1981/17. Inspection of proposed dam site near Gunns Plains

W.L. Matthews

Abstract

A dam about 4.5 m high and 150 m long is proposed on a small creek in the western part of Gunns Plains. The site is underlain by recent alluvium and Ordovician limestone. Test pits show that the alluvium is made up mainly of clayey material to a depth of at least two metres and tests show that this material does not have strong dispersive properties. Interpretation of three seismic spreads, although not conclusive, suggests that large near-surface cavities in the limestone are unlikely to occur.

INTRODUCTION

Mr T. Ewington of Gunns Plains is planning to construct a 4.5 m high dam for use in irrigation. The site [CQ138270] is in a limestone area and he requested advice on whether the area is regarded as favourable for a dam. The wall of the dam is expected to be about 150 m long.

GEOLOGY

The dam area is underlain mainly by alluvium, although a small outcrop of limestone of Ordovician age occurs just upstream. The whole area is probably underlain by limestone at depth, as evidenced by the presence of sinkholes. One such sinkhole is quite close to the embankment alignment on the south side of the creek, with sinkhole-like features further upstream. Sinkholes are also present downstream from the dam site on the north side. Conglomerate, sandstone and siltstone occur on the hills west of the dam site.

The creek has cut into the alluvium to a depth of 2-3 metres and brown silty clay is exposed in the banks.

POSSIBLE PROBLEMS WITH THE DAM SITE

From a surface inspection of the area it was apparent that the factors which may make the site unsuitable for a dam would include:

(a) the presence of permeable gravel or sand beds in the alluvial deposits that would allow loss of water if not cut off, and

(b) the load of water could promote further collapse if large channels or caverns occur in the limestone beneath the site.

Test pits dug with a backhoe were suggested to examine the near-surface material for permeable beds.

The firing of seismic spreads was suggested in an attempt to locate any large scale cavities underneath the site. Narrow localised cavities would probably not be identified and, in any case, there would be less danger of collapse structures developing.

TEST PITS

The approximate locations of the test pits are shown on Figure 1 and the logs are given in Appendix 1. Material with low permeability was encountered in all test pits. The material consisted dominantly of silty clay. Test Pits 2 and 4 contained thin bands of gravelly and sandy clay

towards the base of the holes. In each case, this coarser grained material does not appear to be very permeable because of the high percentage of fine grained material contained in it. The base of each pit was in clay or silty clay when the excavation was stopped, so that the thickness of the coarser grained material is limited, although other layers may occur at depth.

Dispersion tests on samples from each hole, although of a fairly crude nature, suggest that the material does not have strong dispersive properties, so that failure due to the development of piping is not regarded as likely. An added precaution against such a failure is to ensure good compaction of the embankment of the dam.

SEISMIC SURVEY

A seismic survey is capable of indicating the approximate depths to different layers under the surface because of the layers' ability to transmit vibrations at different velocities. From these velocities it is possible, with a knowledge of the geology of the surrounding area, to make suggestions about the nature of the materials with different velocities.

The near-surface material with seismic velocities of 250-390 m/sec which underlies all spreads (fig. 2) is probably soil and fractured fairly dry silty clay, as exposed in the test pits and on the sides of the creek. The material with the seismic velocities of 540-700 m/sec is probably similar, but slightly more compact and perhaps a little more moist. The 915-1175 m/sec layers are also unconsolidated material, but are quite compact and may be almost saturated with water in the higher part of the range. It should be pointed out that it is difficult to interpret any difference from seismic velocities between saturated sand or gravel and saturated clay or silty clay. Material with velocities of 2950-3450 m/sec is probably weathered or fractured rock. Limestone, in an unweathered and unfractured state, is expected to have a higher seismic velocity.

It seems unlikely that there are extensive open cavities in the rock under Spreads 1 and 3. The surface of the deeper refractor is uneven (fig. 2), but limestone, if this is the rock that this velocity represents, often tends to weather with an uneven surface. No higher velocity than 1175 m/sec is indicated under Spread 2. This is possibly what would be expected with a large extensive cavity under the area, with the seismic vibrations travelling along slow surface layers. However a cavity of this extent is very unlikely, and a more likely explanation for the absence of a higher velocity is that the unconsolidated material overlying rock is much thicker than on the north side of the creek (and further upstream on the south side where Spread 3 is sited). If material with a seismic velocity of 3000 m/sec or greater underlies the ends of Spread 2, then it is probably at least 14 m below the surface.

CONCLUSIONS

The test pits indicate that a considerable depth of unconsolidated material with low permeability occurs near the surface and this is favourable for dam construction. Dispersion tests suggest that the development of piping will be unlikely, but as an added precaution, the material forming the dam should be well compacted. Seismic spreads indicate that unconsolidated material extends to much deeper levels than the base of the test pits. It is not known whether this is material with low permeability or whether some consists of permeable sand or gravel.

Large open cavities in limestone underneath the site and near to the surface are unlikely. The most likely occurrence is under seismic Spread 2, although this prospect is fairly remote and the absence of a refractor with higher velocity is probably due to the presence of a greater depth of unconsolidated material in this area.

[31 March 1981]

APPENDIX 1

Logs of test pits

Hole No.	*Depth (m)*	*Description*
1	0 - 0.3	Clay soil, sandy and silty, brown, occasional gravel fragments.
	0.3 - 0.8	Silty clay, dry, fractured, darker brown, becoming lighter with depth, hard.
	0.8 - 2.1	Silty clay, mottled light brown and slightly darker brown, moist and hard. At two metres from the surface is a thin seam of iron oxide.
2	0 - 0.8	Silty clay soil, hard, fractured, mid-brown, fine roots.
	0.8 - 1.2	Silty clay, hard, darker brown, moist, some carbonaceous fragments up to 5 mm across.
	1.2 - 1.5	Clay, gravelly, no seepages, low permeability. Root channels extend to base of this layer.
	1.5 - 2.0	Clay, moist, mid-brown, fractured.
3	0 - 0.8	Clay soil, fractured, slightly moist.
	0.8 - 1.5	Clay, brown, moist, fractured. Roots extend to 1.2 m.
4	0 - 0.6	Clay soil, hard, fractured, dark brown, changing to lighter brown with depth, fine roots, a few pebbles.
	0.6 - 1.5	Clay, silty, hard, light brown, slightly moist.
	1.5 - 1.8	Sandy silty clay, mid-brown, hard. Not very permeable.
	1.8 - 2.1	Silty clay, brown.
5	0 - 0.6	Silty clay soil, dark brown, fractured, occasional gravel fragments to 0.3 m, then 0.3 m light brown fractured clay with fine roots.
	0.6 - 1.8	Silty clay, mid-brown, hard moist. Larger roots extend to bottom of pit.

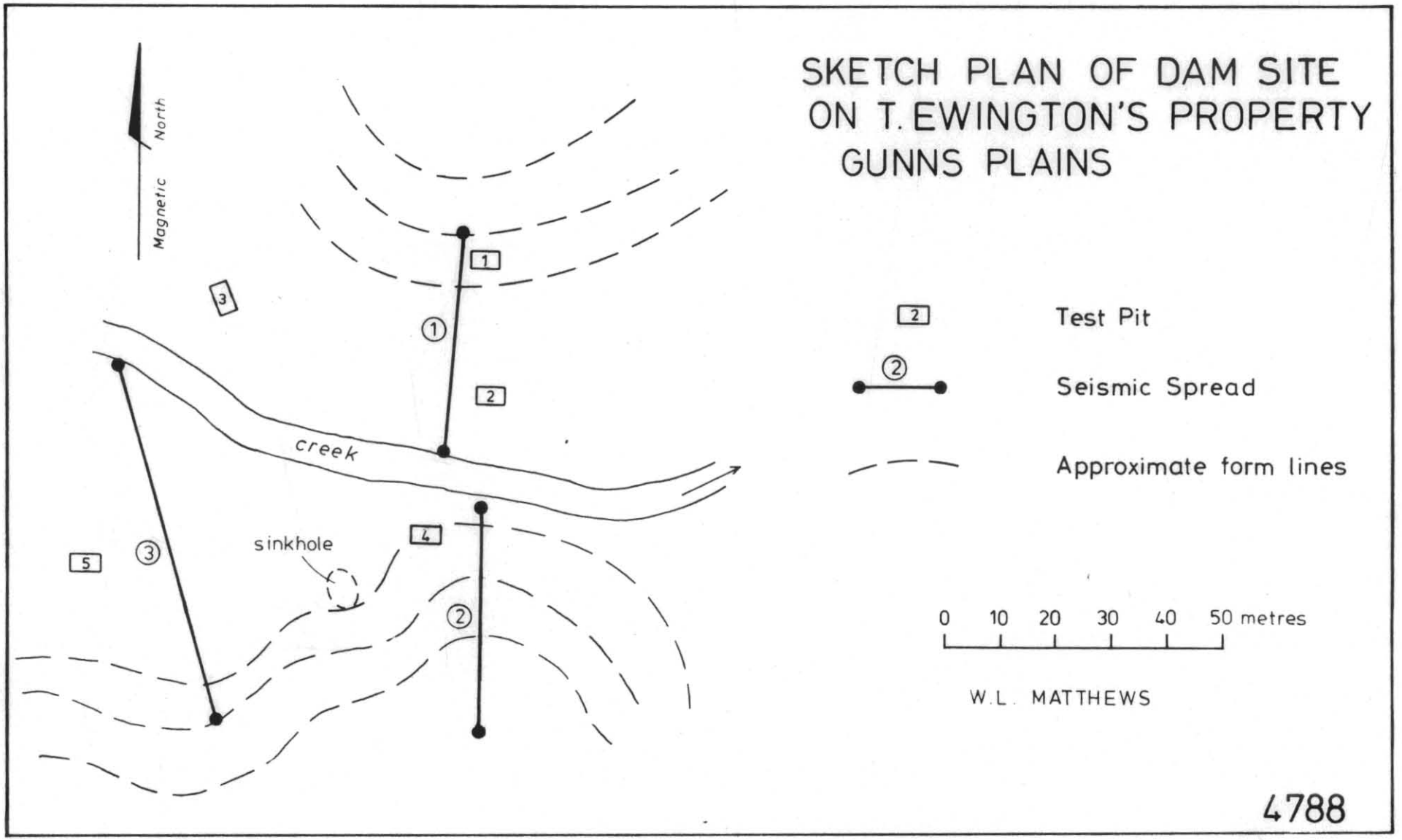

Figure 1

5 cm

9/5

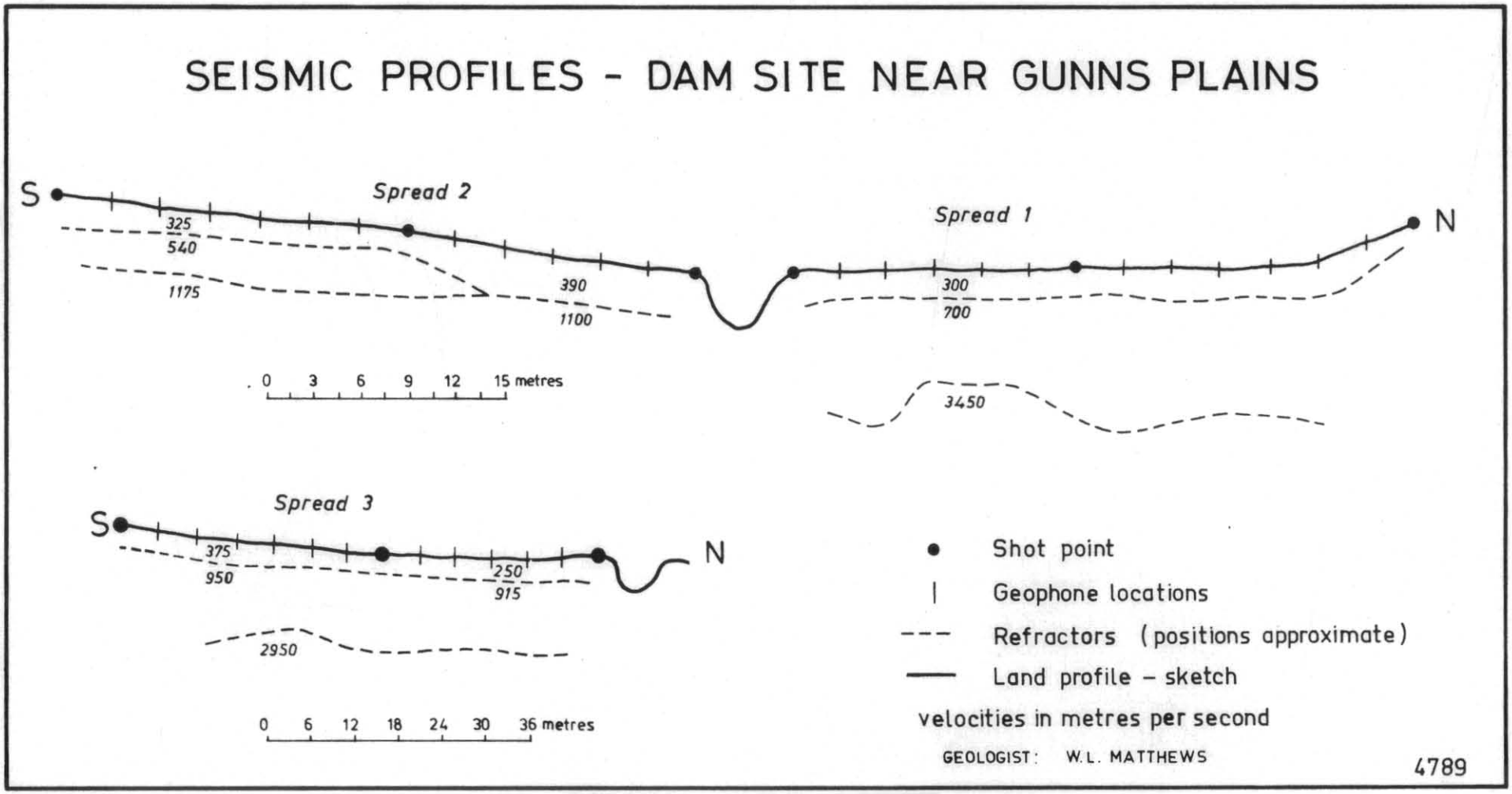
SEISMIC PROFILES - DAM SITE NEAR GUNNS PLAINS
S
Spread 2
325
540
1175
390
1100
Spread 1
300
700
N
0 3 6 9 12 15 metres
3450
Spread 3
S
375
950
250
915
N
2950
0 6 12 18 24 30 36 metres
Shot point
Geophone locations
Refractors (positions approximate)
Land profile – sketch
velocities in metres per second
GEOLOGIST: W.L. MATTHEWS
4789

Figure 2

5 cm