, but their distal edges are truncated by the 1,257 m shoreline.

**$Qf_2$ Alluvial-fan deposits (15,500–3,600 cal yr BP) (middle Holocene to latest Pleistocene)** Alluvial fan surfaces that are mapped as the $Qf_2$ unit are younger than the Lake Lahontan highstand at 1331 m (15.5 cal ka; Adams and Wesnousky, 1998) because they are below that shoreline but are older than 3.6 cal ka because they are truncated by the 1,262 m shoreline. The surfaces of the $Qf_2$ unit tend to be smoother than those of the younger $Qf_3$, $Qf_4$, $Qf_5$, and $Qf_6$ fan units, but exposures through $Qf_2$ deposits show similar coarse-grained debris-flow facies as those in younger fans.

**$Qf_1$ Pre-late Pleistocene alluvial-fan deposits (late to middle Pleistocene)** The focus of this mapping was deciphering the ages of the younger alluvial fans in the basin, so all alluvial fan surfaces that are older than the Lake Lahontan highstand, determined through crosscutting relations, were mapped as $Qf_1$. These older fan surfaces commonly display more rounded and smoothed topography than the younger fans, some of which are deeply dissected. Some of the $Qf_1$ surfaces are expressed as highly eroded "ballena topography" (Peterson, 1981), where much of the original relatively flat topography of the fan surface has been eroded, and only rounded interfluves remain between the deeply entrenched channels on the fan.

## Beach Gravel Deposits and Landforms

All of the beach gravel units at Walker Lake share a number of common traits including that they were formed through wave action on the margins of the lake as it repeatedly rose and fell through time. The gravels that comprise the various units range from sand and fine gravel through cobbles and sometimes boulders but the coarseness of the deposits generally has nothing to do with age but is more dependent on location and source. Most of the semi-rounded to semi-angular beach gravels are likely derived from alluvial fan surfaces with various textures so that superimposed beach features tend to reflect the underlying coarseness of the deposit upon which they are developed (e.g., Adams and Wesnousky, 1998), but the gravel is more rounded. Constructional beach features, including beach ridges and spits, are found on relatively low slopes (< 5°) with abundant sediment supply, while erosional beach features are formed on steeper slopes (Adams and Wesnousky, 1998; Reheis et al., 2014). The ages of the various beach gravel units were determined by the elevation ranges in which they are found. For example, beach gravel found below the elevation of 1,252 m (historical highstand) was mapped as historical (Qlgh) while beach gravels found between 1,252 m and 1,262 m were mapped as late Holocene, and so on. Past lake levels and their ages used in this mapping are from Adams and Wesnousky (1998), Adams (2007), and Adams and Rhodes (2019).

**Qlgh Beach gravel and related shoreline features (Historical)** This unit represents beach gravel that was actively being transported and deposited by waves at the time of the historical highstand (AD 1868) at 1,252 m and all subsequent, lower lake levels that have been occupied by Walker Lake as the lake has now dropped to an elevation of about 1,185 m. There has essentially been no soil formation on these features because of their young age.

**Qlgy Beach gravel and related shoreline features (late Holocene)** Beach gravels and beach ridges assigned to this unit occur from 1,252–1,262 m and were deposited during the period of about 3,600–82 cal yr BP (Adams and Rhodes, 2019). Soil development typically is minimal and generally consists of a small amount of silt (dust) infiltrated into the upper few centimeters of the generally sandy fine gravel surfaces.

**Qlgi Beach gravel and related shoreline features (late Pleistocene)** Deposits and landforms assigned to this unit represent beach deposits formed during the Lake Lahontan highstand and subsequent recession. Soil development on these late Pleistocene features is typically weak with Av-Bw-Bwk profiles reflecting about 15,000 years of dust infiltration and bioturbation (e.g., Adams and Wesnousky, 1999).

**Qflp Fan-pediment/lacustrine platform veneer sediments (late Pleistocene)** Surfaces mapped as Qflp are represented by relatively flat, lakeward-sloping benches located directly below the Lake Lahontan highstand (~1,331 m) and extending as low as 1,262 m. The surfaces are covered by rounded beach gravel but also have scattered, large boulders (< 2 m) that seem to have also been somewhat rounded. Overall, the Qflp deposits appear to be wedge-shaped, thickening toward the lake to a point where they are typically terminated by a large eastward-facing scarp. The interior of the deposits consists of coarse, bouldery gravel. Overall, these features seem analogous to the "high level gravel embankments" that Morrison (1964) noted in the Carson Sink subbasin of Lake Lahontan. The reason that the term pediment is used in this description is that there is evidence that the bedrock surfaces upon which the Qflp units typically rests are erosional in nature.

**Qflo Beach gravel and related shoreline features (middle Pleistocene)** Beach deposits assigned to the Qflo unit are found in the southeast part of the basin near the Thorne bar between elevations of 1,331 m and 1,410 m. Degraded constructional beach features are found up to an elevation of about 1,360 m (Reheis et al., 2003). Soil development on these features is much more advanced than on the late Pleistocene beach features (Adams and Wesnousky, 1999). Estimates in the ages of these features range up to several hundred thousand years (Kurth et al., 2011).

## Fine-grained Lacustrine Sediments

These types of sediments are typically deposited in lake settings below the depth of wave action and are primarily composed of silt with lesser amounts of clay and sand. They are commonly thin-bedded, but sometimes massive, have a light color, and generally occupy large flat areas. Distinguishing between the different ages of fine-grained lacustrine deposits generally comes down to their elevation range because of their physical similarities.

**Qlh Lacustrine sediments (Historical)** Recent fine-grained lacustrine deposits located beneath the historical highstand (1868) of Walker Lake along the lower Walker River.

**Qly Lacustrine sediments (late Holocene)** Late Holocene silt-rich sediments deposited between 1,252–1,255 m near the north end of the historical highstand lake, just south of Schurz.

**Qli Lacustrine sediments (late Pleistocene)** In contrast to younger outcrops of fine-grained lacustrine sediments, the Qli unit is typically expressed as low, rounded, and eroded hills located above 1,262 m but below 1,331 m.

**Qlo Lacustrine sediments (after Reheis et al., 2002) (middle to early (?) Pleistocene)** This fine-grained, flat-lying lacustrine unit is exposed in cliffy bluffs along the east side of the Walker River north of Schurz. This unit has been correlated to similar deposits mapped by Reheis et al. (2002) farther to the north near Weber Reservoir.

## Miscellaneous Deposits and Features

**Qp Playette sediments (Historical to late Holocene)** This unit represents the accumulation of silt and clay, and to a lesser extent sand and fine gravel in small closed depressions behind beach ridges, sand dunes, and other obstructions. The surfaces of these features are horizontal, flat, and commonly display relatively small mudcracks, scattered small pebbles, and/or sparse vegetation. They form by fine sediment (e.g., dust and sand) being washed off surrounding slopes and accumulating in the closed depressions (Adams and Wesnousky, 1998).

**Qcs Scarp colluvium (Holocene to late Pleistocene)** This unit essentially represents hillslope colluvium found on scarps that have formed in a variety of ways including fault scarps, beach back slopes, fluvial terrace risers, and the side slopes of steep drainages cut through alluvial fans and other deposits. This colluvium tends to be poorly sorted sands and gravels that reflects the compositional variability and sedimentology of the different deposits from which it is derived.

**Qcr Range front colluvium/debris cones (Holocene to late Pleistocene)** The Qcr unit is also colluvial and is found on steep range fronts bordering Walker Lake. It is typically coarse grained with various amounts of fine-grained sediment mixed in and its composition reflects the bedrock from which it is derived. It occurs as sheets, debris cones, and fringing accumulations of sediment that commonly grades into alluvial fans of various ages. The age of the Qcr unit is likely time transgressive.

**Qtr Rock rubble, commonly coated by tufa cones (Holocene to late Pleistocene)** This unit occurs on the west side of Walker Lake at the base of the Wassuk Range and consists of bedrock and rock rubble that is commonly coated by tufa. This unit occurs along an escarpment within a relatively narrow elevation range between about 1,262 m to 1,245 m, suggesting that it may have formed during the late Holocene through wave erosion.

**Wa Walker Lake** The outline of Walker Lake is from 2020, when the basin-wide LiDAR data was collected.

**An Disturbed areas\anthropogenic deposits** Includes town sites and disturbed areas such as gravel pits and other activities where the surface geology has been significantly altered.

**Bx Bedrock, undivided (Tertiary to Triassic)** Bedrock in the mapping area consists of Mesozoic metamorphic rocks and igneous rocks dating from the Mesozoic and Tertiary periods (Hardyman, 1980; Stewart et al., 1981a, b).

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