Figure 1. Index map showing selected geologic maps available for the Midvale and surrounding 7.5’ quadrangles.
Suggested citation:

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INTRODUCTION

The Midvale 7.5’ quadrangle is in the south-central part of Salt Lake Valley. The quadrangle contains parts of Midvale City, South Jordan City, West Jordan City, Riverton City, Sandy City, Draper City, Herriman City, and Bluffdale City and the southern part of South Valley Regional Airport. The Jordan River and Bingham, Midas, Barneys, Rose, Corner Canyon, Willow, and Dry Creeks flow through the quadrangle. A single outcrop of Pennsylvanian Oquirrh Group bedrock, likely Bingham Mine Formation, was previously exposed in the southeast corner of the quadrangle; however, recent development has destroyed and covered this outcrop. The surficial geology is composed of alluvial, deltaic, eolian, lacustrine, and mass-movement deposits. The Midvale quadrangle was mapped to provide geologic data for a variety of derivative uses. The Utah Geological Survey (UGS) Geologic Hazards Mapping Initiative will use this map to identify and delimit potential geologic hazards for UGS geologic hazard maps of urban, high recreational use, and rapidly developing areas.

The Midvale quadrangle covers part of the southern Salt Lake Valley, which is a Basin and Range graben bounded on the east by the Wasatch fault zone and on the west by the Harkers fault along the north half of the Oquirrh Mountains and a zone of east-stepping, normal concealed faults inferred from gravity data on the southwestern side of the valley (see Cook and Berg, 1961; Zoback, 1983; Biek, 2005a; Biek et al., 2005, 2007; Clark et al., 2020). No normal faults with surface fault rupture scarps or Quaternary active faults were identified in the quadrangle. The Traverse Mountain North fault is mapped from the Jordan Narrows quadrangle (Biek, 2005a) in the southeast corner of the quadrangle and is inferred from gravity data.

Subsurface geology is inferred from well data (Kennecott Utah Copper Environmental Engineering Projects Group, 1998), surrounding and previous geologic maps, and stratigraphic studies (Slentz, 1955; Davis, 2000; Biek, 2005a, 2005b; Biek et al., 2005, 2007; Solomon et al., 2007; McKean and Solomon, 2018; Clark et al., 2020). The subsurface geology in the quadrangle includes Quaternary unconsolidated deposits underlain by unnamed Pliocene basin fill and Pliocene to Miocene Jordan Narrows and Camp Williams units of the Salt Lake Formation (includes part of the previously named Harkers Fan-glomerate, see Biek, 2005a; Biek et al., 2007; Clark et al., 2020). Beneath these units are Oligocene to Eocene volcanics related to the Little Cottonwood stock and volcanic and intrusive rocks of the west Traverse Mountains, as well as Sevier orogeny thrusts and folds in the Paleozoic rocks. In the southeast corner of the quadrangle, the Traverse Mountain North fault is a down-to-the-northwest normal fault inferred from gravity data just west of the former location of the only known bedrock outcrop in the quadrangle described above.

Surficial unconsolidated deposits within the quadrangle consist of alluvial, deltaic, eolian, lacustrine, and mass-movement deposits of Quaternary age. Lacustrine and deltaic sediments were deposited in late Pleistocene Lake Bonneville (30 to 13 ka) (see Table 1; all ages in this report are in calibrated years). Table 1 is based on features produced by Lake Bonneville transgressive, overflow, and regressive phase deposits and provides time constraints and elevations for many geologic units. During the regression of Lake Bonneville, Dry Creek formed a delta deposit (Qdp) at the mouth of the Dimple Dell incision in the east part of the quadrangle. During and after the Lake Bonneville regression, the Jordan River and other streams incised into the newly deposited Lake Bonneville sediments. The resulting incision and deposition formed the post-Bonneville Holocene alluvial channels, floodplains, and alluvial fans. These incisions also exposed the older Bonneville transgressive phase deposits and in places the pre-Bonneville deposits (Qlb) (Davis, 2000).

Human disturbances are widespread throughout the quadrangle. Areas of large disturbance are mapped as Qh and environmentally remediated land is mapped as Qhr. The Qhr unit includes remediated land that had been contaminated by smelting and other industrial operations. Many of these sites have been redeveloped following their remediation work. Since development, the Jordan River floodplain has been modified significantly by channelization and diversion by levee construction as seen by the difference of Qal1 (pre-1937 floodplain) and Qalh (historical modified channel and levees).

PREVIOUS WORK

Previous detailed surficial geologic maps of the Midvale quadrangle include a 1:24,000-scale geologic map by Davis (2000), and a regional 1:100,000-scale surficial geologic map of the Wasatch Front by Miller (1980). Surficial geologic mapping of the quadrangle is also included in Personius and Scott’s (1992) map of the Salt Lake City segment of the Wasatch fault zone at 1:50,000 scale. Personius and Scott’s mapping is based on the 1:24,000-scale map of Scott and Shroba (1985). Scott and Shroba’s (1985) mapping only covers part of the east side of the quadrangle. The quadrangle was remapped to edge match with newer 1:24,000-scale mapping in the surrounding 7.5-minute quadrangles (Figure 1 on Plate 2).
Methods

Mapping of surficial deposits by the UGS is based on age and depositional environment or origin (Doelling and Willis, 1995). The letters of the map units indicate (1) age (ex: Q = Quaternary), (2) depositional environment or origin determined from landform morphology, bedding, or other distinctive characteristics of the deposits, (3) grain size(s), and (4) age as related to the phases of Lake Bonneville. For example, unit Qaf₂ is a Quaternary (Q) surficial deposit of alluvial-fan origin (af), and the subscript number two indicates it is younger than Lake Bonneville but not the youngest alluvial fan. Numbering of alluvial terrace deposits is the exception and does not relate to Lake Bonneville deposits. The letters “y” and “o” are used in place of a subscript and indicate deposits younger and older than Lake Bonneville (uppermost Pleistocene), respectively. Unit numbers indicate relative age with “1” being the youngest and increasing with age.

Mapping for the project was done using stereographic pairs of aerial photographs, including black-and-white aerial photographs at an approximate scale of 1:20,000 from the U.S. Department of Agriculture (USDA) Agricultural Adjustment Administration (1937) and USDA Agricultural Commodity Stabilization Service (1958) photographs at a scale of 1:10,000. Contacts were revised using 2018 NAIP imagery, Hexagon, and Google orthophotographs (Utah Geospatial Resource Center [UGRC], 2018a, 2018b, 2021a, 2021b), and high-resolution topographic data derived from lidar (UGRC, 2013–2014). The geologic map was made by transferring the geology from the aerial photographs to a geographic information system (GIS) database in ArcPro for a target scale of 1:24,000, using the lidar data, orthophotographs of Salt Lake County (UGRC, 1977), 1990s digital orthophoto quadrangles (DOQ) (UGRC, 1990s), and 2018 NAIP orthophotographs (UGRC, 2018a). Some unit contacts were mapped with the aid of NRCS (2015) soil map data. Water boundaries were digitized from a 2017 U.S. Geological Survey topographic map of the Midvale quadrangle. Field data was collected using an iPad and ESRI Field Maps application in 2023.

Cross section A-A’ was created by combining available subsurface and gravity data. Well logs from Lawrence Berkeley Laboratory and Idaho National Engineering Laboratory (1981), Meiiji Resource Consultants (1983), Kennecott Utah Copper Environmental Engineering Projects Group (1998), and others compiled online (UGS, undated) were used to estimate the subsurface contact between Quaternary unconsolidated deposits and Tertiary semiconsolidated to consolidated strata. Depth of unconsolidated to semiconsolidated material was also inferred from water well logs in the area (online well data from Utah Division of Water Rights, 2009). The top of semiconsolidated material described in well logs was marked mostly by a transition from unconsolidated clay, silt, sand, and gravel to more semiconsolidated deposits, typically described as hard pan, or various types of cemented or hard material, conglomerate, or lava (Arnow et al., 1970), but also may include shale or limestone. These hypothesized contacts have not been dated and may not actually represent the transition from Quaternary to Pliocene (Tertiary) deposits. Only the Kennecott Utah Copper Environmental Engineering Projects Group (1998) well
logs in the west part of the quadrangle specifically identified strata of the Pliocene to Miocene Salt Lake Formation or older Oligocene to Eocene volcanic and volcanioclastic rocks that are common along the Salt Lake Valley margins (see for example Biek, 2005a, 2005b; Biek et al., 2005, 2007). These units are likely part of the Tertiary strata in the subsurface in the rest of the cross section and quadrangle.

In the central and west part of the quadrangle, based on exposures in nearby mountain ranges, the Tertiary volcanic and sedimentary rocks are underlain by Mesozoic and/or Paleozoic sedimentary bedrock (see for example Biek, 2005a, 2005b; Biek et al., 2005, 2007). In the east part of the quadrangle, I expect Paleozoic rocks and Proterozoic metamorphic rocks are intruded by the Little Cottonwood stock (see for example Biek, 2005b; McKean and Solomon, 2018; McKean, 2020). Depth to underly- ing Mesozoic and/or Paleozoic bedrock was also estimated from gravity models by Meiiji Resource Consultants (1983) and the Wasatch Front community velocity model (Magistrale et al., 2008). Basin depth and structure were estimated from gravity data from Cook and Berg (1961), Zoback (1983), and the Pan-American Center for Earth and Environmental Studies (PACES) (2012) gravity database. The actual depth to Mesozoic and Paleozoic bedrock is constrained by one well that penetrated the entire thickness of Tertiary strata and reached a total depth of 5008 feet (1526 m) in sandstone bedrock (see Table 2, Utah Roses #2, Lawrence Berkeley Laboratory and Idaho National Engineering Laboratory, 1981; UGS, undated).

### MAP UNIT DESCRIPTIONS

#### QUATERNARY

**Alluvial Deposits**

**Qal**<sup>1</sup> Active floodplain and stream deposits (upper Holocene) – Moderately to well-sorted, medium- to light-brown sand, silt, clay and gravel; very fine to medium-grained, rounded to subangular sand grains; rounded to subangular pebble to boulder clasts; contains discontinuous sand and gravel lenses; thin to medium bedded; sand grains are quartz, lithic fragments, biotite, plagioclase, and mica flakes; mapped in channels and active floodplains of Jordan River, Bingham Creek, Midas Creek, Corner Canyon Creek, Willow Creek, and Dry Creek on terraces less than 10 to 15 feet (3–5m) above active creek and river channels; includes oxbow lakes and marshy areas too small to map separately; equivalent to the younger part of Qal<sub>y</sub>; differentiated from Qal<sub>y</sub> where active channels incise older Qal<sub>y</sub> along the Jordan River; this unit contains the historical alluvial floodplain and channel from 1937 aerial photographs (USDA, 1937) before human modification of much of its natural course; locally includes minor colluvial deposits along steep embankments.

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### Table 2. Summary of selected water well data from the Midvale quadrangle.

<table>
<thead>
<tr>
<th>Well ID No.</th>
<th>Water Right</th>
<th>Well Type</th>
<th>Owner</th>
<th>Year Completed</th>
<th>Latitude (°N)</th>
<th>Longitude (°W)</th>
<th>Total Depth (ft (m))</th>
<th>Lithology Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>442882</td>
<td>57-8337</td>
<td>geothermal test well</td>
<td>Utah Roses Incorporated</td>
<td>1979</td>
<td>40.585502</td>
<td>111.908401</td>
<td>5008 (1526)</td>
<td>0–500 ft - Sand and gravel</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>500–1200 ft - Clay and fine sandstone</td>
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<td></td>
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<td>1200–1500 ft - Brown clay and fine sandstone</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>1500–1900 ft - Clay, quartzite, and limestone</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>1900–2200 ft - Dark-brown clay and sandstone</td>
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<td></td>
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<td>2200–2900 ft - Sandstone</td>
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<td></td>
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<td></td>
<td></td>
<td>2900–3050 ft - Some fractures</td>
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<td>3050–3700 ft - Sandstone</td>
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<td></td>
<td></td>
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<td>3700–4500 ft - Red sand, sandstone, and quartzite</td>
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<td></td>
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<td></td>
<td>4500–4700 ft - Possible fractures</td>
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<td></td>
<td></td>
<td></td>
<td>4700–4998 ft - Sandstone</td>
</tr>
</tbody>
</table>

Notes:
Data from Utah Division of Water Rights database ([https://www.waterrights.utah.gov/wellInfo/wellInfo.asp](https://www.waterrights.utah.gov/wellInfo/wellInfo.asp), accessed January 24, 2024), UGS (undated), and Lawrence Berkeley Laboratory and Idaho National Engineering Laboratory (1981).
Water well location is approximate, location is in NAD83 coordinates.
and natural levees; some deposits are channelized and include channel embankments; may locally include small unmapped artificial earthen levees or fill along the Jordan River channelization (Qalh) that cannot be shown individually at map scale; the Jordan River has eroded a channel into this unit along its floodplain and has channel banks between 2 and 10 feet (0.6–3 m) high (Davis, 2000); thickness variable, probably less than 30 feet (10 m), but could be as much as 67 feet (20 m) or more (Davis, 2000).

**Qaly**  
**Young floodplain and stream deposits, undivided** (Holocene to upper Pleistocene) – Moderately to well-sorted, medium- to light-brown sand, silt, clay and gravel; very fine to medium-grained, rounded to subangular sand grains; rounded to subangular pebble- to boulder-size clasts; mapped in channels and active floodplains of the Jordan River, and along Barneys Creek, Rose Creek, Willow Creek, Dry Creek and other small creeks; includes oxbow lakes and marshy areas too small to map separately; locally includes small areas of alluvial-fan and coluvial deposits; inset into Lake Bonneville deposits; includes deposits equivalent to level-2 floodplain and stream deposits (Qal2, see McKean, 2019) incised by active floodplain and stream (Qal1); Qaly mapped where Qal1 and Qal2 deposits cannot be mapped separately due to lack of bars and swales and because patches of deposits are too small to show separately at map scale; postdates regression of Lake Bonneville from the Provo shoreline and lower shorelines; thickness variable, probably less than 30 feet (10 m), but could be as much as 67 feet (20 m) or more (Davis, 2000).

**Qat2**  
**Level-2 stream-terrace deposits** (Holocene to upper Pleistocene) – Moderately to well-sorted, pebble and boulder gravel, locally contains boulders, with a matrix of sand and silt; contains thin sand lenses; subangular to rounded clasts; mapped along the Jordan River where deposits are 13 to 30 feet (4–9 m) above the modern stream channel; although Qat1 and Qat3 stream-terrace deposits are not present in this quadrangle, they are mapped to the south in the Jordan Narrows quadrangle where the Jordan River terrace numbers are relative to other terraces and therefore this unit is mapped to match similar level 2 deposits that are 10 to 30 feet (3–9 m) above the modern stream channel in the Jordan Narrows quadrangle (Biek, 2005a); numbered subscripts for stream terrace deposits are relative to each other and do not indicate a specific age related to Lake Bonneville; estimated thickness is 5 to 30 feet (1.5–9 m).

**Qaf1**  
**Level-1 alluvial-fan deposits** (upper Holocene) – Poorly to moderately sorted, pebble to cobble gravel, with a matrix of sand, silt, and clay; subangular to subrounded clasts; weakly to non-stratified; deposited by debris flows, debris floods, sheet floods, and intermittent flow along Bingham Creek; forms fans below regressive Lake Bonneville lacustrine and deltaic deposits (Qldgp); equivalent to the younger part of young alluvial-fan deposits (Qafy), mapped where active fans can be shown separately; thickness variable, 6 to more than 30 feet (3–10 m).

**Qaf2**  
**Level-2 alluvial-fan deposits** (middle Holocene to upper Pleistocene) – Poorly to moderately sorted, pebble to cobble gravel, with a matrix of sand, silt, and clay, which becomes finer grained away from source; clasts subangular to subrounded; weakly to non-stratified; deposited by debris flows, debris floods, sheet floods, and perennial and intermittent streams; mapped in the northeast and southeast corners of the quadrangle and where Corner Canyon Creek enters the Jordan River incision; equivalent to the older part of young alluvial-fan deposits (Qafy) but mapped separately where incised by younger streams (Qal1); thickness variable, 6 to more than 30 feet (3–10 m).

**Qafy**  
**Younger alluvial-fan deposits, undivided** (Holocene to upper Pleistocene?) – Poorly to moderately sorted, pebble to cobble gravel, with a matrix of sand, silt, and minor clay, which becomes finer grained away from source; clasts angular to subrounded; weakly to non-stratified; deposited by debris flows, debris floods, sheet floods, and perennial and intermittent streams; includes both ages of younger alluvial-fan deposits (Qaf1 and Qaf2) across large alluvial slopes where individual fan surfaces cannot be differentiated consistently; locally may include some undifferentiated thin Bonneville transgressive deposits or pre-Bonneville alluvial-fan deposits; postdates Lake Bonneville highstand (Table 1), may coincide with the regression of Lake Bonneville; Lake Bonneville shorelines are not present on these alluvial fans; thickness variable, 6 to more than 30 feet (3–10 m).

**Deltaic Deposits**

**Qdp**  
**Deltaic deposits related to Provo shoreline and regressive phase of Lake Bonneville** (upper Pleistocene) – Moderately to well-sorted pebble gravel, sand, silt, and clay; subrounded to rounded clasts; contains thin discontinuous sand lenses deposited as thin to thick planar and cross-bedded foresets, locally includes topset beds; mapped on the east edge of the quadrangle where the incised Dry Creek leaves the Lake Bonneville Little and Big Cottonwood delta.
Interim geologic map of the Midvale quadrangle, Salt Lake County, Utah

(McKean and Solomon, 2018); deposited into Lake Bonneville during the regressive phase below the Provo shoreline, could include concealed transgressive deposits as well (Table 1); thickness 50 to 60 feet (15–18 m) (Davis, 2000) and could be up to 100 feet (30 m).

**Eolian Deposits**

Qes  
**Eolian sand deposits, undivided** (Holocene to upper Pleistocene?) – Well- to very well sorted, well-rounded, windblown, very fine to medium-grained sand in both sheet and dune forms; bedding ranges from cross-bedded, to laminar, to no distinct bedding; on aerial photos the deposits are distinguished from lacustrine deposits (Qlf, Qls, Qlsp, Qlb) by characteristic hummocky sheet and dune forms; prior to development, deposits were active to partially stabilized with vegetation; internal contacts between Qes deposits signify separate deposits; may be locally derived from Lake Bonneville deposits (Qlf, Qls, Qlsp, Qlb); a thin veneer of eolian deposits may exist on other units that are not differentiated at map scale; 0 to 20 feet thick (0–6 m).

Qed  
**Eolian dune deposits** (Holocene to upper Pleistocene?) – Well- to very well sorted, well-rounded, windblown, very fine to medium-grained sand; mainly longitudinal dune forms; located in the west-central part of the quadrangle; on aerial photos the deposits are distinguished from other eolian deposits by distinctive dune shapes; prior to development dunes were active to partially stabilized with vegetation; 0 to 15 feet thick (0–5 m).

**Human-Derived**

Qh  
**Fill and disturbed land** (historical) – Undifferentiated earthen fill and/or disturbed land related to construction of road, rail, and bridge embankments, water storage, canals, water treatment plants, and potentially unremediated smelter slag deposits (Mingo Smelter, 100 East 9000 South, Sandy); the map outlines of fill and disturbed land are based on 1958 USDA (1958) aerial photographs and updated 2018 NAIP imagery, Hexagon, and Google orthophotographs (Utah Geospatial Resource Center [UGRC], 2018a, 2018b, 2021a, 2021b), and high-resolution topographic data derived from 0.5 m lidar (UGRC, 2013–2014); only larger areas of disturbed land are mapped; unmapped fill and disturbed land are present in most developed areas (note the city street system on base map); land within developed areas contains a changed and still changing mix of cuts and fills; thickness variable, interstate and rail embankments up to 40 feet (12 m).

Qhl  
**Lime piles** (historical) – White lime piles, located just east of the old sugar refinery (in the NW 1/4 section 34, T. 2 S., R. 1 W., Salt Lake Base Line and Meridian [SLBLM]) (Davis, 2000); deposits appear to have been removed during development, may contain some latent material; remaining thickness unknown.

Qhr  
**Remediated land** (historical) – Unit delineates approximate boundaries of selected environmentally remediated sites in the quadrangle, including the Midvale Slag (MS), Sharon Steel (SS), and Kennecott South Zone (KS) Superfund Sites (these sites are described below and labeled on Plate 1), the extent of surficial (soil) or groundwater contamination may exceed the mapped unit; other remediated lands may exist in the quadrangle; areas near these remediated sites may contain latent contaminated material or groundwater and a comprehensive site-specific environmental investigation is recommended prior to development; thickness of remediated material is variable, Midvale Slag and Sharon Steel sites up to about 50 feet thick (15 m).

The Midvale Slag (MS) and Sharon Steel (SS) Superfund Sites are adjacent to each other and have a shared and related ore processing and milling history. Smelting occurred at the sites between 1871 and 1958 in five separate smelters built over time on the shared site. Milling facilities that processed ore and produced lead, copper, zinc, and other metals were on the site from 1906 to 1971. For more information about the history of these sites see Lamborn and Peterson (1985) and reports by the U.S. Environmental Protection Agency [EPA] (2004, 2008, 2014) and Utah Department of Environmental Quality Division of Environmental Response and Remediation (DEQ, 2019). Their remediation is discussed separately as they were separate superfund sites.

The Midvale Slag Superfund Site (see MS on Plate 1) was the location of five lead and copper smelters between 1871 and 1971. Site information here is summarized from EPA reports (2008, 2014). The approximately 446-acre site is located between 7800 South Street on the south, the Jordan River on the west, 6400 South Street on the north, and 700 West Street on the northeast and east, and Holden Street on the southeast. The site was divided into two operational units with evaluation and remediation occurring between 1983 and 2007. Soil and groundwater contamination
included heavy metals, primarily arsenic and lead. Remediation included, but was not limited to, the excavation of contaminated soils, stabilization of the Jordan River banks, disposal of highly contaminated smelter waste, construction of soil caps over waste and contaminated soils, and groundwater monitoring. The site has been redeveloped and is occupied by businesses, residential housing, and a light rail station.

The Sharon Steel Superfund Site (see SS Plate 1) was the former milling facility that processed ore and produced lead, copper, zinc, and other metals from 1906 to 1971. The information present here is summarized from DEQ (2019) and EPA (2004) reports. Tailings from the milling facility were disposed in ponds next to the milling facility and eventually expanded by rerouting the Jordan River and associated wetlands to the west. Evaluation of the site and remediation occurred between 1982 and 1999. Soil contamination encountered at the site includes arsenic, cadmium, and lead. Several heavy metals were also found in shallow groundwater under the tailings, but arsenic was the primary metal of concern. Remediation included, but was not limited to, excavation of the tailings located within 150 feet of the center line of the Jordan River, removal and replacement of contaminated soil in the mill building area, dredging of the wetlands and reconstruction, installation of a soil cap over the entire tailings and soil pile, groundwater and storm water control around the tailings pile, and monitoring of groundwater levels and metal concentrations in the Jordan River. The site has been partially redeveloped with business and residential use.

The Kennecott South Zone Superfund Site (see KS on Plate 1) had numerous remediation sites. Only the former South Jordan Evaporation Ponds and Zone B groundwater contamination is discussed here. The information for this section is summarized from reports and fact sheets from the Kennecott Utah Copper Environmental Engineering Projects Group (1998), EPA and DEQ (2000), and EPA (2013). Mining began in the Oquirrh Mountains to the west of the quadrangle in 1863, where miners recovered mainly gold, silver, lead, and zinc. In 1903 copper mining, milling, and smelting techniques were developed by Utah Copper and Boston Consolidated. Miners in the area processed gold, silver, lead, zinc, and copper in many mills and smelters. Water seepage from the historic Bingham reservoir and acid mine drainage release from the Bingham mine waste dumps and other mining activity, milling, evaporation, and smelting sites contaminated the principal aquifer of the southwest Salt Lake Valley, producing a 72-square-mile plume of sulfate-contaminated groundwater. In the Midvale quadrangle, the South Jordan evaporation ponds were used intermittently from 1936 to 1986 to dispose of excess water from Bingham Canyon. The waters were acidic and high in sulfate. The original ponds were not lined and had sand and gravel bottoms. Some ponds were eventually lined, and the water was treated with lime before disposal. The ditches leading to the ponds were cleaned as a part of the Bingham Creek removal action in 1993. Between 1994 and 1997, waste mine rock was removed from the numerous evaporation ponds, and contaminated sludges and soil were removed, consolidated, and capped. Groundwater seepage from these ponds and other sources caused the sulfate-contaminated groundwater plume. Groundwater treatment is ongoing. The site of the evaporation ponds is now part of a 4500-acre master planned community called Daybreak.

Lacustrine Deposits

Undivided deposits of the Bonneville Lake cycle:

Qlg  Lacustrine gravel and sand (upper Pleistocene) – Moderately to poorly sorted, subrounded to rounded, pebble to cobble gravel in a matrix of pebbly sand, sand, silt, and clay; locally interbedded with lenses of silt and sand; thin to thick planar and cross-beds; mapped below the Provo shoreline; sediments could be Lake Bonneville transgressive, overflowing, and/or regressive phase deposits; distinguished from Qlf and Qls by the presence of gravel and sand as indicated in soil maps (NRCS, 2015); commonly interbedded with or laterally gradational with lacustrine sand and silt (Qls); mapped as Qlgbp in the Magna and Copperton quadrangles (Solomon et al., 2007; Biek et al., 2007); exposed thickness up to 30 feet (20 m).

Qls  Lacustrine sand and silt (upper Pleistocene) – Moderately sorted very fine to coarse sand, silt, clay, and minor pebbly gravel; thin to thick bedded; bedding commonly has climbing ripples and scour features; mapped below the Provo shoreline; sediments could be Lake Bonneville transgressive, overflowing, and/or regressive phase deposits; deposited in relatively shallow water nearshore settings, downslope from gravel and sand (Qlg); locally includes a surficial loess veneer; distinguished from Qlf and Qlg by the presence of silty sand and sand as indicated in soil maps (NRCS, 2015); mapped as Qlsbp in the Magna and Copperton quadrangles (Solomon et al., 2007; Biek et al., 2007); exposed thickness 10 to 30 feet (3–10 m).
Interim geologic map of the Midvale quadrangle, Salt Lake County, Utah

**Qlf** Lacustrine silt and clay (upper Pleistocene) – Moderately sorted silt, clay, fine sand, and minor pebbly gravel; typically laminated or thin bedded; variably calcareous; locally contains ostracodes; deposited in shallow to moderately deep parts of Lake Bonneville; commonly grades upslope into lacustrine sand and silt (Qls); locally includes a surficial loess veneer; regressive Lake Bonneville shorelines typically poorly developed in contrast to shorelines on unit Qlg; distinguished from Qls and Qlg by the presence of silty sand, silt, and clay as indicated in soil maps (NRCS, 2015); mapped as Qlmbp in the Magna and Copperton quadrangles (Solomon et al., 2007; Biek et al., 2007); exposed thickness variable, up to 40 feet (12 m) (see Davis, 2000, for measured section).

**Deposits related to the Provo shoreline and regressive phase of Lake Bonneville:** The Provo shoreline is located above the elevation range of the Midvale quadrangle. In nearby quadrangles, the Provo shoreline is between about 4820 and 4860 feet (1469–1482 m) (Table 1). In the Copperton quadrangle to the west Biek et al. (2007) mapped the Provo shoreline lower, between 4790 and 4820 feet (1460–1470 m) and should be present in the Midvale quadrangle. However, other geologic mapping of the shoreline in the southern half of Salt Lake Valley places it at a higher elevation (McKean and Solomon, 2018; McKean, 2019, 2020). As a result, the Provo shoreline mapping from the Copperton quadrangle is too low and is not mapped in the Midvale quadrangle.

**Qldgp** Deltaic gravel and sand (upper Pleistocene) – Moderately to well-sorted gravel and sand, locally including thin beds of silt and sandy silt; clasts subrounded to rounded; thin to thick planar and cross-bedded foresets; mapped along Bingham Creek where regressive deltaic and lacustrine deposits stepped down with a receding Lake Bonneville; locally includes alluvial beds; locally weakly cemented with calcium carbonate; exposed thickness 15 to 30 feet but could be thicker (5–9+ m).

**Qlgp** Lacustrine gravel and sand (upper Pleistocene) – Moderately to well-sorted, subrounded to rounded, clast-supported; pebble to cobble gravel with a matrix of sand and pebbly sand; locally interbedded with lenses of silt and sandy silt; thin to thick planar and cross-beds; mapped on the east side of the quadrangle below the Provo shoreline on nearshore linear beaches, spits, a large v-bar, and/or offshore gravel bars related to the Provo shoreline and regressive shorelines; commonly interbedded with or laterally gradational into lacustrine sand and silt (Qlsp); estimated thickness 65 to 100 feet (20–30 m).

**Qlsp** Lacustrine sand and silt (upper Pleistocene) – Moderately to well-sorted, subrounded to rounded, fine to coarse sand and silt with minor pebbly to cobble gravel; thin to thick bedded; commonly has ripples and scour features; locally includes a surficial loess veneer; mapped downslope from gravel and sand deposits (Qlgp) that form nearshore linear beaches, deltas, spits, v-bars, and/or offshore gravel bars related to the Provo shoreline and regressive shorelines; exposed thickness less than 40 feet (12 m).

**Qlfp** Lacustrine silt and clay (upper Pleistocene) – Moderately sorted silt and clay with minor fine sand and local pebble gravel; typically laminated or thin bedded; variably calcareous; ostracodes locally common; commonly grades upslope into lacustrine sand and silt (Qls); locally concealed by loess veneer; regressive lacustrine shorelines typically poorly developed, in contrast to units Qlgp and Qlsp; mapped in small areas along the west and east edge of the quadrangle where transgressive and regressive deposits can be mapped separately because of their proximity to clearly regressive coarser deposits (Qlgp, Qlsp), may include some undifferentiated transgressive deposits; deposited in quiet water in shallow to moderately deep parts of the Bonneville basin; estimated thickness more than 15 feet (5 m).

**Deposits of the transgressive phase of Lake Bonneville and pre-Bonneville deposits** – Mapped below the Bonneville and Provo shorelines in bluffs along the incised Jordan River where transgressive-phase and pre-Bonneville deposits likely underlie the undivided deposits of the transgressive, overflow, and regressive phases of Lake Bonneville.

**Qlb** Transgressive-phase deposits of Lake Bonneville and pre-Bonneville deposits, undivided (upper Pleistocene?) – Moderately sorted, subrounded to rounded, fine to coarse sand, silt, and clay with pebbly gravel; locally includes beds of gravel and sand; mapped in bluffs along the Jordan River and stream terraces where slope colluvium conceals the relative amounts of gravel, sand, silt, and clay in these transgressive deposits; locally includes small clusters of gypsiferous minerals in the sediment, which may be part of the undivided pre-Bonneville deposits that are not differentiated due to concealing colluvium; Davis (2000) measured and described a large natural exposure of undeformed Lake Bonneville fine-grained lacustrine deposits that were 38.6 feet (11.8 m) thick over a 12-foot (3.7 m) exposure of pre-Bonneville alluvial laminated silt and sand beds with deformed strata in places (SE1/4 SW1/4 section 26, T. 3. S., R. 1 W. SLBLM); exposed thickness less than 100 feet (30 m).
Mass-Movement Deposits

Qms **Landslide deposits** (historical? to upper Pleistocene) – Poorly sorted, clay- to pebble-size material in six mapped landslides; composition includes Qlf and Qlb source material; characterized by hummocky topography, main and internal scarps, toe thrusts, back-rotated blocks, and chaotic bedding in displaced slides and slumps; landslides are all mapped on the incised margin of the Jordan River floodplain and appear to be sourced from Qlf and Qlb; apparent age is post-incision of Jordan River, likely after Lake Bonneville began to regress from the Provo shoreline (see Table 1 for shoreline age); not subdivided by apparent age because even landslides with subdued morphology (suggesting that they are older, weathered, and have not moved recently) may continue to exhibit slow creep or are capable of renewed movement if stability thresholds are exceeded (Ashland, 2003); age and stability determinations require detailed geotechnical investigations; other unmapped landslides or unstable slopes may be present along the Jordan River bluff or other steep slopes in unit Qlf and Qlb; thickness variable, less than 30 feet (10 m).

Mixed-Environment Deposits

Qalh **Historical alluvial deposits and artificial levees, undivided** (historical) – Moderately sorted sand, silt, clay, and gravel alluvial deposits and artificial earthen levees, undifferentiated along channelized Jordan River; very fine to medium-grained sand; rounded to angular sand grains; rounded to subangular pebble-size clasts; thin to medium bedded; this unit contains the channelized Jordan River shown on 1958 aerial photographs (USDA, 1958) after human modification of much of its natural course; mapped in active channels, modified channel margins and minor terraces less than 10 feet (3 m) above active channels; includes artificial channels and levees; locally includes minor colluvial deposits along steep embankments; most streams have been modified from their natural course and are channelized; in places the Jordan River has returned to a more natural meandering course and departed from its channelized path (see Qal); estimated thickness less than 15 feet (5 m).

Qac **Alluvial and colluvial deposits, undivided** (Holocene to upper Pleistocene?) – Poorly to moderately sorted, generally poorly stratified, clay- to boulder-size sediment; rounded to subangular clasts; mapped where alluvium and colluvium (slope wash and soil creep) grade into one another or are intermixed and cannot be shown separately; mapped in small drainages where alluvium and colluvium from the sides of the drainage are intermixed; thin unmapped deposits are likely present in most drainages; thickness less than 15 feet (5 m).

Qla **Lacustrine and alluvial deposits, undivided** (Holocene to upper Pleistocene) – Poorly to moderately sorted silt, sand, clay, and gravel; subangular to rounded clasts; moderately to well-bedded; includes Lake Bonneville-age deposits and post-Bonneville alluvium, the alluvial streams and fans interfinger, rework, and overlie mixed lacustrine and alluvial deposits; 1 to 10 feet (0.3–3 m) thick.

Qmc **Mass-movement and colluvial deposits, undivided** (Holocene to upper Pleistocene?) – Mixed landslide, slump, slope wash, and soil creep that grade imperceptibly into one another; typically has a slightly hummocky appearance on the lidar-derived elevation models; often lacks clear landslide scarps and lateral margins; mapped along the Jordan River and Dry Creek incisions in areas where deposits are derived from Lake Bonneville units (Qdp, Qlsp, Qlf, and Qlb); age and stability determinations require detailed geotechnical investigations; thickness less than 30 feet (10 m).

Stacked-Unit Deposits

The term “stacked” indicates a thin covering of one unit over the other, which is shown by the upper map unit (listed first) then a slash, then the underlying unit. See individual map unit descriptions for more information regarding materials.

Qes/Qls **Eolian sand deposits, undivided over lacustrine sand and silt related to Lake Bonneville** (Holocene to upper Pleistocene? over upper Pleistocene) – Well- to very well sorted, windblown very fine to medium-grained sand in both sheet and dune forms over moderately sorted very fine to coarse sand, silt, clay, and minor pebbly gravel; thickness of eolian sand 0 to 20 feet (0–6 m) and exposed lacustrine sand and silt thickness more than 10 to 30 feet (3–10 m).
Eolian sand deposits, undivided over lacustrine sand and silt related to the Provo shoreline and regressive phase of Lake Bonneville (Holocene to upper Pleistocene? over upper Pleistocene) – Well- to very well sorted, windblown very fine to medium-grained sand in both sheet and dune forms over moderately to well-sorted, subrounded to rounded, fine to coarse sand and silt with minor pebble to cobble gravel; also mapped in eolian depessions where deflation and wind erosion are removing and transporting Lake Bonneville sands; based on 1937 aerial photographs (USDA, 1937) includes some thin eolian deposits in the depressions; thickness of eolian sand 0 to 20 feet (0–6 m) and exposed lacustrine sand and silt thickness less than 40 feet (12 m).

Davis (2000) described three large depressions in the S1/2 of section 17 and north part of section 20 (T.3 S., R.1 W. SLBLM). The two smaller oval-shaped depressions are described as being 500 feet (150 m) in diameter and about 16 feet (5 m) deep. The larger depression west of the other two is irregularly shaped at 2000 feet (600 m) at its widest and about 26 feet (8 m) deep. All three depressions lack external drainages or characteristics of a human-made excavation. Davis suggested two explanations: (1) earthquake-induced liquefaction lateral spread, or (2) eolian deflation. The eolian deflation model seems more logical for this location based on the alignment of the depressions and surrounding eolian sheet and dune deposits visible in the 1937 aerial photographs (USDA, 1937), and the lack of other lateral spread hummocks and depressions, main scarp, or other mass movement geomorphology characteristic of lateral spread deposits. In this map, these potential eolian deflation depressions are mapped as eolian sand deposits over lacustrine sand and silt as they are surrounded by and contain what look to be thin eolian deposits.

Remediated land over active floodplain and stream deposits (historical over upper Holocene) – Environmentally remediated land over moderately to well-sorted, medium- to light-brown sand, silt, clay, and gravel; mapped at the site where the Jordan River was moved to accommodate the Midvale smelter slag and Sharon Steel tailings from the milling facility; both sites were later remediated superfund sites; historical alluvial floodplain and channel from 1937 aerial photographs (USDA, 1937) before human modification of much of its natural course; thickness of remediated land is variable and alluvial deposit thickness is variable, probably less than 30 feet (10 m), but could be as much as 67 feet (20 m) or more (Davis, 2000).

Fill and disturbed land over young stream deposits, undivided (historical over Holocene to upper Pleistocene) – Undifferentiated earth fill and disturbed land associated with the South Valley Regional Airport that conceals alluvial deposits that are moderately to well-sorted, medium- to light-brown sand, silt, clay, and gravel; thickness of fill and disturbed land highly variable; alluvial deposit thickness variable, probably less than 30 feet (10 m), but could be as much as 67 feet (20 m) or more (Davis, 2000).

PALEOZOIC

PENNYSYLVANIAN

Bingham Mine Formation, Oquirrh Group (Upper Pennsylvanian) – Surface expression of outcrop has been removed, description modified from Davis (2000). Light-gray, highly fractured, fine-grained quartzite is exposed in a small outcrop in the NE1/4 SWI/4 section 6, T. 4 S., R. 1 E. SLBLM, in the southeast corner of the quadrangle; Biek (2005a) mapped similar nearby outcrops as the Bingham Mine Formation of the Oquirrh Group, based on similar quartzite lithology (see also Pitcher, 1957); in the 1937 aerial photographs (USDA, 1937) it looks like the bedrock outcrop is being mined away, approximately one-third of it has been mined already, by 1958 aerial photographs (USDA, 1958) the above-ground portion of the outcrop in the quadrangle appears to be mostly removed; pre-mining exposure about 10 feet high (3 m) (Davis, 2000); local subsurface thickness unknown, the Bingham Mine Formation is about 7300 feet (2200 m) thick in the Oquirrh Mountains (Tooker and Roberts, 1970).
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