

PRELIMINARY HYDROLOGICAL ASSESSMENT

EAST COACH ROAD QUARRY  
WESTHAMPNETT, WEST SUSSEX

prepared for

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## PRELIMINARY HYDROLOGICAL ASSESSMENT

### EAST COACH ROAD QUARRY WESTHAMPNETT, NEAR CHICHESTER, WEST SUSSEX

#### SUMMARY

Tarmac Roadstone Southern Ltd propose to extract sand and gravel from a site to the east of Coach Road, Westhampnett. This development is unlikely to adversely affect the hydrological balance in this area, and with adequate design may reduce the existing risk of surface flooding in the vicinity of Church Farm Pit. The site is not in hydraulic connection with the underlying Chalk and therefore will have no effect upon this major regional aquifer.

The East Coach Road site lies in the north-eastern portion of an extensive area of quarrying which extends along the eastern margins of Chichester. The groundwater regime in this area has been severely altered by the removal of the natural aquifer and replacement with either impermeable fill material or open lakes. Historically there has been inadequate consideration of these modifications upon the hydrological regime with the result that several sites are now susceptible to periodic flooding. It is therefore important that the impact of further modifications should be thoroughly assessed. The current study outlines the major hydrological implications of extracting sand and gravel from the East Coach Road site.

# PRELIMINARY HYDROLOGICAL ASSESSMENT

## EAST COACH ROAD QUARRY WESTHAMPNETT, WEST SUSSEX

### 1. INTRODUCTION

The following report has been commissioned by Tarmac Roadstone Southern Ltd to accompany an application for Planning Permission to quarry sand and gravel from a site east of Coach Road, Westhampnett. It is proposed to excavate the East Coach Road site in a series of stages with aggregate being transported by dump truck for washing at Tarmac's Portfield plant. The quarry will be restored as a water filled lake and nature reserve.

Other developments currently planned or in progress in the vicinity include the quarrying of sand and gravel from a site to the west of Coach Road and construction of the A27 Westhampnett By-Pass along the northern boundary of the site.

The following report has drawn heavily upon the wider study of the East Chichester area completed by the Institute of Hydrology in 1990. In particular, the numerical groundwater model developed during that earlier study has been re-run to guide assessment of the impact of the proposed quarry. For a more detailed description of the regional hydrological regime and the assumptions inherent in the numerical model, reference should be made to the 1990 report.

#### 1.1 Location

The East Coach Road site, as shown in Figure 1, is located east of Chichester and approximately 300m south of Westhampnett. The site is bounded to the north by Dairy Lane and to the west by Coach Road. The north west corner of the site lies within a few tens of metres of the water filled Church Farm Pit. The northern face of the quarry will extend to within 18m of Dairy Lane as shown on Figure 2.

The village of Tangmere lies approximately 1.2km to the east of the site across open fields. The southern boundary of the East Coach Road site abuts the playing fields of Westbourne House School.

## 2. GEOLOGY

The East Coach Road site is underlain by Pleistocene and Recent gravels which rest unconformably upon the Eocene London Clay. The total thickness of sand and gravel varies from between 6m on the east boundary of the site to in excess of 11m in the central southern portions of the site.

The stratigraphic sequence may be summarised as follows:

Table 1: Stratigraphic Sequence

RECENT	Topsoil Fan Gravel
PLEISTOCENE	Brickearth Head Gravel Raised Beach Deposit (Younger)
TERTIARY	London Clay Reading Beds
CRETACEOUS	Upper Chalk

The site lies along the eastern margin of an alluvial fan of Recent age which has developed where the River Lavant emerges from the Chalk hills of the South Downs as shown in Figure 3. This margin is defined by a gradual transition into finer grained silts to the east of Maudlin Farm. These Fan Gravels have historically been the primary source of quarry material in the East Chichester area.

To the east of the proposed quarry site the alluvial gravels rapidly lens out above the Pleistocene solifluxion deposits of the Head Gravel and brickearth. Although not recorded in geological logs within the site it is possible that an eastward thickening lens of Head Gravel may occur between the marine and alluvial gravels. The alluvial sequence rests with erosional unconformity upon the Pleistocene marine gravels of the Younger Raised Beach Deposit. These marine sediments were deposited on the lower of two wave cut platforms and are characterised by marine fossils and are significantly more cemented than the overlying alluvial gravels. The marine gravels thin towards the west of Coach Road as a result of greater

erosion along the axis of the alluvial fan. The marine gravels have been deposited upon the Tertiary and Cretaceous strata of the Chichester Syncline as seen in Figure 4. The East Coach Road site is directly underlain by approximately 30-40m of London Clay. The south dipping contact between the London Clay and Reading Beds lies some 250m to the north.

### 3. HYDROGEOLOGY

The Pleistocene and Recent gravels form a shallow unconfined aquifer resting above the impermeable London Clay. These gravels are recharged from local rainfall, the winter flow in the River Lavant, and by groundwater and surface flow from the topographically higher Upper Wave Cut Platform.

Cementation of the underlying marine gravels reduces the permeability of this unit to average values of less than 10m/d, while the alluvial gravels have an average permeability of 180m/d. Groundwater levels in the area are such that the Marine Gravels and the lower one to two metres of the alluvial sequence are normally saturated.

Groundwater flow is in a predominantly north south direction as is evident from Figure 5 , with considerable modification on a local scale due to the complex pattern of gravel extraction and after-use. In particular, sealing of the southern side of Church Farm Pit is thought to have focused seepage towards the south east corner of this lake and into the area around Coach Road.

In areas immediately adjacent to the River Lavant it is not uncommon for groundwater levels to rise in the order of 2.5m over the twenty to thirty day period after the onset of ephemeral flow. The short distance and high transmissivity of the intervening alluvial gravels result in high groundwater flow rates from the Lavant into the Church Farm Pit. Peak winter water levels in Church Farm Pit have been increasing over the last fifteen due to silting and now are commonly in the order of 15.5 m.O.D.. Flooding of warehouse sites in the vicinity of Church Farm Pit is an annual problem associated with these water level rises. This flooding is only relieved by semi-continuous pumping from the Bookers site into Church Farm Pit. This pumping creates a local cone of depression beneath the Bookers site while slightly raising the lake water levels.

Local rises in groundwater levels are also evident on the hydrograph for borehole WCSS 1. This monitoring hole is sited adjacent to the small stream along the western side of Coach Road and the hydrograph reflects the intermittent seasonal flow in this stream. Most of this flow find its way either directly or as groundwater flow into Church Farm Pit.

The annual rise in water levels within Church Farm Pit produces a similar rise in groundwater levels in surrounding sands and gravels.

#### 4. HYDROLOGY

There are no natural streams through the proposed quarry site. A north south oriented shallow topographic depression occurs within the eastern portions of the site. Although no defined surface channel exists in the area, this depression would be a focus for surface sheet flow during periods of high rainfall. This depression forms the headwaters of a catchment which, 400m to the south, develops into a series of drains and ponds which pass to the east of Highground Farm before forming the Merston Rife.

The incorporation of this shallow depression into the quarry will marginally reduce the volume of surface water runoff into the Merston Rife. The slight reduction in direct surface flow will be compensated by an increase in groundwater flow from the lake.

To the immediate northeast of the proposed quarry site a small closed catchment exists around the pond at Maudlin Farm. This catchment will be heavily modified during construction of the A-27 By-Pass and will not be affected by quarrying activities.

A similar closed catchment surrounds a small pond 350m southeast of Maudlin Farm. This catchment area will not be affected by the proposed quarry.

An ephemeral stream/drain has been constructed along the western side of Coach Road. The catchment for this stream includes areas to the immediate north of Westhampnett, and runoff from the existing A27. Local residents report that flashy flow can be quite "high" overflowing the channel. At present this water flows by bed loss or directly via an open drain into Church Farm Pit.

#### 5. NUMERICAL MODELLING

The numerical model for the Westhampnett area developed during the 1990 study was re-run assuming the East Coach Road site to be a water filled lake. It is important to note that the original "model" was prepared using available historic data. This data was collated from various sources and did not rigorously define aquifer geometry, characteristics or groundwater levels. The 1990 study involved an approximate calibration of the model.

The following general indications may however be drawn from the model runs which were undertaken as part of the current study.

### 5.1 Hydrological Impact of Dewatering During Quarrying

The proposed quarry will be worked in four separate phases as shown in Figure 2. The first three phases will be worked dry and the fourth phase worked wet.

Groundwater levels in the immediate vicinity of the proposed quarry will be drawn down by up to 7m during Phase 1. Areas outside the quarry site which may be affected by this lowering of the water table include :

**Maudlin Farm :** The water level in the pond at Maudlin Farm are several metres above that within the surrounding gravels. It is therefore reasonable to assume that this pond is perched and not in hydraulic continuity with the gravels. While dewatering of the gravels at the proposed quarry site is likely to lower groundwater levels beneath the pond by less than 0.5m this is unlikely to affect waterlevels within the pond. Similar conditions are likely to apply to the small pond near the south east corner of the proposed quarry site.

**Shopwyke and Westside Nurseries :** Groundwater is abstracted under licence for irrigation purposes at the Shopwyke and Westside Nurseries. This groundwater is drawn from shallow wells within the alluvial gravel aquifer sited approximately 600m south of the Phase 1 excavation site. Drawdown at these two nurseries can be expected to be less than 0.03m after 180 days pumping at 200m<sup>3</sup>/d.

Groundwater levels along the southern boundary of the site with Westbourne House School can be expected to be drawn down by approximately 0.3m during Phase 1 dewatering. Reduction in groundwater levels of this magnitude are unlikely to have any significant effect upon the area.

**Church Farm Pit :** The drawdown at the western end of Phase 1 of the proposed quarry will be approximately 4.0m. A steep hydraulic gradient will develop between the Church Farm Pit and the base of the Phase 1 quarry. The rate of inflow into the quarry will increase as the quarry face moves closer to Church Farm Pit. As a result water levels within Church Farm Pit can be expected to fall by up to 0.40m during the excavation of the western portions of Phase 1. The actual amount of drawdown will be determined by the type of infill material used in construction of the A27 By- Pass.

Phases 2 and 3 of the proposed quarry will be worked dry and will produce local drawdowns of up to 7.0m. These reductions in groundwater levels will be most noticeable to the south of the proposed site.

Shopwyke and Westside Nurseries : Dewatering of the Phases 2 and 3 will lower groundwater levels at these two nurseries by approximately 0.04m. It is unlikely that a fall in water levels of this order will significantly affect abstraction.

Along the immediate southern boundary of the site groundwater levels are likely to be lowered by several metres. There are no hydrological features within this area that are likely to be affected. As the period of time over which these drawdowns will occur will be relatively short it is unlikely that there will be any adverse effect upon the local vegetation.

Church Farm Pit : The western edge of Phase 2 of the proposed quarry will be approximately 300m from the south eastern corner of Church Farm Pit. The excavation and dewatering of the western portions of Phase 2 will produce a relatively steep hydraulic gradient between the quarry and the standing water within Church Farm Pit. Water levels with Church Farm pit can be expected to be lowered by up to 0.3m during this period of quarrying.

The infilling of the Phase 1 excavation with overburden from Phases 2 and 3 will seal the northern face of the quarry and reduce the impact of dewatering upon areas to the north.

The gravels within the Phase 4 and 1A areas will be worked wet. Groundwater levels will be approximately coincident with those expected after the completion of quarrying.

## 5.2 Hydrological Impact of Proposed Restoration

Restoring the proposed quarry site as a lake and conservation area will lower groundwater levels within gravels on the up-gradient side of the lake and raise levels on the down-gradient side. In detail these changes will include the following :

Church Farm Pit : The rapid rise in water levels with Church Farm Pit associated with the onset of flow in the Lavant will result in almost as rapid rises in water levels within the proposed lake at East Coach Road.

The levels at which these two lakes will equilibrate with respect to each other will depend upon the rate of outflow from the East Coach Road lake. With exposed ballast along the

southern bank of the East Coach Road lake leakage will be relatively high and water levels in both lakes will be maintained at relatively low levels. With either natural or intentional sealing of this southern face water will escape at a slower rate from the system and water levels in both lakes will equilibrate at correspondingly higher levels.

If the southern face of the East Coach Road lake is unsealed the model predicts water levels in this lake will be approximately 1.0m lower than in Church Farm Pit. It is also probable that current water levels in Church Farm Pit will be lower by up to 1.0m after the development of the East Coach Road lake. In these conditions water levels in the proposed lake can be expected to fluctuate on a seasonal basis initially between approximately 11.0 - 14.0 m.O.D.. The seasonal range in water levels in Church Farm Pit after development of the East Coach Road lake is likely to be in the order of 12.0 - 15.0m

Natural silting of the proposed lake will gradually reduce the permeability of the banks and result in a gradual increase in peak winter water levels. The seasonal range after natural silting has occurred (10-15 years ) is likely to be between 11.5 - 14.5 m.O.D. The maximum volume of water above the present land surface is expected to be in the order of 500m<sup>3</sup>.

Westbourne House School : The elevation of the land surface along the southeastern edge of the proposed quarry site is between 13.7 - 15.4 m.O.D.. With anticipated peak winter water levels in the East Coach Road lake being approximately 14.5 m.O.D. the bund along the southern edge will need to be adequate to retain water at these levels.

The model predicts that groundwater levels along the northern boundary of Westbourne House School will be raised by a few tens of centimetres as shown on Figure 9. As permanent ground water levels are in excess of 3 metres below ground level the effect of this rise in levels will be negligible.

WSCC Westhampnett Landfill Site : Groundwater levels along the southern margins of the WSCC Westhampnett Landfill Site will be drawn down by 0.5m - 1.0m after restoration of the proposed quarry site.

DOT A27 By-Pass Soakaway : Runoff from the A27 By-Pass will be channelled to a soakaway sited approximately 10m south of eastern end of Dairy Lane. The excavation of the East Coach Road site and restoration to a lake will result in more rapid seepage of water from this soakaway. The area of roadway to be drained by this soakaway is estimated to be approximately 7500m<sup>2</sup>. With this area of roadway a sudden high rainfall event of 50mm would result in 375m<sup>3</sup> of water entering the lake in a short period of time. Runoff from the By-Pass in such an event would raise water levels in the lake by approximately 5mm.

## 6. CONCLUSIONS

The hydrological regime in the vicinity of the proposed East Coach Road quarry will be modified by both the pumping operations during quarrying and the restoration of the site as a lake. These modifications are likely to result in a reduction to the existing flood risk in the Church Farm Pit area. The impact of drawdown during the quarrying operations upon other areas and licensed abstractors around the site will be insignificant. With adequate precautions the surface water flow regime is also unlikely to be significantly affected.

A steep hydraulic gradient will develop between Church Farm Pit and the base of the quarry during the of excavation Phase 1). High rates of inflow are likely to occur through the narrow strip of highly permeable gravel between Church Farm Pit and the proposed quarry. Water levels in Church Farm Pit will be depressed by up to 0.4m during this period of quarry operations. After restoration water levels in Church Farm Pit will be lowered by approximately 1.2m compared to current levels.

Groundwater levels along the southern margins of the WSCC Westhampnett Landfill Site will be drawn down during quarrying by 2-3m. After infilling of the Phase 1 excavation and restoration of the site to a lake groundwater levels around the WSCC Landfill Site site will remain to their present levels.

Dewatering during quarrying activities will depress the water table to the south of the site by up to 6.5m adjacent to the quarry face, to less than 1.0m at distances in excess of 70m from the quarry face. After restoration groundwater levels will be raised by a few tens of centimetres above their current levels.

Peak winter water levels in the lake can be expected to be about 14.5 m.O.D., or about 0.7m above the present land surface. These anticipated levels have been considered in the design of the embankments along the southern portions of the site.

# Pit Development 1991

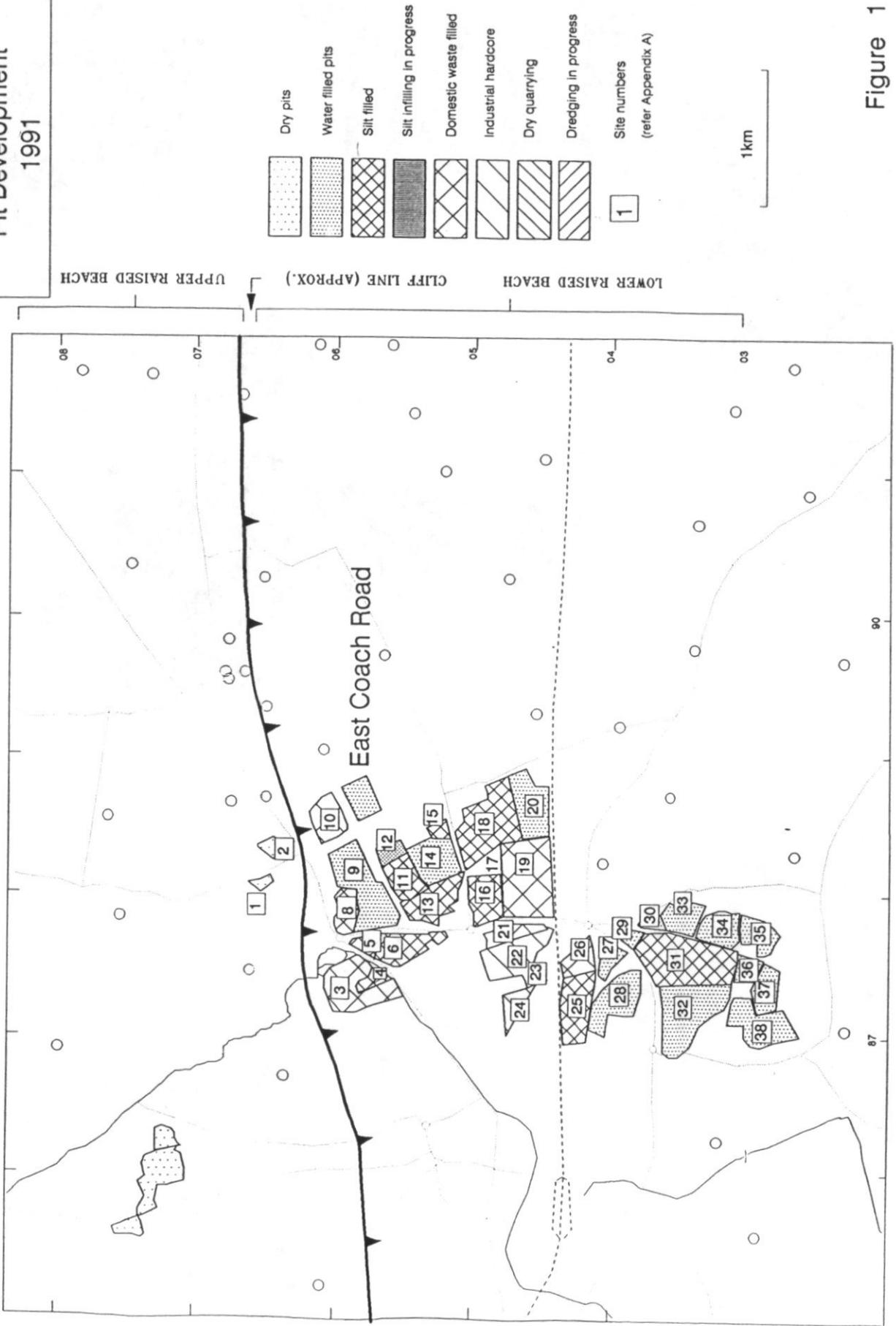


Figure 1

Proposed Quarry - East Coach Road

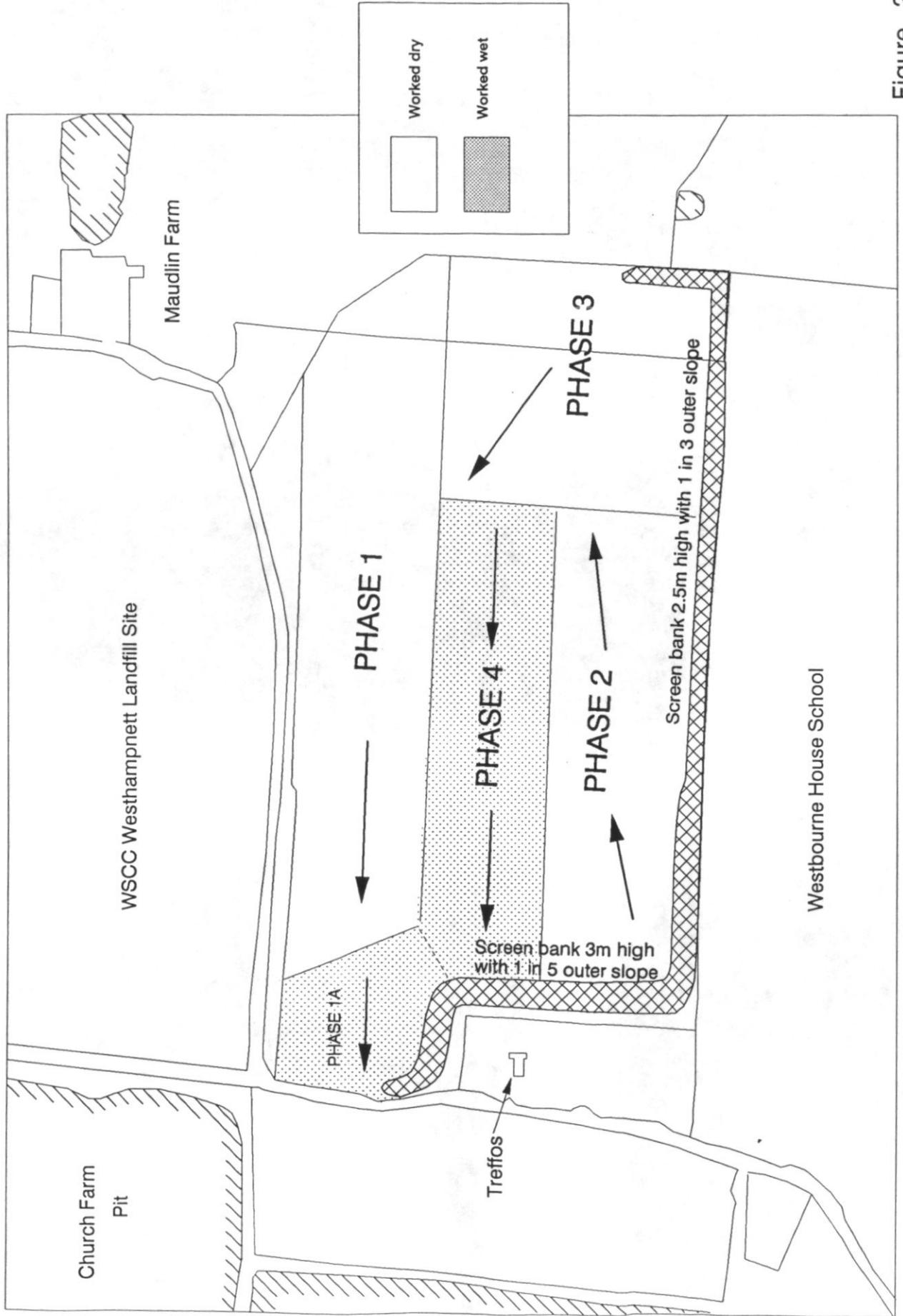


Figure 2

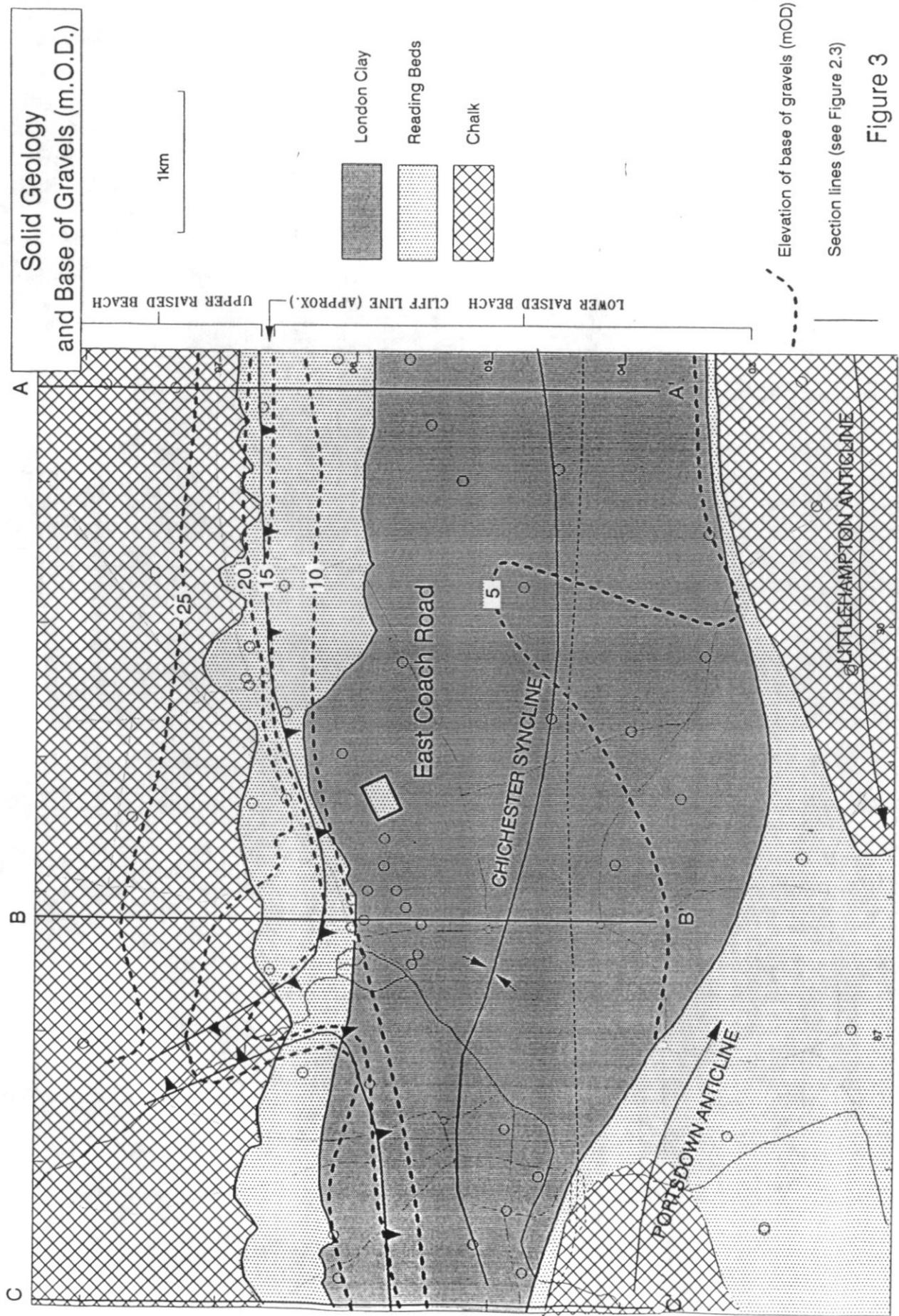


Figure 3

# Geological Cross Sections

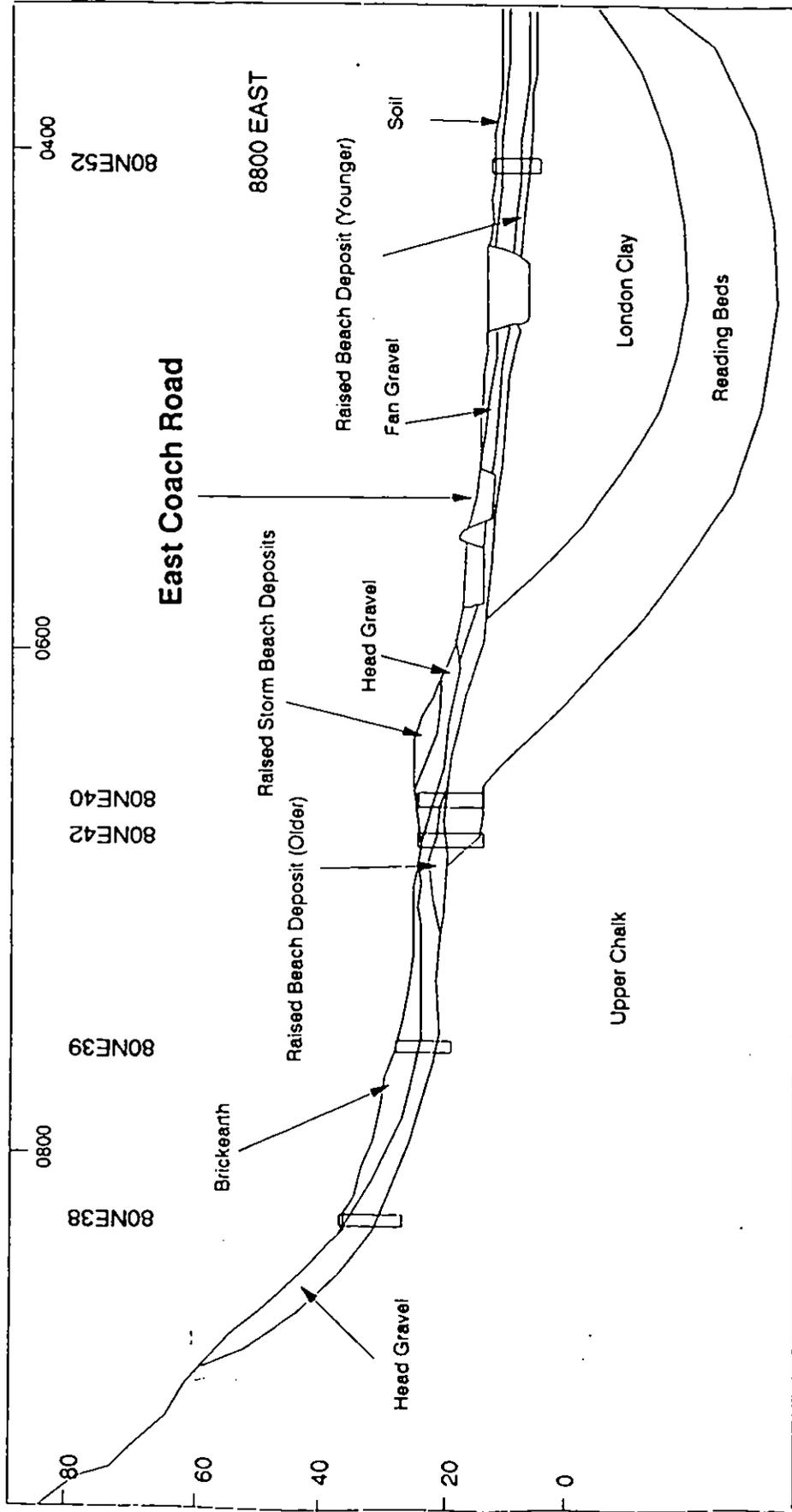


Figure 4

Groundwater Level Contours (m.O.D.)  
21st April 1970

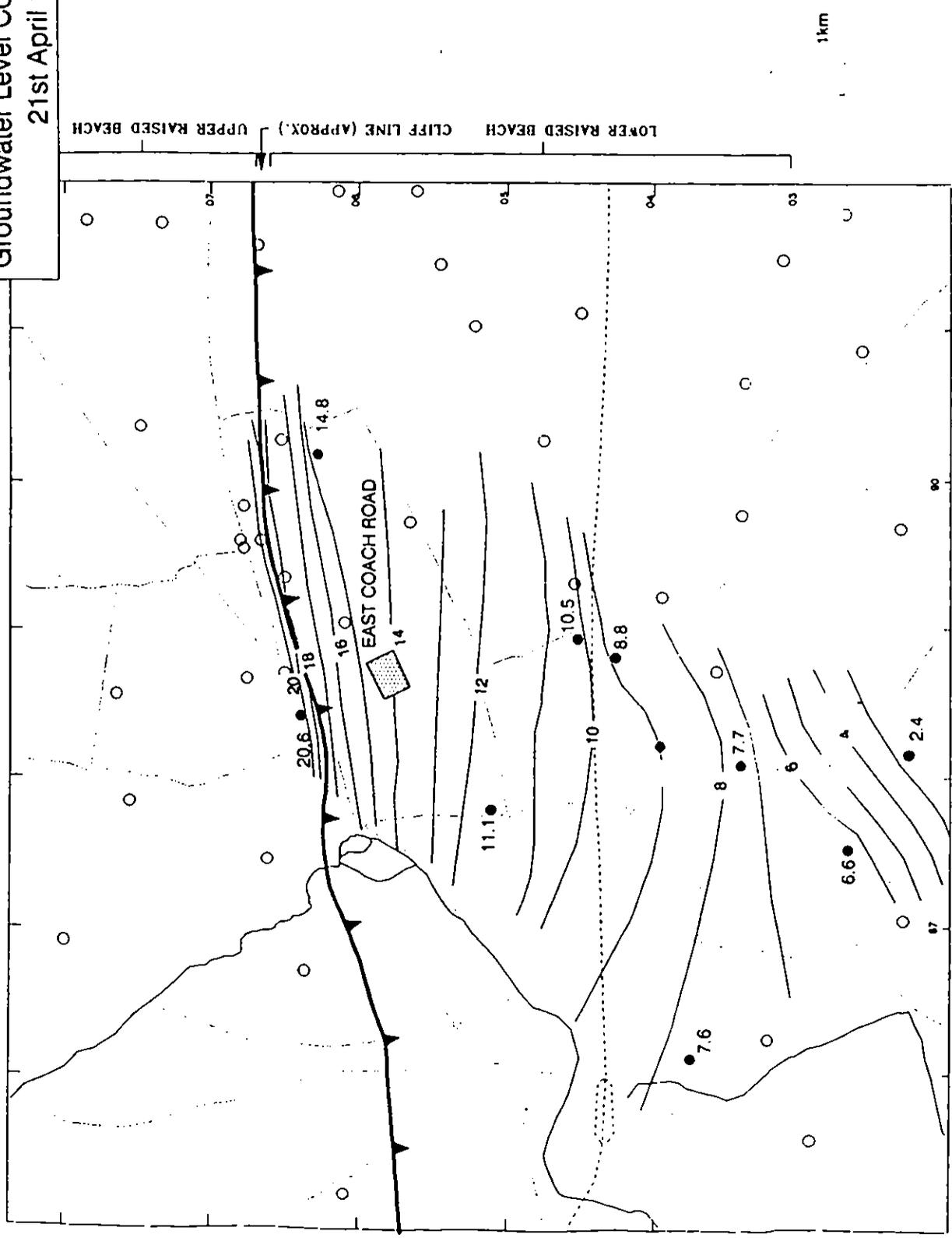
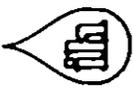
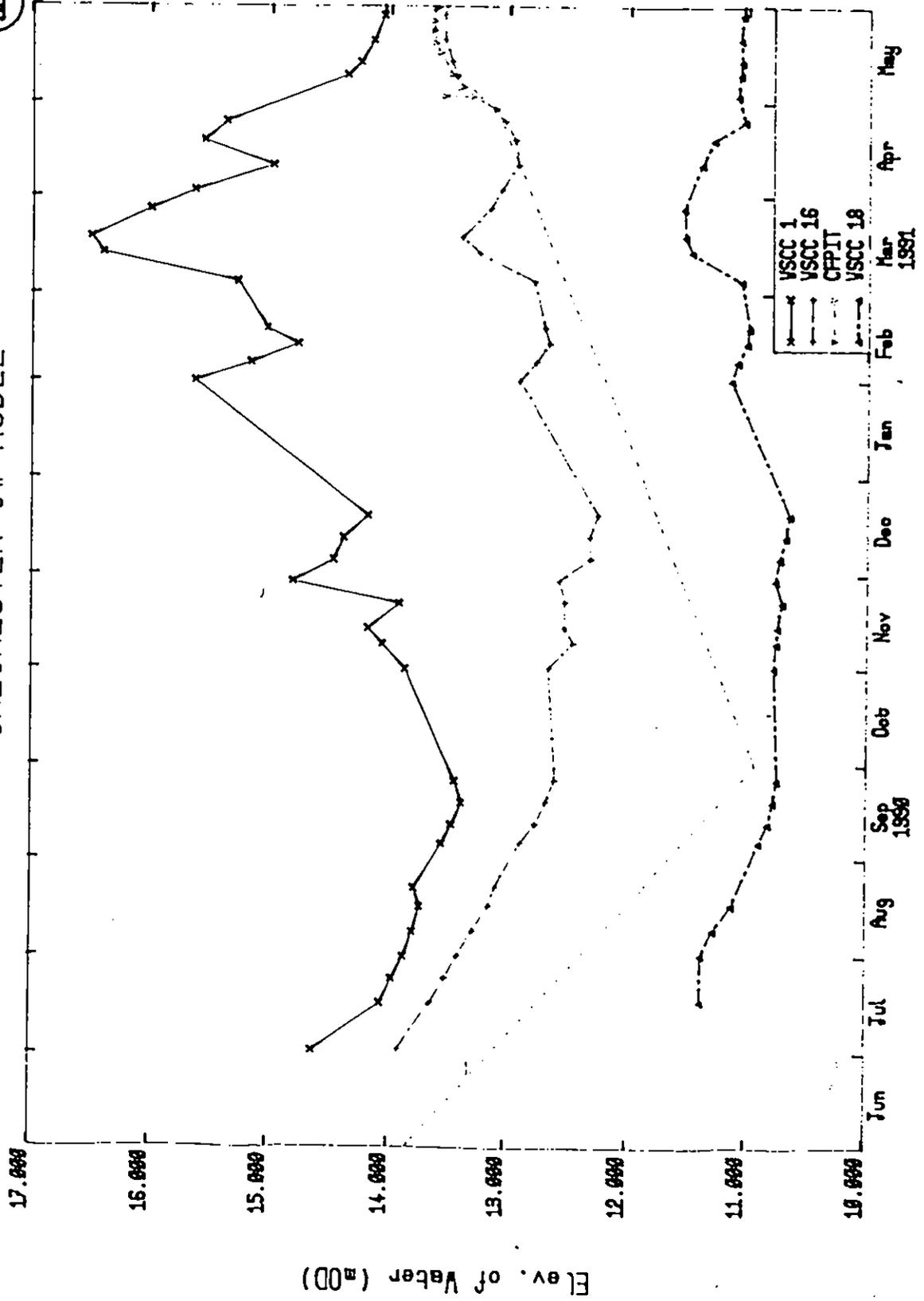


Figure 5



# CHICHESTER GW MODEL



Hydrograph

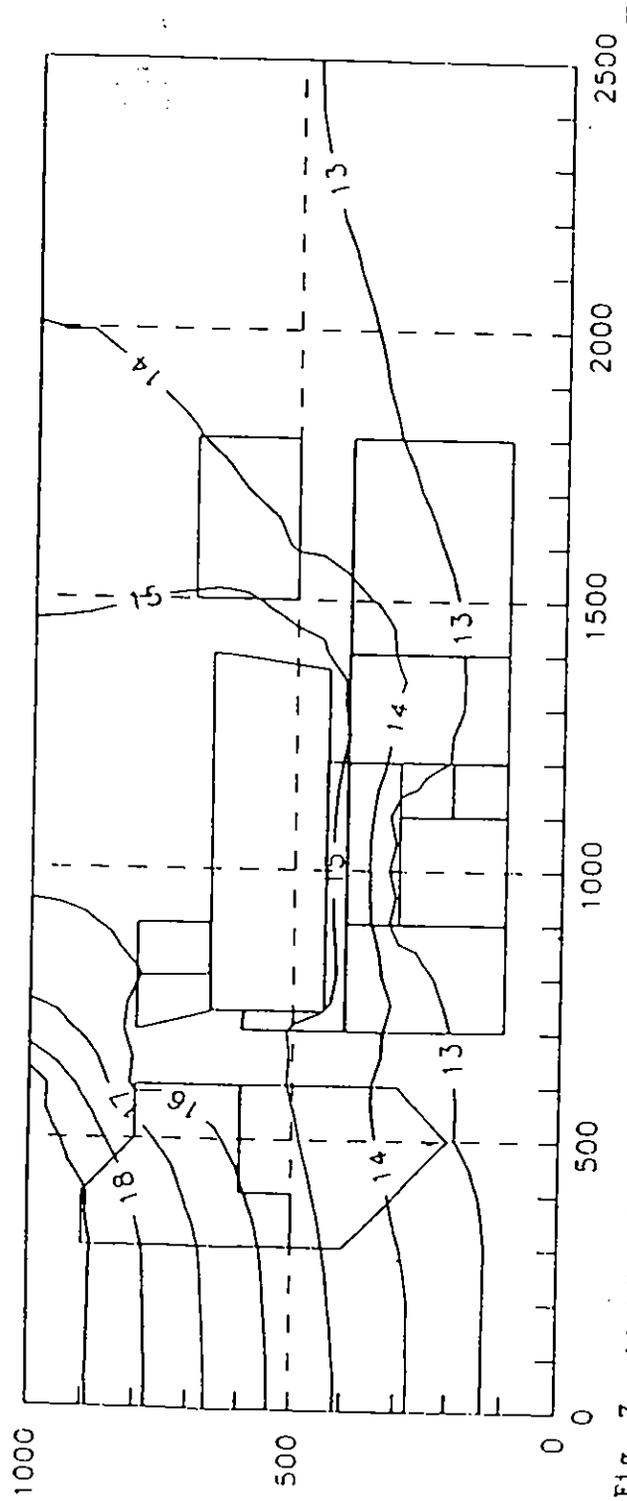


Fig. 7. Modelled Groundwater Levels Under Existing Conditions.

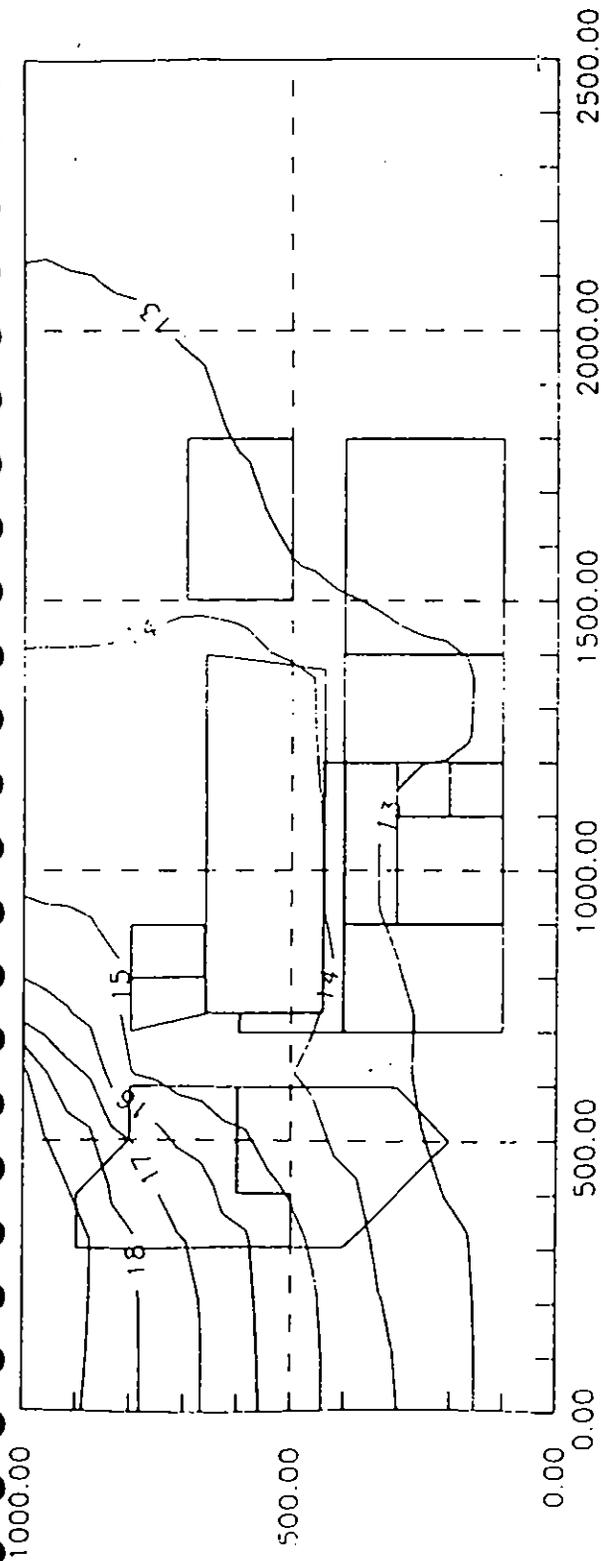


Fig. 8. East Coach Road Pit as water filled: Modelled groundwater levels

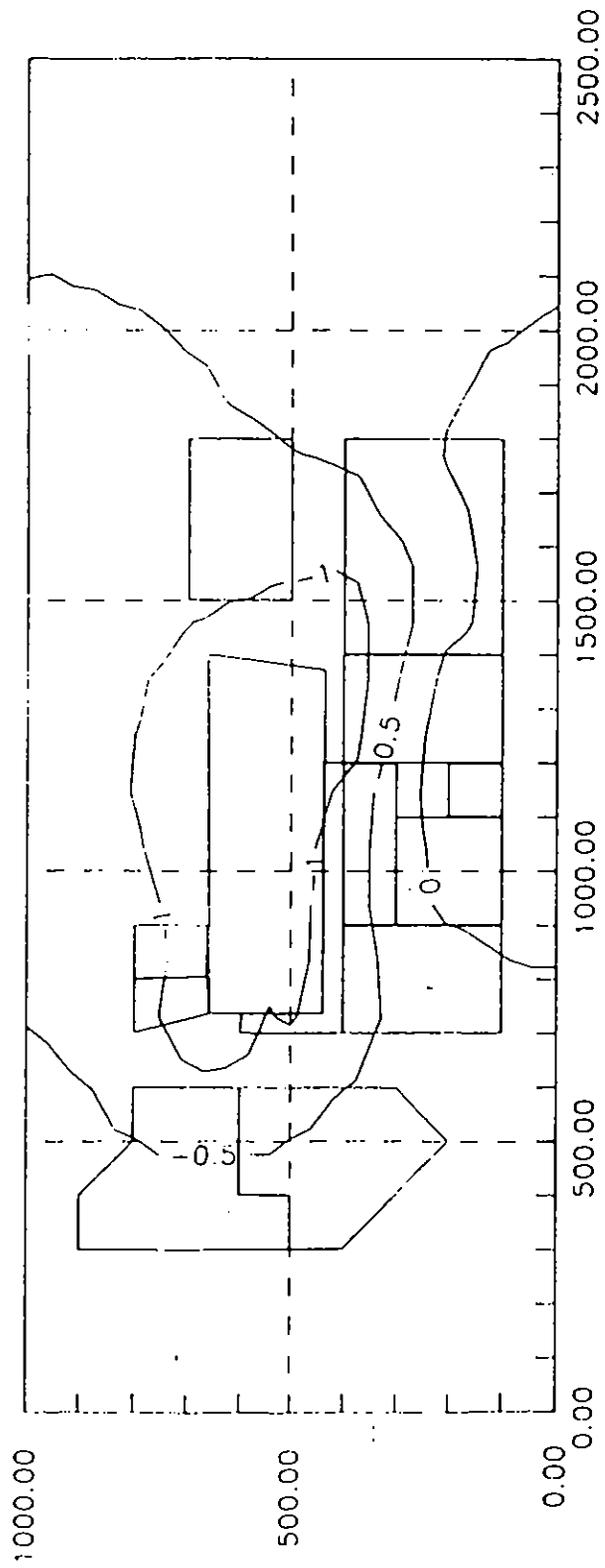


Fig. 9. East Coach Road Pit as water filled: Groundwater level difference from existing conditions

Proposed Quarry - East Coach Road

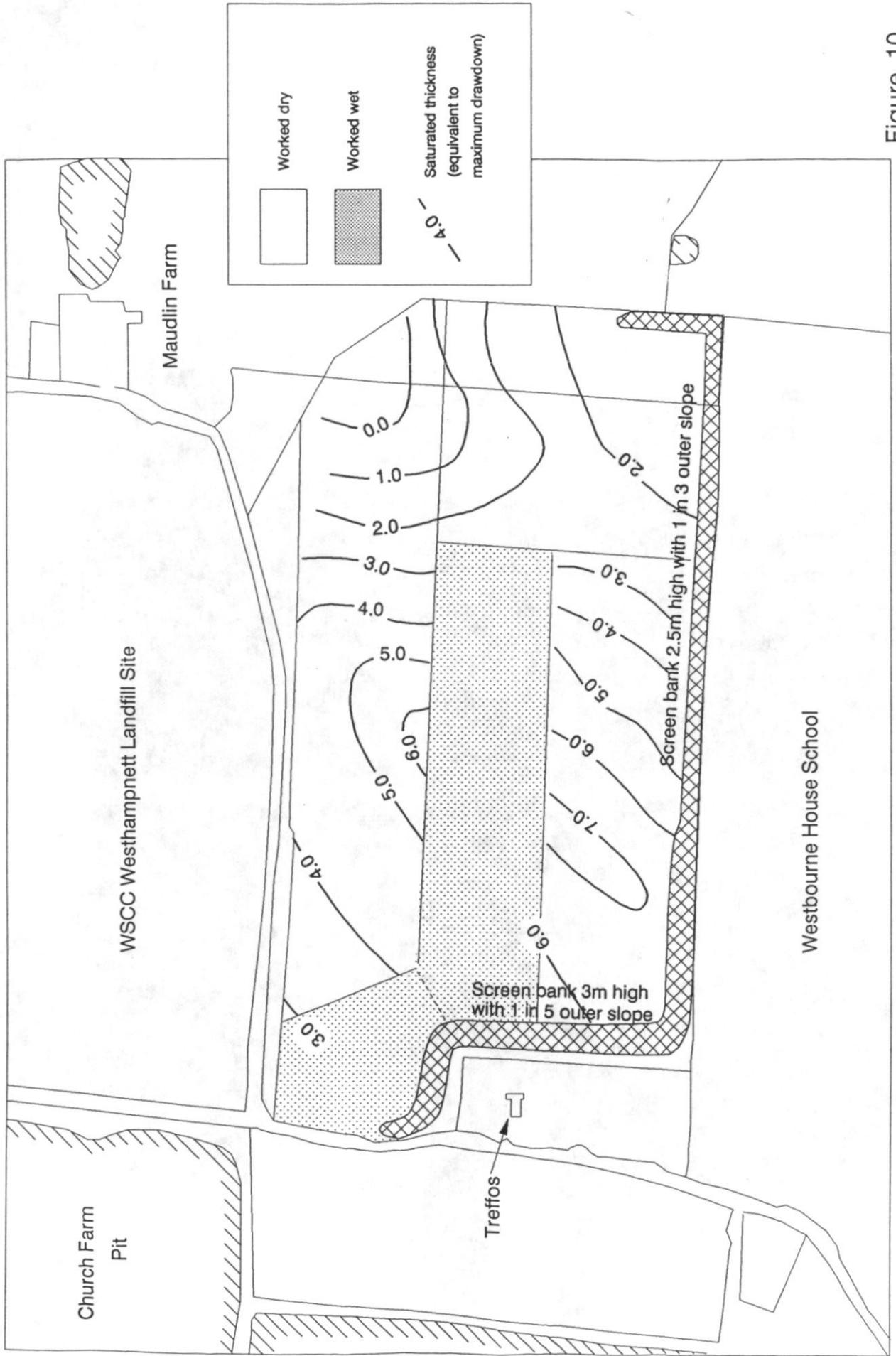


Figure 10



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