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Subsurface geotechnical evaluation for the seismic microzonation of the Greater Johannesburg area, South Africa

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A significant part of the damage related to destructive earthquakes around the world is associated with seismic wave amplification due to local site effects. The local site conditions could be very different due to variations in thickness and properties of soil layers.

Geotechnical investigations form an important step in seismic microzonation of urban centres, in spite of the inherent uncertainty and risk. When available, geotechnical information becomes invaluable in the evaluation of hazards at ground surface, local site effects and liquefaction.

In South Africa, reference has already been made to the occurrence of earth tremors associated with mining activity on the central Witwatersrand. To date numerous seismic events of various magnitudes have been recorded in and around the City of Johannesburg area. The intention is to identify areas where strong ground motion could be amplified. It has become apparent that such areas are characterized by relatively thick soil cover prone to collapse which could result in death, injury and/or damage to property.

The primary objectives of this research project were to determine the subsoil and groundwater conditions at the site in order to delineate the most favourable locality for the first level microzonation map in support of the strong ground motion amplification prediction and the development of an early warning system for risk reduction.

Knowledge of the subsurface extent of the site has been derived from extensive drilling of geotechnical investigation trial holes for building and infrastructure development, but also from very extensive exploratory drilling related to gold mining activities. An amount in excess of 5000 geotechnical trial holes was collected from archives of the Council for Geoscience, engineering and consultants firms, City Engineers Johannesburg, etc. for geotechnical investigations carried out for several major residential and commercial projects in Johannesburg.

Available information indicated that the site is geologically complex and is underlain by an extremely variable sequence of four important systems of rocks. The oldest, the Archaean Granite, underlies the northern portion of the area and is unconformably overlain by the sediments of the Witwatersrand, Ventersdorp, and Transvaal Supergroups.

The groundwater table is seldom encountered in holes of less than 25 m depth in the grabben valley, while elsewhere it is generally shallow and is believed to be corrosive to normal concrete.

The results have indicated that the most favourable topographic situation for thick soil deposits in the study area occupies the Johannesburg graben. The underlying geological formation on the site is lava of

the Ventersdorp System. It is weathered to depths greater than 50m to a low density, sandy silt. The decomposed lava is covered by a thick deposit of transported soils consisting of compressible silty sand.

Moreover, the study has revealed that residual soils resulting from the weathering of the diabase intrusions and the granite often developed to depths of the order of 10-20m below surface, while the residual quartzite soils, derived from the *in-situ* weathering and decomposition of the parent rock, although sometimes variable, are not deeply developed.