

## Drake Gardens Lead Mine Stabilisation, Tavistock, Devon

**Client:** West Devon Council  
**Designer:** Hyder Consulting  
**Project Manager:** Cyril Sweet  
**Value:** £1.0m  
**Date:** November 2010 – July 2011

The project was undertaken to treat historical lead mine workings which were found to exist under residential property in the Drake Gardens area of Tavistock. The Land Stabilisation Programme, managed by the Homes & Communities Agency, provided gap funding for the project to deal with the effects of the abandoned non-coal mine workings.

The Lead seam or 'Lode' was conjectured to have been worked between 1857 & 1874. Some 14 properties were affected by the shallow workings which had caused settlement, minor damage and evacuation of some of the properties. The lode dips at approximately 60° deepening eastwards against the topography and was mined from a series of adits driven horizontally along the lode at depths of 22, 44, 73 and 95m. The site is overlain by 5 to 7m of river terrace deposits beneath which is a soft slate within which the lead lode has been formed. The sub-crop of the lode runs close to or under several properties on the West side of Drake Gardens resulting in the risk of void migration to the surface.



The Drake Gardens stabilisation scheme has been carried out in two phases;

- **Phase 1 Site Investigation (Nov – Dec 2010).** A range of intrusive investigation work was completed to confirm the extent and condition of the lead mine workings beneath highway, gardens and the 14 residential properties using rotary probing, dynamic probing, and trial pits. Investigations also focussed on location of a main access adit and 3 mineshafts. Both standard geotechnical drilling rigs and mini-rigs were used depending on drill hole positions and access restrictions. Down-hole ultrasonic cavity surveys were undertaken to obtain data on the size of any significant voids that were located. The investigation phase also included a grouting trial to prove the proposed stabilisation methodology.

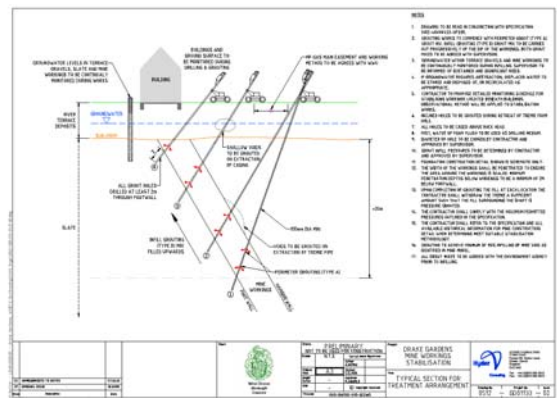
The investigation proved that although there were no major voids there was significant micro voiding of the soft and loose material filling the mined lode and stabilisation work involved treating this very soft material.



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- Phase 2 Treatment (March – June 2011).** Treatment involved stabilisation of the upper 25m of the steeply dipping lead workings by drilling and grouting under the affected properties with a close grid of boreholes and using a compaction grouting methodology to treat the broken and collapsed ground. 300 treatment holes were completed starting with a 3m perimeter line along the down-dip edge of the treatment grid, and 450m<sup>3</sup> of grout injected. Much of the treatment phase drilling required angled holes to treat under the properties and due to the confined nature of the site with drilling carried out from gardens, driveways and the cul-de-sac outside the properties versatile Klemm KR 904 Geotechnical drilling rigs and Klemm 701 mini-rigs were used.

Grout mixing was carried out remote from the properties in the site compound at the northern end of the site. The grout mix of sand, cement and bentonite was used to produce a stiff but pumpable grout mix for the compaction grouting stabilisation process. Mixed grout was pumped to the treatment holes using staged 4m<sup>3</sup>/hr screed pumps. Stabilisation started in the south of the site and worked towards the north, with validation test holes following on behind. Grout flow and pressure gauging equipment allowed continuously monitoring of grouting at each borehole with information being transferred to a datalogging system. This data was fed into a Rockworks 3D modelling software programme to map the real time progress of the stabilisation work .



This high profile and high impact local scheme in a confined residential area involved extensive residents’ liaison and customer care. Well attended public meetings were held prior to the start of each phase and every effort was made to ensure that work was carried out to fit in around residents’ routines, particularly since properties had to be vacated whenever drilling was conducted close to or under a property. The key to the success of the contract was the ability of the team to foster the cooperation of the public during the work and resident feedback following completion was very good.

