

Previously published in Proceeding of the 30th Symposium on Engineering Geology and Geotechnical Engineering, 1994, "Hydrogeology, Waste Disposal, Science and Politics," p. 121-135.

Geologic and Geotechnical Investigation of the Windsor Park Subdivision North Las Vegas, Nevada

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Abstract: The Windsor Park subdivision in North Las Vegas, Nevada has received wide attention for damage to the homes and infrastructure from fissures, land subsidence and adverse soil conditions. Between March and July, 1992, Converse Consultants Southwest, Inc. ("Converse") conducted a geologic and geotechnical investigation for the Windsor Park Revitalization Project. The purpose of the work was to investigate the probable factors contributing to the reported damage and distress in the area, evaluate the potential for future damage, and assess the feasibility of possible mitigation and repair.

The site is constructed on the juncture of at least two subsidence-related fault scarps, and earth fissures have been extensively mapped in the Windsor Park and surrounding area. A total of twenty-one trenches and fifteen borings were located within the subdivision and around the perimeter to observe subsurface geologic features and to collect samples for laboratory testing. The primary causes of damage within the development were found to be (1) earth fissuring and (2) expansive clays.

The risk of future damage to structures at the Windsor Park site was also evaluated. A high potential for fissuring was found at the site, and future structural distress in the area will likely be similar to past damage. Although engineering upgrades will reduce the risk posed by underlying expansive clays, they cannot totally eliminate the risk from fissuring.

Introduction

The Windsor Park subdivision is a residential development consisting of 246 homes in the central portion of North Las Vegas, Nevada. The homes were built between 1964 and 1965 and consist of single-story, wood-frame construction supported by either slab-on-grade foundations or perimeter footings with elevated wood floors (crawl spaces). Damage to homes and infrastructure in the area has been documented since the early 1980's, and numerous studies have been performed since

1984 to assess these problems and determine possible causes for damage and fissures in the subdivision. However, conclusions made in previous investigations were often contradictory indicating that the problem is very complicated as multiple and possibly interrelated problems may coexist at the site.

In February, 1992, Converse was contracted by the City of North Las Vegas to conduct a geologic and geotechnical investigation for the Windsor Park Revitalization Project. The purpose of the work was to determine the probable cause of distress to the neighborhood homes and infrastructure, evaluate the risk for future damage and provide recommendations for mitigation accordingly. The scope of work consisted of compilation and review of previous investigations and geologic literature for the area, extensive subsurface explorations, laboratory testing, and assessment of our findings.

Geologic Setting

Geologic and Hydrologic Conditions

The Windsor Park subdivision in North Las Vegas, Nevada lies in the north-central portion of the Las Vegas Valley in the Basin and Range physiographic province. The distinctive features of the province are isolated, nearly parallel mountain ranges separated by long, wide valleys. The Valley is filled with Tertiary and Quaternary Age unconsolidated alluvial and lacustrine (playa-like) sediments derived from the surrounding mountains. It is approximately 50 miles long and 5 to 25 miles wide. Figure 1 shows the location of the site within the Valley.

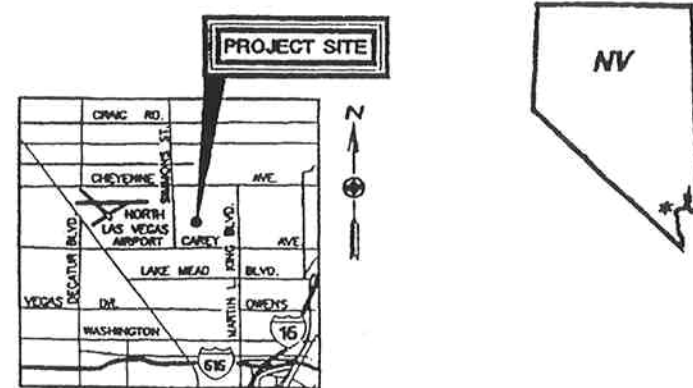


Figure 1. Windsor Park Location Map

Two separate aquifers exist in the Las Vegas Valley: a shallow relatively unconfined aquifer and a series of deep confining water-bearing zones (Plume, 1984). Each zone typically contains granular sediments that are separated by low permeability silts and clays. The fine-grained sediments occur as lenses or layers which act as semi-confining barriers or aquitards that impede vertical flow. The majority of the groundwater withdrawn in the Valley is from the deeper aquifer zone at depths greater than 200 feet.

The aquifers are faulted as a result of differential consolidation of the interbedded fine-grained sediments. The features termed subsidence-related faults significantly affect the movement of groundwater, both laterally and between aquifers. Prior to artesian head decline as a result of heavy pumping, flowing springs were often observed along these fault scarps (Bell, 1981).

Site Conditions

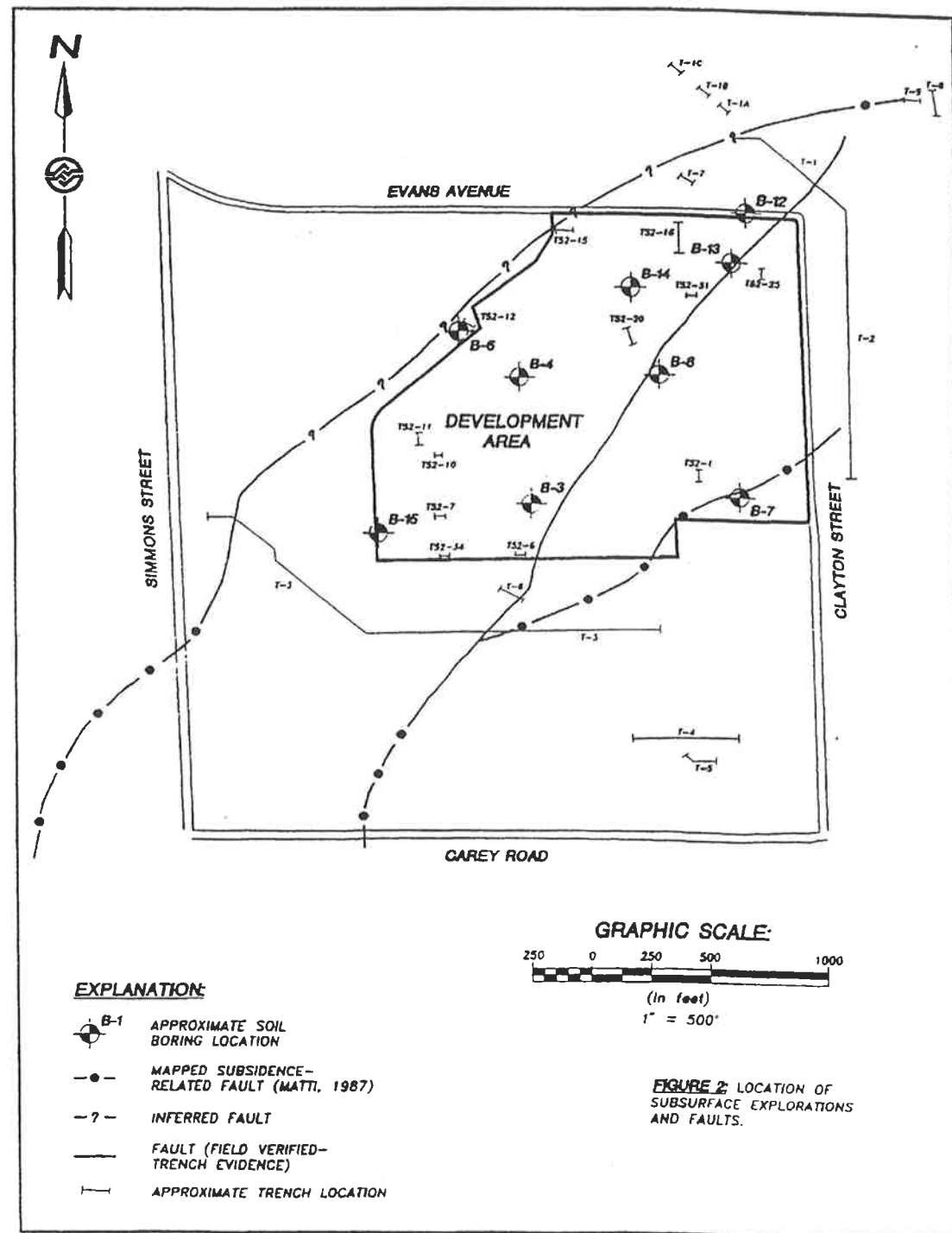
Near surface soils at the site consisted of man-made fill and playa-like deposits including silts, clays and fine sands overlaying clays, clayey sands and cemented (caliche) soils. The majority of soils contained various amounts of gypsum in the form of crystallized gypsum layers and gypsiferous clays.

Geologic Constraints

Geologic Faults

The site was constructed on the juncture of two fault scarps trending southwest-northeast across the Windsor Park Subdivision (Matti, et. al., 1987). The location of these fault scarps is shown on Figure 2. These fault scarps are generally believed to be topographic expressions of subsidence-related faults that extend throughout the Las Vegas Valley. They are generally thought to be nontectonic features of Quaternary Age (Cibor, 1983). Although several authors (Bell and Price, 1991) have noted that the fault escarpments may be tectonic in origin (from faults extending up from the bedrock basement underlying the valley and capable of generating seismic events), these fault scarps are most commonly thought to be the surface expressions of prehistoric differential consolidation or compaction of alluvial and playa-like sediments having dissimilar grain-size and compressibility characteristics. Therefore, the faults are not capable of generating earthquakes although they may be partially induced by an earthquake event (Bell, 1981).

Subsidence-related faults may be historically reactivated due to differential land subsidence as a result of groundwater withdrawal. They are also associated with earth fissures, former springs and adverse geotechnical conditions.



Land Subsidence

The principal cause of historical land subsidence in the Las Vegas Valley is the regional extraction of groundwater resources. The Las Vegas Valley soils contain much silt and clay sediments which are very conducive to consolidation upon fluid (water) extraction.

Evidence for land subsidence is based upon regional land level surveys conducted over years; in some areas near downtown Las Vegas, a total subsidence of more than 5 feet has been reported since land subsidence was first documented in 1940 (Bell, 1981). Elevation surveys conducted between 1963 and 1986/87 show the pattern for valley-wide subsidence as one large subsidence bowl punctuated by three secondary, localized zones. At present, the localized bowl in the northwest part of the valley is the most actively subsiding of the three and presents the greatest subsidence hazard to urbanization in the valley. The maximum surface subsidence of the northwest area is greater than 5 feet as measured between 1963 and 1986/87 (Bell and Price, 1991).

Land subsidence near the subject site is interpolated as 1 1/2 total feet between 1963 and 1986/87 (Bell and Price, 1991). In addition, the site is directly between the northwest and downtown subsidence bowls (see Figure 4). In the period between 1978 and 1991, approximately 0.8 foot of vertical subsidence has occurred along a land level line which crosses the fault zone about 1,000 feet northeast of Windsor Park.



Figure 3. Fissure located beneath caliche cap in trench T-5