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LAND SUBSIDENCE IN BUILT-UP MARSHLAND

BY

M. BOZOUK AND E. PENNER

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Land Subsidence in Built-up Marshland¹

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Severe land subsidence has been observed in a residential area in Ottawa built some 15 to 20 years ago on marshland. Subsidence varies from 12 to 18 in. (30 to 45 cm), affecting streets, sidewalks, driveways, fences, garages, and other structures supported on the ground surface. Houses were not affected because they were founded on shallow bedrock. Accelerated decomposition of the peat and the underlying marl is believed to have started when the area was drained for development, and this is believed to be responsible for the severe subsidence observed.

On a observé un affaissement grave du sol dans un quartier résidentiel d'Ottawa construit sur un sol marécageux il y a 15 ou 20 ans. L'affaissement varie entre 30 et 45 cm (12-18 po.) et affecte les rues, trottoirs, entrées, clôtures, garages, et autres constructions à la surface du sol. Les maisons n'ont pas été touchées par l'affaissement puisqu'elles reposent sur un fond rocheux. On estime que le drainage du secteur en vue de la construction a entraîné la décomposition accélérée de la tourbe et de la marne, ce qui aurait été la cause de l'affaissement.

Marshland often consists of saturated peat or organic matter supported by weak and compressible mineral soil or marl. When it is drained for use as a building site, weathering and decomposition of the underlying material is accelerated and may, in time, induce serious settlements of the ground surface. This note describes problems that developed in a residential area located on drained marshland in Ottawa.

The investigation was prompted by complaints that ground settlement was causing severe damage to property. An inspection of

the area, several city blocks in extent, showed that streets, sidewalks, and driveways had required frequent repair, that lawns had settled and that garages and fences were greatly distorted. The main dwelling units, probably 15 or 20 years old, were founded on shallow bedrock and were undamaged although the ground around them appeared to have subsided some 12 to 18 in. (30 to 45 cm). Lawns and gardens had marked depressions, with soft centers, and most of these had cavities below the sod cover. The 'springy' character of the ground surface suggested that the subsoil was highly organic.

Two inspection pits were excavated in the center of the problem area. The profile (Fig. 1)

¹NRCC No. 12175.

FIG. 1. Profile of test pit.

FIG. 2. Marl located between bedrock at 2.5 ft (.76 m) and the peat at 1.5 ft (.46 m).

revealed 6 in. (15 cm) of turf and a mixture of decomposed peat and shells, probably the spoil from the house basements. This was underlain by 1 ft (30 cm) of highly decomposed peat containing little or no mineral soil, although some small tree roots were found in it. The organic layer rested on about 1 ft (~30 cm) of brownish gray marl consisting almost entirely

of small shells (Fig. 2). Competent gray limestone bedrock was exposed at the bottom of the test pit below the marl.

The marl layer was heavily fissured with vertical wedge-shaped channels up to 5 in. (12.5 cm) wide; some contained organic matter that had fallen in from above. The channels extended vertically through the peat to the sur-

TABLE 1. Analysis of marl (% by weight)

Carbonates:	74.7	(Treatment with HCl)
Organic content:	2.6	(Treatment with H_2O_2)
Soil particles:	22.6

FIG. 3. The exposed foundation shows 17 in. (.43 m) of subsidence since construction.

FIG. 4. A subsidence of 2 ft (0.6 m) around fire hydrant.

FIG. 5. Earth mound around tree.
FIG. 6. Subsidence under sidewalk.

face where the 'sink-holes' appeared. Analysis of the marl (Table 1) confirmed a suspected high carbonate content.

It is believed that before the marshland was

converted into a residential area the ground-water table was at or near the surface. In this saturated condition the peat and marl were relatively stable. When the area was developed

and sewer and water services were installed, the groundwater level probably receded, permitting the peat to decompose more rapidly. Rain, snow melt, and frequent watering by the residents must have provided moisture movement through the organic layer, and the organic acids formed by the decomposing peats are thought to have reacted with the carbonates in the marl layer. Both the soluble portion of the organic material and the dissolved salts were gradually removed with the drainage water, slowly at first, then more rapidly, when the fissures in the marl enlarged into channels.

Deterioration of the marl and peat has resulted in a general subsidence in the area, but the houses are undamaged because they were

founded on the underlying bedrock. Structures such as garages and sheds which rest on the organic or marl layers, however, are seriously affected. Figs. 3 to 6 illustrate the effects of subsidence.

This note describes one of the rare cases where severe subsidence of the soil has developed but houses are unaffected because they are founded on bedrock. It illustrates the need at the planning stage, for proper assessment of the future behavior of foundation soils with respect to proposed structures and services.

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