

# Construction, Design & Engineering

## Settling: Is the ground beneath your property moving?

Across the United States, the ground beneath many urban areas is slowly settling, and in Colorado, the shift can be even more substantial. Land subsidence, once considered a coastal or flood plain concern, is increasingly recognized as a nationwide situation affecting growing metropolitan regions.

For developers, contractors, property owners and facility managers, the implications can be significant. Even subtle changes in ground elevation can affect foundations, slopes, drainage systems and the long-term performance of buildings and infrastructure.

Recent research published in the journal [Nature Cities](#) documents widespread subsidence across major U.S. metropolitan areas. While other regions are most affected, similar patterns are appearing in Colorado. In fact, Denver has an area-weighted average subsidence greater than 2 millimeters per year.

The key takeaway for the real estate and construction industries is the ground beneath many properties is not static and understanding how soil movement occurs can protect the asset value.

■ **Small movements, big impacts.** Subsidence often occurs gradually. Over time, however, those small movements can accumulate and place stress on foundations, alter drainage patterns and increase erosion.

Uneven or differential settlement substantially multiplies the risks. Structural damage occurs when one end of a foundation drops relative to the other, causing drywall, framing and/or concrete to crack. Because of this, slopes may also destabilize, retaining walls can experience additional pressure and underground utilities may shift or break. If a water pipe breaks below ground, it will exacerbate the problem immediately. Understanding how subsidence interacts with slope stability and erosion is becoming an essential component of risk management.



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■ **Why land subsidence occurs.** Land subsidence occurs when the ground surface sinks, consolidates or settles due to changes in underlying soil conditions.

The most significant driver of foundation movement in Colorado is the increase and decrease in soil moisture. Adding moisture to the soil can cause consolidation, settlement and/or erosion of the soil beneath a building. When expansive soil is present, adding water can also cause it to heave. Similarly, if the soil dries out, fine-grained soils, especially clays and silts, compress when that support is reduced. Once compressed, the soils typically do not rebound, resulting in permanent settlement. Ultimately, we want the moisture content in the soil beneath our buildings to remain fairly consistent.

Moisture content is primarily managed by controlling and maintaining the grading and drainage conditions around the property to channel precipitation away from the foundation. Simply put, it is important to keep the soil sloped away from buildings and ensure gutter downspouts discharge water away from the structure.

More global concerns are those highlighted by Nature Cities, which include groundwater extraction. When water is pumped from underground aquifers, the pressure that once supported the surrounding soils decreases. Similarly, as we experienced a significant drought during the 2025-2026 winter, overall groundwater levels decreased.

As metropolitan areas expand, redevelopment intensifies and snowfall decreases, the moisture in the soil beneath us will continue to settle and affect our buildings and infrastructure.

■ **The importance of soil conditions.** Soil composition



Emergency shoring was required on this soil bank and retaining wall.



Signs of soil movement can be seen near a home foundation.

plays a critical role in how land responds to environmental stress and structural loading. Much of the United States, including Colorado, is underlain by clay-rich soils that are particularly prone to movement.

Expansive clays, for example, swell when saturated and shrink when dry. These repeated cycles of expansion and contraction can place pressure on foundations, slabs and retaining structures. Regions with pronounced wet-dry cycles often experience seasonal soil movement in addition to long-term subsidence.

Alluvial soils, commonly found in Colorado's river valleys and flood plains, present another challenge. These loose sediments may appear stable initially, but they can compress significantly under sustained loading or groundwater changes.

In urban environments, engineered fill can also create long-

term settlement risks if soils are not properly compacted during construction.

Because soil conditions vary widely from site to site, geotechnical investigation is critical before development begins.

■ **A Colorado perspective.** Colorado presents its own unique soil challenges. Along the Front Range, expansive clay soils are common and have long been a concern for builders and property owners. These soils can swell dramatically when moisture levels rise and shrink during dry periods, placing stress on foundations and slabs. In mountain and foothill areas, steep terrain and highly variable soils add additional slope stability considerations. When combined with increasingly intense rainfall events and ongoing development along the Front Range, these conditions make careful geotechnical evaluation and drainage planning especially important for

projects across the state.

■ **Implications for property owners and builders.** For the real estate industry, soil movement is more than a technical issue; it is a long-term performance and liability concern.

Because subsidence often develops slowly and out of sight, damage may not become visible for years. Cracks in walls or pavement, shifting drainage patterns, or misaligned doors and windows may all indicate underlying soil movement.

Sites located near slopes, drainage channels or large embankments may face additional risk. In these environments, subsidence can gradually alter slope geometry while erosion and soil saturation weaken structural support.

■ **Strategies for managing soil movement.** Although subsidence cannot always be prevented, proactive planning can significantly reduce its impact.

A comprehensive geotechnical investigation is one of the most important steps. Detailed studies evaluate soil layers, groundwater conditions, compressibility and the presence of expansive or collapsible soils.

Foundation design should account not only for immediate structural loads but also for long-term soil behavior. Depending on site conditions, solutions may include deep foundations, mat foundations or soil stabilization techniques.

Effective water management is particularly critical. Poor drainage can accelerate erosion, slope instability and overall moisture content in the soil, so properly designed swales, channels and outlet protection systems help prevent runoff from undermining structures.

Slope stability analysis is particularly important for developments near embankments or waterways. Where possible, gentler slopes reduce both erosion potential and structural stress. Flexible systems, such as mechanically stabilized earth walls or reinforced vegetated slopes, may perform better than rigid structures in areas experiencing settlement.

Finally, erosion control measures during and after construction help stabilize soils until vegetation becomes established and long-term drainage systems are functioning properly.

■ **Building on a dynamic landscape.** For generations, development has operated under the assumption that the ground beneath a property remains largely unchanged. Increasingly, research suggests that the assumption may not hold true. Recognizing the forces in play and designing structures with them in mind can help ensure they continue to perform safely and reliably for decades to come. ▲

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The crew is installing drainage systems to move water away from the foundation.