90 Attachment 12

Table 1
Development on Karst Terrain
Township of Franklin, New Jersey
[Added 6-10-1996 by Ord. No. 96-9]

Design Element	Risk(s)	Testing Requirements	Performance Standards	Preferred Design Features	Remedial Plan Elements
High-load and broad-load structures (high-rise buildings, parking decks, warehouses, water towers, etc.)	Settlement Structural damage/loss Personal injury/death	Evaluate available data Reconnaissance..... Test pits..... Borings..... Geophysics..... Conceptual failure model..... Bridging analysis..... Inspection of footings.....	 prior to design to confirm shallow bedrock where suspected 1 per 5,000 feet, 2 area of building footprint; depth based on column/slab load proposed at foundation elements discretionary discretionary intermittent during construction	Optimal layout Redundancy of support elements Predrill pile foundation sites; depths determined by proposed loads High-tensile-strength slabs with load transfer capability Use pile tips Drill caisson sites; depths determined by proposed loads Preconstruction grouting	Inspection Evacuation plan Remedial grouting plan Remedial designs
Low-load structures (single-family homes; small offices, stores, etc.)	Settlement Collapse Property damage Personal injury	Evaluation of available data Inspection of footings.....	 during installation of trench for footing	Foundation areas shows no evidence of creep or settlement Drainage directed away from foundation	Foundation reinforcement Occasional inspection by owner
Bridges	Settlement Collapse Embankment failure	Test pits..... Borings.....	to competent bedrock 5 to 10 feet into competent bedrock	Piles, caissons to competent bedrock Redundancy Footing with bridging of anticipated failure Preconstruction grouting	Alternate route Abutment reinforcement modifications Evacuation plan Escrow to cover repair
Underground tanks	Settlement/failure Undermining/failure Undetected leaks	Test pits..... Borings.....	in excavation in or near excavation, 10 feet into competent bedrock	Soil and rock void-free Voids grouted Above ground tanks	
Roads and Parking areas	Settlement Undermining Collapse Contaminated runoff	Analysis of existing data Reconnaisance of route Test pits or borings..... Geophysics.....	 installed in depressions or other likely karst features where warranted and to link data from pits and borings	Layout to avoid karst features Minimize paved areas Control drainage under pavement Controls on blasting Use of ripping Compaction of roadbase Reinforced roadbed	Alternative route Evacuation route Repair procedures Subsidence monitoring Bridging over sinkholes
Drainage features: Conduits Swales Catch basins Detention basins Ponds Injection pits	Settlement Leaks Collapse Undermining of adjacent areas Injection of pollutants to groundwater	Analysis of existing data Reconnaisance of route..... Test pits, probes at select catch basin sites Inspection schedule..... Evaluate available data Reconnaisance of route Borings into bedrock..... Permeability testing.....	 prior to design continuous during construction locations and depth based on geology and practical considerations, ± 2 per acre for injection sites	Route consistent with site evaluation results Swales/lined swales Water-tight joints Impermeable backfill Layout to avoid karst features Liners/compacted substrate Velocity reducers Ponds at water-table elevation On-stream ponds Facilities remote from structures	Inspection schedule Repair proposal/escrow Reserve area Grouting specifications Repair escrow Abandonment plan
Utility conduits	Leaks Conduit failure Pollution/explosion/fire Property damage	Reconnaisance of route..... Inspection schedule..... Test pits, borings, probes at key locations.	prior to design continuous during construction identification of possible areas of undermining	Route consistent with site evaluation results Backfill with native soil Geotextiles Piers, where appropriate Strong, flexible conduit Proper backfill procedures	Evacuation plan Shutoffs at key locations Alternate routes
Subsurface sewage disposal systems	Groundwater contamination Structural failure	Test pits.....	1 per 1,000 square feet, 2 at a minimum	Pressure-dosed disposal beds Beds not located next to rock pinnacles nor in natural depressions	Alternate sites Closed systems (holding tanks)
Wells	Wash-out subsidence during drilling Subsidence due to dewatering Excessive grout take Turbidity in well/aquifer Natural water quality: hardness, metals, radium, rad	Careful oversight Intermittent reconnaisance, monitoring Sampling of parameters of concern		Well screen and gravel pack Minimize well loss Reconnaisance/monitoring of subsidence	Alternate site Grout modification Pumpage modification Casing-off of mud zones Well screen and gravel pack