DEVELOPMENT CODE

June 2009
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PAPAKURA DISTRICT COUNCIL

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JUNE 2009

PART 2: EARTHWORKS AND FOUNDATIONS

2.1 SCOPE

This part of the code sets out the requirements for the carrying out of earthworks or preparation for foundations, or both, including:

(a) The excavation and filling of land to form new contours

(b) The assessment and protection of slope stability

(c) The suitability of both natural and filled ground for the founding of roads, buildings, services and other works

(d) The control of erosion and siltation during and after earthworks.

Because of the wide range of soil types, physical conditions and environmental factors applying in different areas it is not possible to lay down precise requirements which will be applicable in all situations. The criteria set out in this section will be subject in particular instances to the judgment of the Engineer, developer or Soils Engineer.

2.2 GENERAL

Refer to the Council's District Plan for matters concerning the layout of developments. The choice of final landform is dependent on many factors which may be specific to the subdivision. These include:

(a) Relation with surrounding landscape

(b) Size

(c) Roading pattern

(d) Preservation of natural and cultural features

(e) Stability

(f) Damage by flood or other natural occurrences such as erosion by sea, river, or surface water runoff.

The New Zealand Standard NZS 4431 ‘Code of Practice for Earthfill for Residential Development’ provides a means of compliance with Council's requirements for earthfills. The New Zealand Standard NZS 4402 defines and describes the methodology for all tests for fill material.

The New Zealand Standard ‘Methods of Testing Soils for Civil Engineering Purposes’ provides details and methodology for the various tests used to determine the strength of in-situ and constructed soil formations.

Attention is also drawn to the Papakura District Council Document ‘Building Roads on Peat’. This is not to be regarded as a design guide but provides some information as

to past experience on peat formations in the Papakura District. All development on peat formations will require specific design by the developer.

The operative document for earthworks in the District is TP 90, Erosion and Sediment Control. This document requires that "Guidelines for Land Disturbing Activities in the Auckland Region" be adopted by Developers. When the Proposed Regional Plan for Erosion and Sediment Control is adopted the adopted document shall be used.

The Papakura Operative District Plan requires appraisals of the stability and suitability of the land before development consent is given. Many of the requirements in this part of this code will therefore be relevant to the pre-consent stages of a development in particular the clauses covering 'site investigations' and 'planning and design'.

Earthmoving activities are subject to both Regional and District Council approvals. Resource and earthworks consents shall be obtained before commencement of site work.

2.3 TECHNICAL RESPONSIBILITIES

Where any development involves the carrying out of bulk earthworks, the assessment of slope stability, or the detailed evaluation of the suitability of natural ground for the foundations of buildings, roads, services or other works, then a Soils Engineer shall be appointed by the developer to carry out the following functions:

(a) Prior to detailed planning of any development to undertake a site inspection and such investigations of subsurface conditions as may be required to satisfy the requirements of the Papakura District Council District Plan.

(b) Before work commences review the drawings and specifications defining the earthworks proposed and submit a written report to the Engineer on foundation and stability aspects and any proposed departures from this standard.

(c) Before work commences and during construction determine the extent of further specialist Soils Engineering services required (including investigation and geological work).

(d) Before and during construction the Soils Engineer shall:

(i) determine the methods and frequency of construction control tests to be carried out
(ii) determine the reliability of the testing
(iii) evaluate the significance of test results and field inspection
(iv) assess the quality of the finished work.

(e) During construction to provide such regular and sufficient inspections and guidance to ensure that all lots are stable and suitable for their intended purpose, drainage lines are compacted, any uncompacted or unsuitable materials removed, road designs and their construction is based on appropriate soils strength assumptions and the requirements of (f) below are met.

(f) On completion to submit a statement of professional opinion as to suitability of land for building development as shown in Appendix A.

The construction quality control testing shall be carried out by a competent person under the control of the Soils Engineer.

Quality control is defined as "the operational techniques and activities that are used to fulfil requirements for quality", and shall include the provision by the Developer of testing of materials and workmanship in accordance with the project specification.

All sampling and testing shall be undertaken under the supervision of personnel who have signatory authority for such operations from International Accreditation New Zealand (IANZ), and all results shall be submitted through an IANZ Accredited Registered Laboratory. The results shall carry the IANZ marking where applicable.

The Certifying Engineer will be required to ensure compliance with the quality assurance and quality control requirements of the project as specified by the Soils Engineer. All materials sampling and testing shall be carried out under the signatory of an IANZ accredited materials testing laboratory.

2.4 SITE INVESTIGATIONS

2.4.1 Preliminary Site Evaluation

Prior to any detailed planning or design, the developer or Soils Engineer, as applicable, shall undertake a preliminary evaluation of the site to determine the likely requirements for earthworks or the need for further investigations into the suitability of foundation conditions, and the stability of the natural ground. The preliminary evaluations should be carried out in the context of the total surroundings of the site and should not be influenced by details of land tenure, territorial or other boundary considerations.

2.4.2 Specialist Services

Where a Soils Engineer has been appointed as required by Section 2.3, then prior to or at the time of submission of a scheme plan shall submit to Council a written report setting out the particulars of any investigations carried out including details of contours, natural features and modifications proposed thereto; and shall furnish to Council a statement of professional opinion as to the suitability of the land for the proposed development with details of any special conditions that should be imposed.

2.5 PLANNING AND DESIGN

2.5.1 Landform

The final choice of landform should represent the most desirable compromise between the factors referred to above and the preservation of natural features and the natural quality of the landscape including the retention of natural watercourses.

The choice of a suitable landform is dependent on many factors which may be specific to a particular site. In general, unnecessary earthworks should be avoided and every effort made to maintain the natural landform but considerations which may justify the carrying out of earthworks include:

(a) The minimisation of the possibility of damage to property occurring through ground movement in the form of slips, subsidence, creep, erosion or settlement and damage to the land.

(b) The minimisation of the possibility of damage to property occurring through flooding, or surface water runoff.

(c) The development of a more desirable roading pattern with improved accessibility to and within the site and the creation of a better sense of orientation and identity for the area as a whole.

(d) The efficiency of overall land utilisation including the quality of individual sites and amenity areas around buildings, the economics of providing engineering services and the standard of roading and on-site vehicular access.

(e) The need to create suitably graded areas for neighbourhood reserves and other community facilities.

(f) The enhancement of the general environmental character of the area by softening the landscape or by artificially creating or emphasising landforms of visual significance particularly on flat sites or on areas devoid of landscape features.

2.5.2 Soil Investigations

Where appropriate the general nature and shape of the ground shall be studied and particular note taken of:

(a) The geological nature and distribution of soils and rock

(b) Existing and proposed drainage conditions and the likely effects on ground water

(c) Previous history of ground movements in similar soils in the area

(d) Performance of comparable cuts and fills (if any) in adjacent areas.

Soil data should be obtained for areas which:

(a) Are intended to form in situ bases for fills

(b) Are intended to yield material for construction of fills

(c) Are intended to be exposed as permanent batters.

Sufficient borings, probings, or open cuts shall be made to:

(a) Classify the soil strata by field and visual methods

(b) Evaluate the likely extent and variation in depths of the principal soil types

(c) Establish the natural ground water levels.

The soil information thus obtained shall form the basis for:

(a) Further sampling and testing which may be required on representative soil types

(b) Relating subsequent soil test properties to relevant strata over the site.

The appropriate test data in different areas shall be determined by the Soils Engineer.

2.5.3 Stability Criteria

Settlement
The most important factor in ensuring satisfactory performance of stable fills is the limiting of post-construction differential settlement. The design and construction of fills shall be such that these settlements are kept within acceptable limits.

Bearing capacity
The strength of the ground resisting general shear failure (and resulting gross deformation) under the footings of a house is a local phenomenon distinct from settlement. Fill constructed to minimise settlement in accordance with this code will have adequate shear strength.

Shrinkage and expansion
Because some clay soils are likely to undergo shrinkage and swelling when subjected to seasonal or other changes in water content, special examination of swelling and shrinkage characteristics should be made in the case of highly plastic soils. Where peat soils are present in the area of the subdivision then special provisions shall be made to limit drainage of the peat which would lead to shrinkage. Where applicable, the need for a foundation depth or design sufficient to minimise these effects, particularly for continuous brittle walls, should be noted in the completion report and statement of the Soils Engineer.

Slope stability
In most cases, it is unnecessary or impracticable to measure quantitatively the factor of safety of a slope against shear failure. Maximum slopes of cuts and fills may be determined by the Soils Engineer from experience and from observation of slopes in the vicinity which have a long-standing history of stability, are of similar height to the proposed slope and are of apparently similar geological formation. Where necessary or a precedent is not available, a special Soils Engineering investigation should be carried out by the Soils Engineer to determine acceptable limits to cut and fill slopes. In assessing slope stability account should be taken of possible future changes in ground water level or other conditions. Where a fill may be required to act under extreme conditions as a detention dam, investigation should include the ability of the fill to act as a detention dam and upstream effect of the fill.

2.5.4 Quality of Filling Material

The majority of soils, other than organic material, are potentially suitable for fillings under controlled conditions. Compaction standards for fill material are covered in the next clause of this code.

2.5.5 Compaction Standards for Fill Material

As described in NZS 4431, the standard of compaction shall be measured in terms of one of the following:

Relative compaction

That is, the ratio of the field dry density of fill to the maximum (laboratory) dry density expressed as a percentage. Unless otherwise required by the Soils Engineer, fill should be compacted to at least 95% relative compaction, in terms of the standard method of compaction.

Air voids and shear strength

Used for cohesive soils, where specific test methods and criteria should be determined by the Soils Engineer, who may, for example, require air voids to be less than 10% and shear strength to be not less than 50kPa on completion of construction.

Relative density

That is, the field dry density expressed in terms of maximum minimum densities established by laboratory test (used for cohesionless soils). The specific minimum value should be determined by the Soils Engineer who may, for example, require a minimum relative density of 80%. See NZS 4431.

Field relative compaction (field Proctor test)

This is the ratio of the density of the compacted fill material at its in situ moisture content, relative to the density of the same material at the same moisture content after standard compaction (New Zealand Standard compaction) in terms of Test 14 of NZS 4402. (This method gives a quick determination of the actual field compaction effort being applied, relative to New Zealand Standard compaction, without need for drying in the testing procedure and this may be adequate control provided the material is close to optimum moisture content.)

2.5.6 Erosion Control

Development work shall be carried out in such a manner as to restrict soil erosion by water and wind action to acceptable levels.

Before commencing any site works, adequate silt retention structures as detailed in the Auckland Regional Council Technical Publication No. 97 "Erosion and Sediment Control Guidelines for Earthworks", shall be designed to ARC Technical Publication No. 90 and constructed to the satisfaction of ARC Environment, and the Engineer. These structures shall be maintained and cleaned out as necessary until complete grass cover has been re-established over the site to the satisfaction of the Engineer. Earthworks on sites exceeding 1 hectare in area require the specific approval of ARC Environment. Such approval shall be obtained by the developer.

Two copies of the location and details of the silt retention structures, together with a copy of the ARC Environment approval if required, shall be forwarded to the Engineer prior to his giving approval for any earthworks on site.

The discharge of sediment laden runoff from earthworks must comply with the ARC Environment Proposed Regional Plan for Erosion and Sediment Control.
The diversion of natural water is only permitted for those activities listed in the Auckland Regional Council Transitional Plan. All other diversions will require a Water Permit from ARC. The obtaining of, and compliance with, the water permit will be the responsibility of the developer.

Earthworks operations shall be carried out in such a manner that a dust nuisance is not created to adjoining properties.

Stripped areas of the site shall at all times be kept to a minimum and all bare surfaces not to be bulk earthworked for a period of two months or more shall be topsoiled and grassed, or otherwise sealed.

In dry windy conditions haul roads shall be watered and in extreme conditions operations on site shall cease immediately if a dust nuisance to adjoining properties exists.

Without prejudice to the conditions of any water permit the following practices shall be adopted in the planning and design of developments involving earthworks:

(a) Large projects shall be programmed for construction in self-contained stages which can be largely completed within one earthworks season. Where possible, the upper part of a catchment should be developed first.

(b) Where possible, the permanent stormwater system shall be designed so it can be constructed at an early stage in the project and be used to collect runoff from the site during construction in conjunction with silt control measures.

(c) The specifications shall require the use of construction procedures which minimise concentration of runoff and excessive velocities, which could otherwise result in erosion.

(d) Silt retention ponds shall be constructed and maintained in all earthwork projects as required by ARC Environment.

(e) Graded 'V' drains (also called contour drains) shall be used to divert runoff water from non-construction areas past site-works, or to divert runoff from exposed areas into silt retention ponds and reduce overland flow distances on bare surfaces. Such drains should have a maximum slope of 1% and a maximum design velocity of flow of 1 m/s.

(f) Cut and fill areas shall be re-topsoiled and sown as soon as possible after earthworks and drainage works.

(g) The batter faces of cuts and fills shall be protected as soon as possible after construction by grassing, hydroseeding, tree planting, or other suitable surfacing.

(h) Existing shelter belts, wind fences and standing vegetation shall be maintained in order to reduce wind erosion.

2.5.7 Provision for Permanent Services

Where settlement is expected to occur, all service pipes installed within or under earthfilling shall be designed and constructed to ensure adequate capacity, strength and water-tightness to withstand the loads due to settlement and to prevent leakage into the fill.

Where surface water could cause erosion of batters or internal instability through soakage into the soil, open interceptor drains shall be constructed in permanent materials, benches in batter faces shall be sloped back and graded longitudinally to reduce spillage of stormwater over the batter. Water from stormwater systems shall be prevented from flowing into a fill or into natural ground near the top or sides of a fill and no stormwater soak pits shall be constructed in a fill whereby the stability of the fill might be impaired.
All drains required permanently to protect the stability of fillings or to prevent flooding and erosion shall be clearly identified as such on the As-Built drawings.

2.6 CONSTRUCTION PROCEDURES

2.6.1 Specifications

Before any earthworks are commenced, areas of cut and fill shall be clearly defined. Where necessary, sufficient fencing or barriers shall be provided around trees or other features to be protected. All site activities including clearing, storage, cutting and filling must be kept away from the root zone of trees (best defined as the extent of the canopy plus 2m). Adequate provision shall also be made for the control of erosion, surface water runoff and siltation.

Specifications including the following are to be prepared to control the earthwork construction as follows:

(a) All rubbish, vegetation and debris shall be removed from earthworks areas prior to the commencement of topsoil stripping. Areas on which fill is to be placed, or from which cut is to be removed and haul roads shall be stripped of all topsoil and such unsuitable soft or organic material as determined by the Soils Engineer. Special care shall be taken to ensure the organic materials and areas of old uncompacted filling are not overlooked through being overlaid by other soils.

(b) Stripping shall be carried out as a specific operation with areas being stripped in large enough increments to ensure that there is an adequate margin of stripped ground beyond any current cutting or filling operation. Particular care shall be taken to ensure that overspill is not left in an uncompacted state anywhere on the site, when constructing temporary haul roads.

(c) All stripped material shall be deposited in temporary stockpiles or permanent dumps, in locations where there is no possibility of the material being unintentionally covered by, or incorporated into, structural fills.

(d) Where a fill abuts against sloping ground, benches shall be cut into the ground to prevent the development of a continuous surface of low shear strength.

(e) Pervious drains or similar subsoil seepage control systems shall be installed (as necessary) to lead seepage away from all springs and potential areas of ground water under or adjacent to fills in order to -

- Prevent saturation of the fill before construction of the fill is complete;
- Prevent internal erosion (piping); and
- Prevent internal ground water pressures which would detrimentally reduce shear strengths.

(f) Subsoil drains shall discharge via flexible jointed pipes to an outlet approved by the Engineer, preferably a stable watercourse or a piped stormwater system. The position of all subsoil drains shall be recorded on the As-Built plan.

(g) The stripped ground surface shall be prepared and then inspected by the Soils Engineer before any fill is placed thereon.

2.6.2 Fill Construction

The quality of fill material and required control testing shall be determined and specified before the placing of fill commences. Fill shall be placed in a systematic and uniform manner with near horizontal layers of uniform thickness (less than 225 mm) of material being deposited and compacted progressively across the fill area.

Before any loose layer of fill is compacted, the water content shall be suitable for the compaction required and as uniform as possible. Any compacted layer which has deteriorated after an interruption in the earthmoving operation, shall be rectified before further material is placed over it.

Fill batter faces shall be compacted as a separate operation or alternatively, overfilled and cut back.

Where testing shows the compaction achieved in the field to be below the specified minimum, all material represented by the test shall be further compacted or removed as necessary.

2.6.3 Temporary Drainage and Erosion Control

During the construction period, measures shall be taken to prevent excessive water logging of surface materials yet to be to be excavated or compacted or both and to prevent fill material from being eroded and redeposited at lower levels. Such measures shall include:

(a) The surface of fills and cuts shall be graded to prevent ponding.

(b) Temporary drains shall be constructed at the toe of steep slopes to intercept surface runoff and to lead drainage away to a stable watercourse or piped stormwater system.

(c) Surface water shall be prevented from discharging over batter faces by drains formed to intercept surface runoff and discharge via stable channels or pipes, preferably into stable watercourses or piped stormwater systems.

(d) The upper surface of fills shall be compacted with rubber tyred or smooth wheeled plant when rain is impending, or when the site is to be left unattended.

(e) The completed battered surfaces of fills shall be compacted with sheepsfoot or similar non-smooth compaction plant to reduce runoff velocities.

(f) Silt traps and retention ponds shall be constructed where they are feasible and necessary. These shall be cleaned out, as required to ensure that adequate silt storage is maintained.

(g) Temporary barriers or fences choked with brush, sacking or the like, shall be used to reduce flow velocities and to trap silt.

(h) Sections of natural ground shall be left unstripped to act as grass (or other vegetation) filters for runoff from adjacent areas.

(i) All earthwork areas shall be re-topsoiled and grassed or hydroseeded as soon as possible after completion of the earthworks and drainage works.

2.6.4 Inspection and Quality Control

The Soils Engineer shall provide an adequate level of inspection and testing, in order to be able to properly evaluate the general quality of the finished work and to be able to furnish a report as to the compliance of the work with the specifications.

Visual inspection shall be made by the Soils Engineer or a competent inspector acting on their behalf at the following times:

(a) After any part of the existing ground has been finally stripped and prepared and before the placing of any fill on that ground.

(b) Before and after any drain has been installed and at appropriate times as the drain is covered by fill.

(c) At such other times as the Soils Engineer considers necessary to be able to assess the general standard of earthworks and to reasonably satisfy himself/herself that:

- Fill is not placed over soft or organic material
- All areas of existing ground showing seepage or potential seepage have relief drains provided
- Compaction operations are systematic, the water content of fill material is suitable and the degree of compaction is consistently satisfactory
- Unsuitable materials as defined by the Engineer are not being used as fill.

During the construction of earth fills the following quantitative control tests shall be made on fill material:

(a) Tests to determine whether the water content is at optimum

(b) In situ density tests to determine whether the degree of compaction is up to the specified minimum

(c) Where appropriate tests to determine the maximum dry density for the soil tested in each in situ field density test

(d) Such other tests as may be specified by the Soils Engineer for control testing of fills or particular soil types, providing that the soil property tested shall be related to in situ density or water content of the fill by a laboratory investigation. Such tests to include shear strength tests, cone penetrometer tests and Proctor needle tests.

Once the filling work is progressing as a steady operation with uniform compaction methods and provided that -

(a) Adequate compaction effort is being maintained

(b) Adequate visual inspection is being maintained

(c) The specification requirements are being met,

then the minimum frequency of control testing shall generally be one in situ density test (or equivalent) for each 2,000 m³ or 1.0m lift of fill. Testing shall be more frequent than specified above, under any of the following circumstances:

- During the first 4000 m³ of filling carried out on the project.
- On the final layer of not less than 1.0 m depth.
- When soil type or conditions are variable.
- When the Soils Engineer or his inspector is in any doubt about the adequacy of construction methods or soil properties.
- When a decision to reject work based on the judgment of the Soils Engineer or his inspector is disputed.
- When relatively small quantities of fill are concentrated in localised areas or placed discontinuously over a long period of time.

The locations of tests shall be decided by the Soils Engineer or his inspector, who shall select them so as to test the material that is likely to have had the least compaction. In addition, a proportion of tests shall be taken at random locations to check the average standard being obtained.

All field and laboratory test data shall be recorded in a systematic manner that will allow the results to be identified and allow the calculations to be checked at a later date, if necessary. All control test results shall have recorded the time, date, location and elevation. Where work is rejected on the basis of either test results or visual appraisal, the Soils Engineer shall record the extent of the rejected work and the type of remedial work. This information shall be furnished in his report on completion of construction.

2.7 FINAL DOCUMENTATION

2.7.1 As-Built Drawings

On completion of the earthworks an As-Built plan conforming to the requirements of this code (appendix E) of practice shall be prepared. The As-Builts shall include a site plan showing the borelog and test positions and a plan showing the extent of all certified and uncertified fills, the location of any building restriction lines, an extent of the cut and fill contour plan at 1m intervals and the position of all sub-soil drains or other constructed features underground.

2.7.2 Soils Engineer's Report

On completion of construction the Soils Engineer shall furnish for the Engineer two copies of a report together with a statement of professional opinion in the form prescribed in NZS 4431, describing the extent of the inspection and the results of testing together with a statement of professional opinion as to the compliance of the filled ground for specified types of building construction and where applicable, the suitability of original ground for specified types of building construction and that it complies with the relevant rules in the District Plan of the Council and other requirements as may be stipulated in the Resource Consent.

A suitable format for the statement of opinion is included as Appendix A.

2.7.3 Asset Data Standard Specification

A technical specification for the supply of GIS data in electronic format is provided in Appendix E of this code. This data shall be provided at the same time as the As-built drawings, Road Asset Data forms and the Soils Engineer's Report.