

**COLORADO GEOLOGICAL SURVEY**  
**Online Map ON-007-09D**  
**Reconnaissance Map of Sand, Gravel, and Quarry Aggregate**  
**Resources, Elbert County, Colorado:**  
**Map Description and Notes**

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**COLORADO GEOLOGICAL SURVEY**  
**COLORADO SCHOOL OF MINES**

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## ACKNOWLEDGMENTS AND NOTES

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## DISCLAIMER

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## MAP DESCRIPTION

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The Colorado aggregate industry produces sand, gravel, and crushed-rock aggregate for concrete and asphalt products, road construction and maintenance, and in public works and infrastructure projects. Currently, there is general concern that access to these resources is becoming restricted especially in proximity to major population growth areas (e.g., the Front Range) where future project demand is greater than the available supply. The value of aggregate deposits is dependent on several factors including the volume, quality, and proximity to the market area where it will be used. This study identifies potential sources of sand, gravel, and aggregate in Elbert County. Potential sources of sand, gravel, and crushed-rock aggregate in twelve counties east of the Front Range were previously identified and are discussed in CGS Special Publications 5A and 5B by Schwochow and others (1974a, 1974b). These publications contain a detailed discussion of the geology of aggregate resources along the Front Range. The maps presented in these publications are used by counties to support land-use planning and by industry and other entities to delineate and locate these resources.

The map produced during this study is a reconnaissance survey of aggregate resources in Elbert County. Additional fieldwork is recommended to verify the physical properties and extent of these potential resources. The map was created using existing geological maps, geological descriptions, and limited field observations collected during this study. The resulting map provides resource ratings of the surficial deposits based on existing geological maps and on the general properties associated with these deposits as observed in other areas of the Front Range as discussed below. The map is available as a downloadable ESRI® ArcMap Package (version 10.8) and as an online map both available on the CGS website:

<https://coloradogeologicalsurvey.org/publications/aggregate-resources-elbert-map>

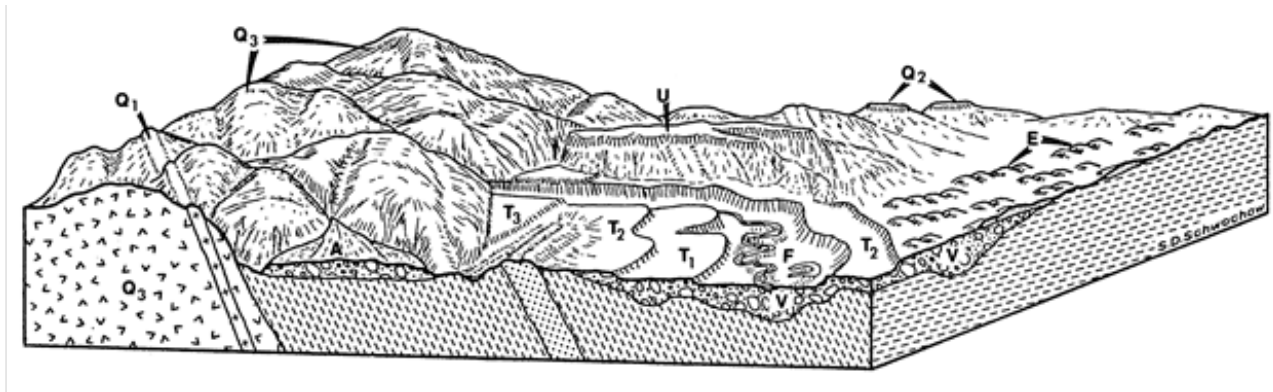
The main reference used for the map produced during this study is the generalized geological map of Elbert County, mapped at a scale of 1:250,000, provided in ArcGIS format by Barkmann and others (2021). This preliminary map contains the general geology associated with groundwater resources in the county. Other 1:250,000-scale geological maps (Sharps, 1976;

Scott and others, 1978; Sharps, 1980; Bryant and others, 1981) and several 1:24,000-scale geological maps (Morgan, 2009; 2014a; 2014b; 2015; Morgan and others, 2012; Thorson, 2004; 2006; 2007), located along the western portion of Elbert County, were also used during this study. The map includes a boundary (1:24,000-scale mapping area) showing where the more detailed geological maps used in this study are located. Edge matching of the geologic formations along the boundary of the 1:250,000- and 1:24,000-scale maps was not performed.

In this study, potential aggregate resources are mapped according to their associated landform classes, like those of Schwochow and others (1974a, 1974b), and according to the resource classes of the surficial deposits and bedrock units within Elbert County. Map units from the geological maps referenced above were used to create the landform and resource classes in this study. Landform and resource classes were assigned to the existing geological map units in ArcGIS.

### **Landform Classes**

Sand and gravel resources along the Front Range are associated with landforms such as floodplains, stream terraces, valley fill, upland mesas, dunes, and alluvial fans (Figure 1). Deposits of “clean” sand and gravel used in concrete and asphalt production in other Front Range counties located relatively close to the mountain front are typically associated with stream terrace, valley fill, and flood-plain deposits of rivers with sediment sources that include the Precambrian core of the Front Range and flanking sedimentary rocks. Some of these deposits typically contain an abundance of fresh clasts of igneous and metamorphic rocks that are ideal for concrete and asphalt products. However, much of the stream-terrace, floodplain, and valley-fill sand and gravel deposits in Elbert County were sourced from local sedimentary rocks (e.g., Dawson Formation, Castle Rock Conglomerate, and Denver Formation) containing igneous and metamorphic rock material originally derived from the Precambrian core of the Front Range, deposited and later lithified into bedrock, and subsequently eroded from these bedrock units.



**Figure 1** - Idealized block diagram of the Front Range and adjacent Colorado Piedmont from Schwochow and others (1974a) showing relationships among aggregate-bearing landforms. Lowland forms include valley fill (V), flood plain (F), and terraces (T1-youngest; T3-oldest). Other landforms are upland gravels (U), alluvial fan (A), and wind-deposited sand dunes (E). Potential quarry-aggregate deposits include fine-grained intrusive igneous rocks (Q1), fine-grained extrusive rocks (Q2), and extensive areas of coarse-grained igneous and metamorphic rocks (Q3).

Thus, most of the stream- and terrace-alluvium deposits in Elbert County contain less desirable material for concrete and asphalt products due to the content of weathered and less competent igneous and metamorphic clasts and relatively weak sedimentary rock clasts (e.g., shale, siltstone, and (or) sandstone), fine-grained material (silt and clay), and secondary calcium carbonate.

Old (Pliocene? to Middle Pleistocene) sand and gravel deposits, more weathered than young (Upper Pleistocene - Holocene) deposits and containing less desirable material, are commonly associated with upland mesas in Elbert County. Broad areas of these old deposits are in the southeastern portion of Elbert County and are extracted for uses such as maintaining dirt and gravel roads (road metal), road base, and fill material. Eolian deposits containing sand and finer material occur in upland areas and along drainages throughout Elbert County. The amount of sand versus finer, less desirable material (e.g., very fine sand, silt, clay), varies among these deposits.

Geological units containing sand and gravel were assigned landform classes using the previous CGS classification scheme modified from Schwochow and others (1974a). Quarry aggregate



landform codes were also included for other deposits such as weakly cemented conglomerates (see landform code “O” below), which may or may not need blasting to quarry, and for bedrock quarry aggregate (see landform code “R” below) that would require blasting to quarry for crushed rock. The following landform classes were used in this study:

- A - alluvial-fan or sheetwash deposits
- E - eolian sand (wind deposited) deposits
- F - floodplain deposits
- M - artificial fill
- O - other deposits /rocks (bedrock, includes conglomerates)
- R - potential bedrock quarry aggregate resource (e.g., rocks)
- T - stream-terrace deposits
- U - upland deposits
- V - valley-fill deposits (floodplain and/or terrace deposits, undivided)

### **Resource Classes**

Resource classes were assigned to geological units based on the geological map units and landform classes. The resource classes are modified from Schwochow and others (1974a).

Resource classes for flood plain, stream terrace, valley fill, upland mesa, dune, and alluvial fans were based on the general condition of the deposits (e.g., amount of clay and (or) silt, clast weathering, etc.) and the amount of gravel. Schwochow and others (1974a) determined, with input from local aggregate producers, that a commercial gravel deposit should generally contain a minimum of ~30% gravel-size material by weight. Additional resource classes include several quarry aggregates that would likely need to be blasted to produce crushed rock. The following resource classes were used in this study:

### *Gravel and Sand*

- 1 - gravel and sand: relatively clean and sound (e.g., very little or no clay, silt, weathered clasts, secondary calcium carbonate, undesirable clast types like shale) (none identified at the surface in Elbert County). Generally, includes coarser gravel and sand aggregate deposits locally with ~30% or more clasts ~4.75 millimeters (mm) (~0.2 inches) in diameter as determined by visual estimates or inferred from similar deposits, drilling logs, and (or) similar exposed deposits.
- 2 - gravel and sand: contains significant fines, decomposed rock, and (or) secondary calcium carbonate. Generally, includes coarser gravel and sand aggregate locally with ~30% or more clasts ~4.75 mm (~0.2 inches or retained on a #4 screen) in diameter as determined by visual estimates or inferred from similar deposits, drilling logs, and (or) similar exposed deposits. May include reworked conglomerate clasts and deposits with undesirable sedimentary rock clasts.
- 3 – sand: includes sand ranging from coarse gravelly stream sand to fine-grained, wind-deposited sand. Generally, includes deposits with ~70% or more clasts <4.75 mm (~0.2 inches) in diameter and ~60%, or more, greater than 0.074 mm (~0.003 inches or retained on a #200 screen) in diameter as determined by visual estimation or inferred from drilling logs and (or) similar deposits.
- 4 - unevaluated resource, potential aggregate resource. Eolian sand deposits rated as 4 may contain sand resources, however much of the sand observed in limited areas contained more silt or the sand is very fine-grained. These areas would need additional exploration. May be a good source of borrow material.

### *Quarry Aggregate (rocks, bedrock)*

- 5 - carbonate rocks (limestone and dolomite) (none identified at the surface in Elbert County).
- 6 - volcanic rocks (rhyolitic flows).

- 7 - intrusive igneous rocks (granite) (none identified at the surface in Elbert County).
- 8 - metamorphic rocks (schist, gneiss, and quartzite) (none identified at the surface in Elbert County).
- 9 - other deposits/rocks (includes conglomeratic sandstone besides the Dawson Formation).
- 10 - Dawson Formation (locally conglomeratic; useful for maintaining unpaved roads in some locations).

There are few accessible exposures of sand and gravel deposits in Elbert County. In areas where these deposits can be observed, only a few of the deposits are exposed. Much of the valley fill, floodplain, and terrace deposits are not exposed on readily accessible (e.g., non-private) properties, therefore the resource classes are estimated based on their landform classes especially with regards to the amount of gravel. For example, only sand was observed at the surface at many of the valley fill, floodplain, and terrace deposits. Although these deposits may consist mostly of sand, driller's logs from the area indicate that these deposits may locally contain gravel lenses at depth. In some cases, it was assumed that these deposits likely contain ~30% gravel in areas and were rated as a resource class 2. However, the horizontal and vertical extent of these deposits would need to be verified by drilling. None of the deposits in Elbert County were rated as a resource class 1 due to the reworked nature of these deposits. Also, the eolian sand deposits observed in the southwest portion of Elbert County were relatively thin (< 1 foot) and, in some places, absent. These deposits are underlain by the Dawson Formation, or other rock formations in places, and may have greater thicknesses in some areas.

### **Resource Codes**

One letter and one number resource codes on the map use the combined landform and resource classes listed above. For example, a "V3" indicates the deposit is valley fill (landform class = V) containing sands or fine aggregate (resource class = 3). Quarry aggregates, material that would likely need to be disaggregated by blasting, are also included as rock codes "O" or

“R” with resource classes designated as 5 through 9 for different rock types. The “O” rock code contains conglomerates that may or may not require blasting to disaggregate. Elbert County currently extracts portions of the Dawson Formation, mainly a conglomeritic sandstone, which does not require blasting and has a unique resource class code (10). The county uses this material for maintaining unimproved roads. Some of the Dawson Formation is cemented and may require blasting.

### **Additional Information**

Other information on the map includes the location of historic sand and gravel pits (pre-1981 locations from Schwochow, 1981; pre-2003 locations from Keller and others, 2002) and parcels owned by the Colorado State Land Board. A recent listing of sand and gravel pits, quarries, and permit locations in shapefile format can be obtained from the Colorado Division of Reclamation, Mining and Safety website (<https://www.colorado.gov/drms>). Select drilling log locations obtained from the Colorado Division of Water Resources (DWR) in 2020 are also included on the map. The DWR locations are estimated, and the validity of the drilling log data is uncertain. Labels associated with the DWR drilling log locations include an estimated overburden thickness, estimated resource thickness, and description from the driller’s log. For example, the label “4/16 Sand and gravel” indicates 4 feet of overburden and 16 feet of underlying sand and gravel. The label “14/64 Sand and gravel, clay lenses” indicates 14 feet of overburden and 64 feet of sand and gravel with clay lenses.” The label “0/0 Clay” indicates that clay was observed at the surface. Links to the well records and logs used for these notes are included on the online version of this map.

Field evaluation locations are also included on the map. These locations include descriptions of visible exposures of sand and gravel deposits along roads. The descriptions include the geological unit, clast types, weathering, induration, and clast size estimates, landform, and resource classes.

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