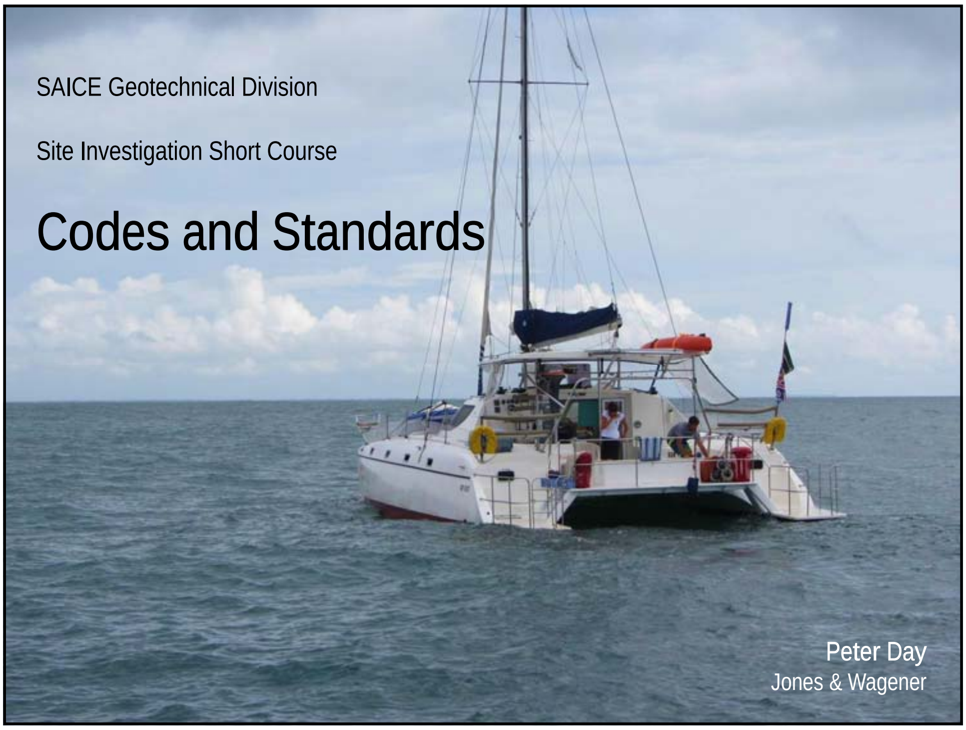
FOUNDATION DESIGN 811

A practical perspective

14: Applicable Codes & Standards

eter Day Site Investigation Codes & Standards

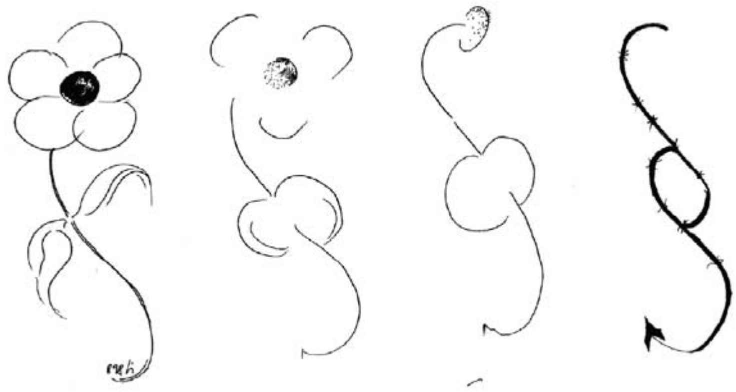


Outline

- Purpose of Codes & Standards
- Applicable Codes, Standards and Legal Requirements
- Status of Codes & Standards
- Requirements of Various Codes & Acts
- Other documents with “code-like” status.

Purpose of Codes

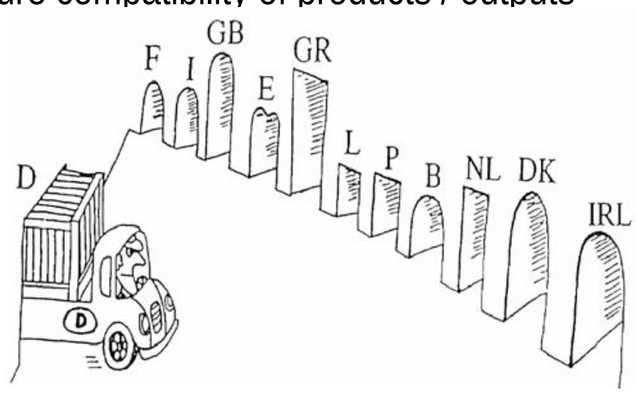
Purpose of Codes



Bernd Schuppener on the evolution of standards

Purpose of Codes

- Lay down minimum requirements
- Ensure compatibility of products / outputs



Courtesy Bernd Schuppener

Purpose of Codes

- Lay down minimum requirements
- Ensure compatibility of products / output
- Provide a uniform basis for pricing
- Protection of the public / consumer
- Statement of acceptable practice

Applicable Codes & Standards

Applicable Codes & Standards

- Safety standards & legal requirements
- Building standards
- Design standards
- Site investigation standards

Applicable Codes & Standards

SAFETY STANDARDS / LEGISLATION:

- OHSA & Construction Regulations 2014
- Mine Safety Act
- SAICE Safety in Trial Holes: 2007

Applicable Codes & Standards

BUILDING STANDARDS:

- National Building Regulations (NBR)
- SANS 10400: Application of NBR
  - 10400-A: General principles
  - 10400-B: Structural design
  - 10400-F: Site operations
  - 10400-H: Foundations
- NHBRC Home Building Manual

Applicable Codes & Standards

DESIGN STANDARDS:

- SANS 10160-5: Basis of Geotechnical Design
- EN 1997-1: Geotechnical Design – General Rules
- SAICE Lateral Support Code 1989

Applicable Codes & Standards

SITE INVESTIGATION STANDARDS:

- SANS 1936-2: Dolomite land – geotechnical investigations
- SANS 633: Soil profiling & chip logging on dolomite land
- SANS 634: Investigations for township development
- SAICE, 2010 Site Investigation Code

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Are standards compulsory ?

All South African standards are “voluntary” standards or statements of acceptable practice

UNLESS...

referenced in legislation

OR:

a contractual requirement.

Are standards compulsory ?

The two main Acts that refer to standards are:

1. National building regulations and building standards act: Act 103 of 1977
2. Housing consumers protection measures act: Act 95 of 1998

Are standards compulsory ?

- NBR applies to:
  - any structure within a given list of uses
  - walls, swimming pools, reservoirs, bridges
  - fuel tanks and fuel pumps
  - any facilities incidental to a building.
- SANS 10400 goes hand-in-hand with NBR
- SANS 10400 refers to SANS 1936.

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Are standards compulsory ?

- Housing Consumers Protection Act:
  - Applies to all residential structures (financed or not)
  - Requires NHBRC to produce a Home Building Manual
  - Makes Manual an integral part of the act (§1(xxxi))
  - Home builders must comply with the manual.

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Outline

- Purpose of Codes & Standards
- Applicable Codes, Standards and Legal Requirements
- Status of Codes & Standards
- Requirements of Various Codes and Acts
- Other documents with code-status.

Safety standards

Safety Standards

APPLICABLE LEGISLATION:

- Compensation for Occupational Injuries and Diseases Act 130/1993
- Mine Health and Safety Act 29/1996
- Occupational Health and Safety Act 85/1993
  - Construction Regulations 2014

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Safety Standards

The Crux:

§8(1): Every Employer shall provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of his employees.

§16(1): CEO to ensure this duty is fulfilled.

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Safety Standards

Reasonably practicable:

OHSA §1(1)(xliii)

Practicable having regard to:

- Severity and scope
- State of knowledge
- Availability of safeguards
- Cost of mitigation
- Benefits vs. risk

Safety Standards

Publications:

- SAICE (2007) The safety of persons working in small diameter shafts and test pits for geotechnical engineering purposes. Code of Practice 2007.
- Day P.W. (2006) Geotechnical Engineers and the Construction Regulations. SAICE Journal No. 4, 2006
- Day P.W. (1996) Geotechnical Engineers and the OSH Act. SAICE Journal, No. 3, 1996.

Safety Standards

- Site investigation practice
- Relevant legislation
- Personnel
- Risk Assessment
- Plant & Equipment
- Procedures
- Emergency Preparedness
- Appendices:
  - Typical Hazards
  - Risk Assessment flowchart
  - Safety Equipment
  - Shoring Systems
  - Gasses

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Building Standards

Building Standards

- National Building Regulations (NBR)
- SANS 10400: Application of NBR
  - 10400-A: General principles
  - 10400-B: Structural design
  - 10400-F: Site operations
  - 10400-H: Foundations
- NHBRC Home Building Manual

These are standards referenced by legislation

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Building Standards

SANS 10400-A: General principles

Definition: Geotechnical site investigation (AZ 2)

process of evaluating the geotechnical character of a site in the context of existing or proposed works or land usage, which may include one or more of the following –

a) evaluation of the geology and hydrogeology;
b) examination of existing geotechnical information;
c) excavating or boring in soil or rock and description of the soil and rock profiles;
d) determining the depth of any fill;
e) in-situ assessment of geotechnical properties;
f) recovery of samples;
g) testing of soil or rock samples;
h) evaluation of geotechnical properties; and
i) reporting the results

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Building Standards

SANS 10400-A: General principles (A19)

Where, in respect of any building:

a) a rational design is required; or

b) a geotechnical investigation is required by Regulation F3;

the owner of the building shall appoint and retain an approved competent person .....

Building Standards

SANS 10400-B: Structural Design

2 Normative References:

The following are indispensible for the application of this Standard:

- SANS 1936-1, *Development of dolomite land – Part 1: General principles and requirements*.
- SANS 1936-2, *Development of dolomite land – Part 2: Geotechnical investigations and determinations*.
- SANS 1936-3, *Development of dolomite land – Part 3: Design and construction of buildings, structures and infrastructure*.
- SANS 1936-4, *Development of dolomite land – Part 4: Risk management*.

Building Standards

SANS 10400-B: Structural Design

4.4 Buildings on Dolomite Land:

Buildings shall not be constructed on dolomite land unless such sites are developed in accordance with the requirements of SANS 1936-1 and

a) competent persons (dolomite land) plan and conduct geotechnical site investigations ..... in accordance with the relevant requirements of SANS 1936-2;

b) competent persons (structures) design buildings in accordance with the relevant requirements of SANS 1936-3;

c) competent persons (civil engineering) design and inspect precautionary measures required on dolomite land ....; and

d) competent persons (dolomite land), develop dolomite risk management strategies in accordance with the requirements of SANS 1936-4.

Invokes SANS 1936 as compulsory standards

Building Standards

SANS 10400-F: Site operations

F3 Geotechnical Site and Environmental Conditions:

(1) Local authority must inform owner of:

- Contaminated land,
- Unstable land
- Land that may cause foundation movements (heave of settlement)

(2) Owner must appoint a competent person to undertake a geotechnical investigation.

Building Standards

SANS 10400-F: Site operations

F3 Geotechnical Site and Environmental Conditions:

(3) Competent Person shall determine:

- whether building should be permitted and under what conditions,
- the magnitude of total and differential foundation movements.

(4) Investigations conducted in terms of 10400-B (for dolomite land) and 10400-H for building foundations are "deemed to satisfy" this regulation.

Building Standards

SANS 10400-G: Excavations

- References SAICE1989 Lateral Support Code
- No investigation requirements

Building Standards

SANS 10400-H: Foundations

2 Normative References

Also references SANS 1936 as indispensible to application of requirements.

3.10 Defines a competent person (geotechnical) as:

- PrSci Nat or PrEng, PrTechEng or PrTechniEng
- with suitable experience in geotechnical investigations and foundation design

3.23 Defines a geotechnical site investigation as in 10400-A

Building Standards

SANS 10400-H: Foundations

4.2 Geotechnical site investigations shall:

- be carried out by a competent person (geotechnical)
- shall classify sites for single and double storey masonry according to site class designations

Building Standards

SANS 10400-H: Foundations

Typical founding material	Nature of founding material	Expected range of total soil movements mm	Assumed differential movement % of total	Site class designation
Rock (excluding mud rocks which might exhibit swelling to some depth)	Stable	Negligible	–	R
Fine-grained soils with moderate to very high plasticity (clays, silty clays, clayey silts and sandy clays)	Expansive soils	< 7,5 7,5 to 15 15 to 30 > 30	50 50 50 50	H H1 H2 H3
Silty sands, clayey sands, sands, sandy and gravelly soils	Compressible and potentially collapsible soils	< 5 5 to 10 > 10	75 75 75	C C1 C2
Fine-grained soils (clayey silts and clayey sands of low plasticity), sands, sandy and gravelly soils	Compressible soils	< 10 10 to 20 > 20	50 50 50	S S1 S2
Contaminated soils[a], controlled fill, dolomite land, landslip, landfill, marshy areas, mine waste fill, mining subsidence reclaimed areas, uncontrolled fill, very soft silts/silty clays	Variable	Variable	–	P[b]

Building Standards

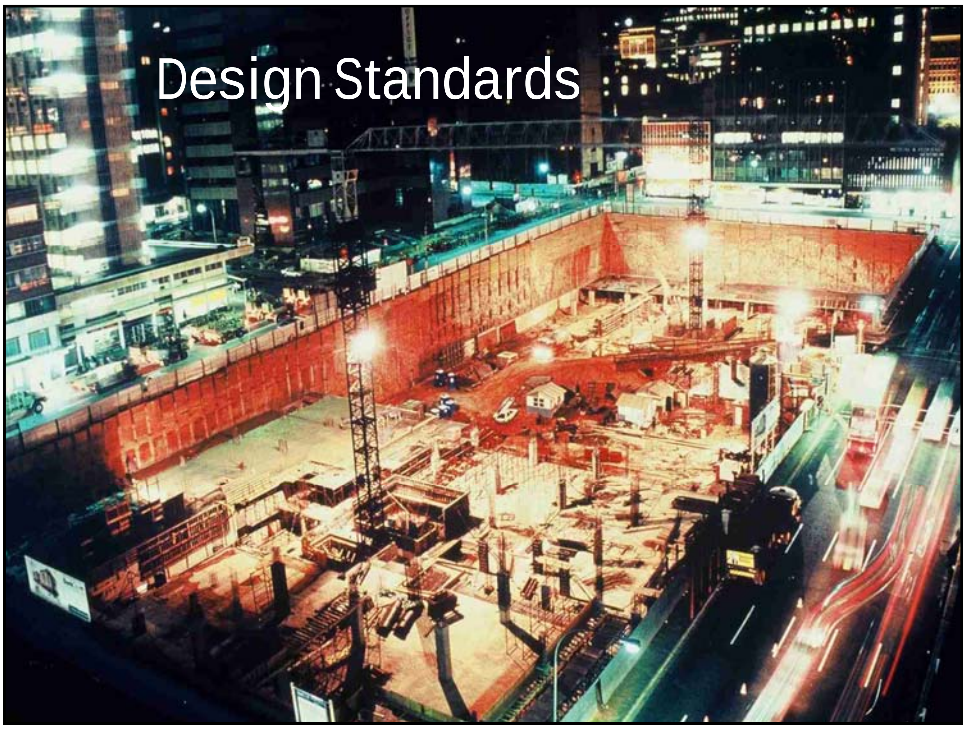
National Home Builders Manual

2.5 Requirements for Geotechnical Investigations and Terracing:

- Home Builder must appoint a competent person to classify site
- same classification system as given in SANS 10400-H.

A word of warning:

NHBRC is now rejecting investigations that do not comply with accepted standards, in particular, the SAICE 2010 code.



Design Standards

- SANS 10160-5: Basis of Geotechnical Design
- SANS 207: Reinforced soils and fills
- EN 1997-1: Geotechnical Design
- SAICE Lateral Support Code 1989

These are voluntary standards

SAICE Geotechnical Division | Peter Day | Site Investigation Codes & Standards

Design Standards

SANS 10160-5: Basis of Geotechnical Design

6.1 Geotechnical Investigations

- Investigations <u>shall be carried out</u>, and shall:
  - provide sufficient data on ground and groundwater
  - proper description of the soil profile
  - assessment of likely behaviour of ground
  - assessment of reliability of parameters to be used in design
  - provide quantitative data except for category 1 structures
  - give sufficient information for deviations form expected conditions to be recognised during construction
  - be commensurate with geotechnical category of structure

Design Standards

SANS 10160-5: Basis of Geotechnical Design

6.2 Ground properties selected for design shall:

- Be obtained from lab or field tests, theory, empiricism, relevant data
- Take account of:
  - differences between test results and in situ conditions
  - level of stress and strain and mode of deformation
  - effect of soil or rock fabric
  - the rate of loading and pore water pressure dissipation.

Design Standards

EN 1997-1: Geotechnical Design – General Rules

3.2.1 General

- Much the same as SANS 10160-5.

3.2.2 & 3.2.3 Investigations

- Gives requirements for preliminary and design investigations

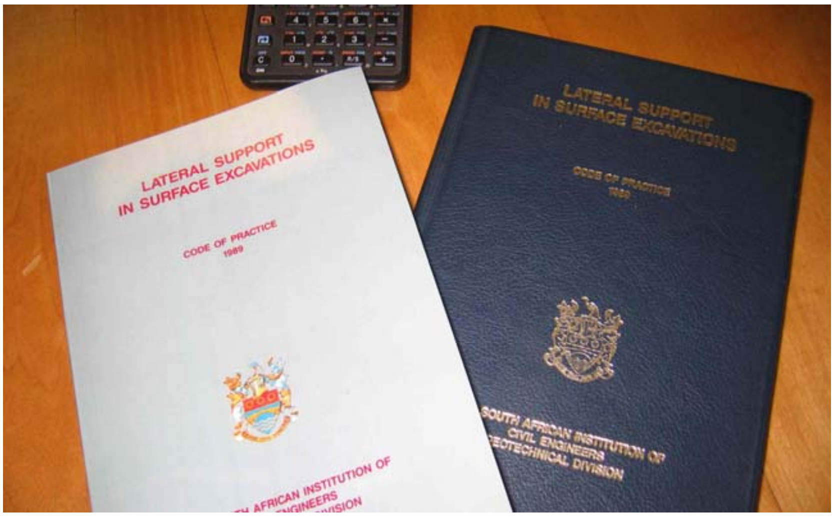
3.3 Evaluation of Parameters

- Provides requirements for assessing various parameters

3.4 Reporting

- Provides requirements for presentation and evaluation of data

Design Standards



Design Standards

Lateral Support Code 1989

- Chapter 2 – Site Investigation
  - Objectives and planning
  - Desk study & preliminary fieldwork
  - Detailed field and laboratory investigation
  - Existing structures and services
  - Reports

Design Standards

Chapter 2 – Site Investigation

- Quantification of parameters required
- Must extend beyond the plan area of works
- Investigate to 2x depth or stable stratum
- Gives guidance of lab and field tests (App B)
- Verification and further investigation / monitoring during construction
- Advice on reporting

Design Standards

Appendix B – Laboratory and Field Tests

TABLE B.1 LABORATORY TESTS ON SOILS *Continued*

TEST	MATERIAL	SAMPLE TYPE	REMARKS	REFERENCE
Triaxial Compression				
(a) Undrained unconsolidated	Saturated, normally consolidated clays	U	Undrained shear strength (c_u; $\phi = 0$). Short term stability and anchor behaviour under rapid loading with fissured clays, sample size may have significant effect.	Akroyd (1957) Bishop & Henkel (1957) Marsland (1971)
	Saturated, overconsolidated/fissured clays	U		
(b) Consolidated undrained with p.w.p measurements	Saturated, normally consolidated clays.	U	Effective strength parameters (c'; ϕ')	Bishop & Henkel (1957) Akroyd (1957)
	Partially saturated clays (soaked)	U	Long term stability.	
(c) Consolidated drained	Clayey sands, sandy clays, silts	U	Effective strength parameters (c'; ϕ') Long term stability.	Bishop & Henkel (1957) Akroyd (1957)
	Partially saturated clays (soaked)	U		

Design Standards

Appendix B – Laboratory and Field Tests

TABLE B.2 FIELD TESTS *Continued*

TEST	APPLICABILITY	REMARKS	REFERENCE
Packer Tests	Generally applied to rocks and clayey soils	Test measures the acceptance of the in situ rock of water under pressure between packers inserted in the hole. Used to assess the grout acceptance of the rock or to check the effectiveness of grouting.	SAICE & NITRR (1978) Lugeon (1933) Ervin (1983)
Pumping Tests	Soils or rocks below W.T.	Involves pumping at a steady known flow and observing the drawdown in observation wells at various distances from the pumped well. Gives permeability of in situ material.	SAICE & NITRR (1978) Lugeon (1933) Ervin (1983)
Piezometer	All soils and rocks	Used to determine ground water pressure at various depths in the ground. In permeable ground, standpipe piezometers are used but in impermeable conditions or where rapid response is required, hydraulic, pneumatic or electric piezometers are used.	SAICE & NITRR (1978) BS 5930 (1981) Penman (1960)
Vane Shear Test	Saturated cohesive soils	Normally restricted to saturated clays with an undrained shear strength of less than 100 kPa. This method can give peak and residual undrained shear strengths.	SAICE & NITRR (1978) BS 5930 (1981) Ervin (1983)
Plate Bearing Test	Most soils and soft rocks. Generally above W.T.	Test performed in trench or auger hole by jacking circular plates against the soil/rock. May be carried out horizontally (across width of hole) or vertically (jacking against a kentledge). Size of plate depends on hole size and stiffness of material – generally 75-300mm for horizontal tests and 200-1 000mm for vertical tests.	Ervin (1983) Wrench (1984)
Test Anchors (Proving test anchors)	All soils and rocks	Where the size of the project permits, test anchors may be installed during the investigation stage. The purpose of these tests is to assess the suitability and load capacity of the selected anchor type(s). See 6.7.2	BS 8081 (1989) Littlejohn (1981)

Design Standards

Appendix B – Laboratory and Field Tests

TABLE B.3 LABORATORY TESTS ON ROCKS

TEST	MATERIAL	SAMPLE TYPE	REMARKS	REFERENCE
Moisture Content Bulk Density Porosity	All rocks	C/L	Gives some indication of strength, modulus of elasticity and degree of weathering	Int. Soc. Rock Mech. (1979)
Thin Section	Intact rock	C/L	Microscopic examination of minerals present. Gives indication of behaviour weathering and drillability.	Williams et al (1954)
X-ray Diffraction	Any rock or soil	L	Gives quantitive information on minerals present. Gives indication of behaviour weathering and drillability. Particularly useful for swelling rocks.	
Slake Durability Test	Mainly argillaceous rocks	L	Slake durability index indicates rate of breakdown under varying moisture content conditions.	Franklin & Chandra (1972) Hoek (1977)
Swelling Test	Mainly argillaceous rocks	C/L	Indicate moisture sensitivity of rock and possible pressures on rigid support work.	Duncan et al (1968)
Point Load Test	Isotropic rocks	C/L	Quick and cheap indicator of rock strength. Useful aid to core logging.	Hoek (1977) Broch & Franklin (1972)
Uniaxial Compression Test	Most rocks which can be cored	C	Strength of intact rock. Upper limit for jointed rock mass strength. Widely used for predicting bearing capacity and skin friction. Gives elastic properties of "intact" rock core. This will overestimate modulus of jointed rock.	Hoek (1977) Hawkes & Mellor (1970) Clark (1966)

SAICE Geotechnical Division　　Peter Day　　Site Investigation Codes & Standards

Site Investigation Standards

Site Investigation Standards

- SANS 1936-2: Dolomite land – geotechnical investigations
- SANS 633: Soil profiling and chip logging on dolomite land
- SANS 634: Investigations for township development
- SAICE Site Investigation Code: 2010

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Site Investigation Standards

SAICE Site Investigation Code: 2010

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Site Investigation Standards

SAICE Site Investigation Code: 2010

Site Investigation Standards

SAICE Site Investigation Code: 2010

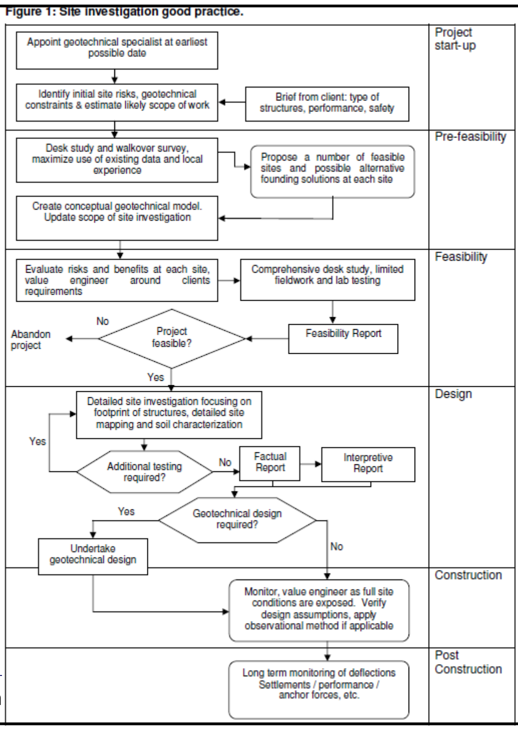
- Purpose
  - Set down standards of good practice
  - Give guidance to geotechnical practitioners
  - Assist Clients in specifying and procuring investigation services.

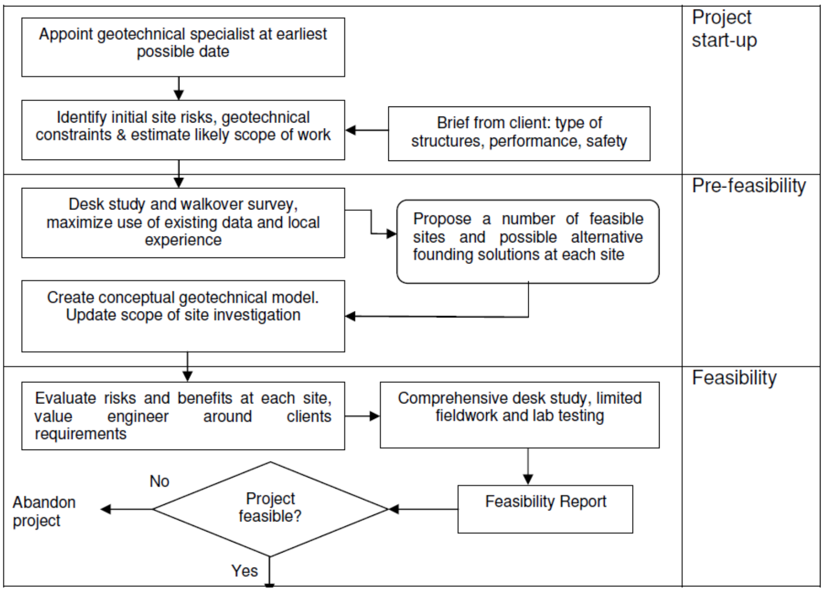
Site Investigation Standards

SAICE Site Investigation Code: 2010

- Contents
  - Planning
  - Procurement
  - Execution
  - Reporting
  - Verification during Construction
  - Bibliography

Figure 1: Site investigation good practice.





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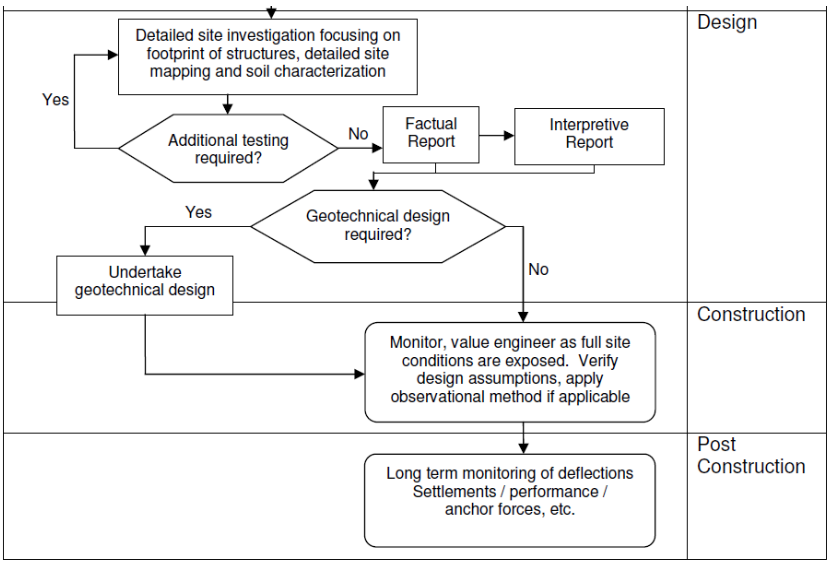

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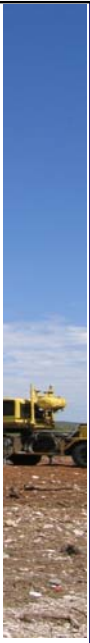

Table 1: Typical guidelines for various stages of site investigation

Category	Development	Phase	Data points	Special Considerations
Compact	Building (Brick or Concrete)	Feasibility	1 per structure	
		Design	3 per structure	Settlement sensitivity of finishes
	Factory (Steel Frame)	Feasibility	2 per ha	
		Design	4 per ha or 4 per structure	Crane & floor requirements
	Quarry or Borrow Pit	Feasibility	1 per 5ha	
		Design	2 per 1ha	
	Tower or Mast	Feasibility	1 per structure	
		Design	1 per 25m^2	
	Reservoir	Feasibility	1 per structure	
		Design	1 per 100m^2	
	Bridge	Feasibility	1 per abutment	
		Design	2 per abutment 1 per pier	
	Substation	Feasibility	2 per ha	
		Design	4 per ha	
Linear	Pipeline	Feasibility	1 per km	
		Design	4 per km	
	Road/Rail/Conveyor	Feasibility	2 per km	
		Design	5 per km	
	Canal	Feasibility	1 per km	
		Design	4 per km	
	Power Transmission	Feasibility	1 per km	
		Design	4 per km	
	Tunnels	Feasibility	2 per km	
		Design	5 per km	
Large	Housing Complex	Feasibility	1 per ha or 1 per structure	GFSH & NHBRC requirements SANS10400 SAICE Code of Practice Van Rooy & Stiff (2001)
		Design	2 per structure	
	Harbour	Feasibility	1 per 5ha	
		Design	4 per ha or 5 per structure	
	Airport	Feasibility	1 per 10ha	
		Design	1 per ha or 5 per structure	

Typical parameters from a geotechnical investigation will include the following:

Classification: Soil

- Grading properties (75mm to 2μm)
- Atterberg limits
- Maximum compacted density and optimum moisture content
- California bearing ratio
- Corrosivity
- Erodibility

Classification: Rock

- Unconfined compressive strength
- Joint characteristics
- Rock mass classification

Characterisation - State

- Specific gravity
- In-situ density & moisture content (void ratio)
- Permeability
- Collapsibility, heave and swell potential

Characterisation - Strength and Compressibility

- Shear strength
- Compressibility
- Consolidation and creep properties

Cost of Investigation

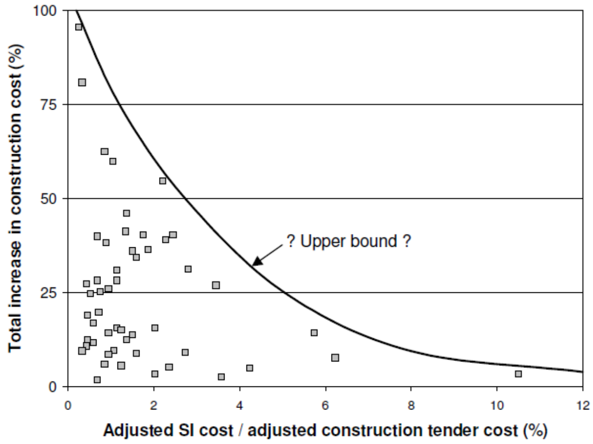

Figure 2: Cost overruns as a function of expenditure on site investigations for United Kingdom highway projects (Mott MacDonald and Soil Mechanics Ltd, 1994)

Cost of Investigation

Table 2: Site investigation costs as a percentage of project costs

Type of Work	% of capital cost of works	% of earthworks and foundation costs
Earth dams	0,9 - 3,3	1,1 - 5,2
Embankments	0,1 - 0,2	0,2
Docks	0,2 - 0,5	0,4 - 1,7
Bridges	0,1 - 0,5	0,3 - 1,3
Buildings	0,1 - 0,2	0,50- 2,0
Roads	0,2 - 1,6	1,6 - 5,7
Railways	0,6 - 2,0	3,5
Overall mean	**0,7**	**1,5**

Site Investigation Standards

SAICE Site Investigation Code: 2010

- Procurement of a Geotechnical Investigation
  - Sole source
  - Solicited proposals
  - Competitive tender

Site Investigation Standards

SAICE Site Investigation Code: 2010

- Selection Criteria for Consultants
  - Professional competence
  - Knowledge and experience
  - Adequacy of scope of investigation
  - Cost
  - Disclaimers
  - PI Cover
  - Programme & resources
  - BBBEE

Site Investigation Standards

SAICE Site Investigation Code: 2010

- Forms of Contract

New Engineering Contract: The Professional Services Contract, Third Edition, June 2005. Institution of Civil Engineers, London. Thomas Telford Limited, London.

FIDIC Client - Consultant Model Service Agreement, Fourth Edition, 2006. International Federation of Consulting Engineers, Paris.

CIDB Standard Professional Services Contract, Second Edition, September 2005. Construction Industry Development Board, Pretoria.

SAACE Form of Agreement for Consulting Engineer Services, July 2003. Consulting Engineers South Africa (CESA), Johannesburg.

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Site Investigation Standards

SAICE Site Investigation Code: 2010

- Remuneration methods
  - Time and Cost
  - Lump sum
  - Percentage fee

SAICE Geotechnical Division Peter Day Site Investigation Codes & Standards

Site Investigation Standards

SAICE Site Investigation Code: 2010

- Execution
  - Investigation stages
  - Field investigation methods
  - Field trials
  - Laboratory testing
  - Supervision & Quality control
  - Specialised investigations

Site Investigation Standards

SAICE Site Investigation Code: 2010

- Reporting
  - Factual information
  - Interpreted information
  - Additional work
  - Investigation during construction
  - QA and Document Control

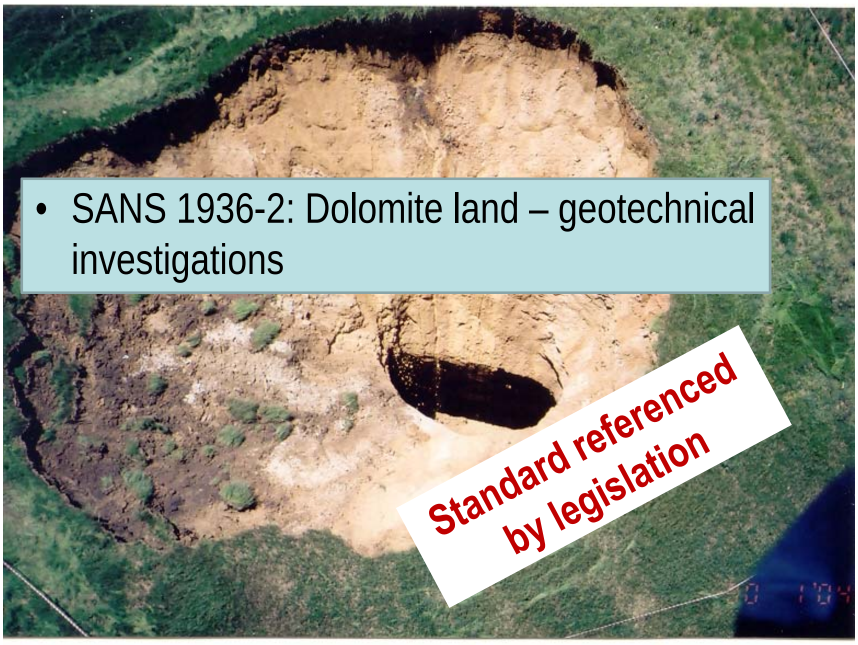
of Practice

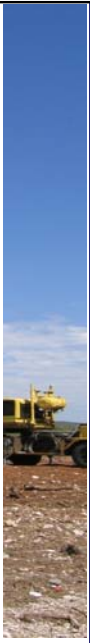
The Geotechnical Division of SAICE

Essential Reading !!

Site Investigation

Code of Practice





Site Investigation Standards

SANS 1936-2: Site Investigation on Dolomite

- Objective (4.1.1)
  - Identification and quantification of hazard
  - Determination of inherent hazard class
  - Dolomite area designation
  - Selection of appropriate design methods
  - Determination of precautionary measures
  - Determine risk management procedures

Site Investigation Standards

SANS 1936-2: Site Investigation on Dolomite

- Feasibility-level investigation (4.2)
  - Basic assessment of geology and site history
  - Gravity survey and borehole drilling
  - Geotechnical model (bedrock, overburden, groundwater)
  - Determination of Inherent Hazard Classs
  - Reporting

Site Investigation Standards

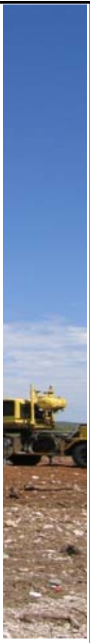
SANS 1936-2: Site Investigation on Dolomite

- Design-level investigation (4.3)
  - Includes footprint investigation
  - Additional work indicated by Feasibility-level Investigation
  - Additional work for a particular development
  - Additional work for design purposes.

Site Investigation Standards

SANS 1936-2: Site Investigation on Dolomite

- Investigation during installation of services (4.4)
  - Establish formal inspection procedure
  - Inspect service trenches to verify zoning
  - Investigate paleao-structures
  - Undertake additional investigation where necessary
  - Confirm or refine inherent hazard class.



Site Investigation Standards

SANS 1936-2: Site Investigation on Dolomite

- Geophysical Surveys (4.2.2)
  - Gravity survey required
  - Grid not specified
  - 0,01 mGal resolution, 0,1 m Gal contours
  - Other methods can also be used:
    - electromagnetic
    - resistivite
    - seismic, etc.

Site Investigation Standards

SANS 1936-2: Site Investigation on Dolomite

- Borehole drilling (4.2.3)
  - Down-the-hole rotary percussion methods
  - Positioned according to gravity map
  - At least 6m into solid dolomite.
  - 15m into non-dolomite rock with selection of holes 6m in dolomite
  - In deep dolomite, drill to rock on gravity highs with shallower holes in-between
  - Backfill all holes to prevent preferential water ingress.

Site Investigation Standards

SANS 1936-2: Site Investigation on Dolomite

- Borehole drilling (4.2.3)

Table 1 — Minimum frequency of boreholes in dolomite areas for a feasibility-level investigation

1	2
Study area ha	**Minimum number of holes per hectare**
≤ 1,0	3
> 1,0 but ≤ 2,5	2
>	1
> 1	0,5
> 5	0,3
> 10	0,2
	,15
NOTE The freque … holes required. Th … adopting a frequenc …	… the minimum number of … compelling reasons for

$$n = \frac{3 \cdot \mathrm{Area}(\mathrm{ha})}{\sqrt{\mathrm{area}(\mathrm{ha})}}$$

Site Investigation Standards

SANS 1936-2: Site Investigation on Dolomite

- Inherent Hazard Classification (4.5)
  - Code allows for Rational Assessment based on geotechnical model (Annex C)
  - Scenario supposition method given in Annex B

Site Investigation Standards

SANS 1936-2: Site Investigation on Dolomite

1	2	3	4	5	6
Inherent hazard class	Statistical occurrences of sinkholes and subsidences				
	Small sinkhole	Medium sinkhole	Large sinkhole	Very large sinkhole	Subsidence
	< 2 m	2 m to 5 m	5 m to 15 m	> 15 m	
1	Low	Low	Low	Low	Low
2	Medium	Low	Low	Low	Medium
3	Medium	Medium	Low	Low	Medium
4	Medium	Medium	Medium	Low	Medium
5	High	Low	Low	Low	High
6	High	High	Low	Low	High
7	High	High	High	Low	High
8	High	High	High	High	High

NOTE The statistical occurrence of the event/hectare over a 20-year period is in the following ranges:

– low: 0 ≤ 0,1 (return period is greater than 200 years)

– medium: > 0,1 ≤ 1,0 (return period is between 200 and 20 years)

– high: > 1,0 (return period is less than 20 years)

Site Investigation Standards

SANS 1936-2: Site Investigation on Dolomite

SANS 1936 is not perfect – it can be improved

Code due for revision in 5 years

Up to the profession to work with SABS to improve code

Need a dolomite seminar to thrash out issues.

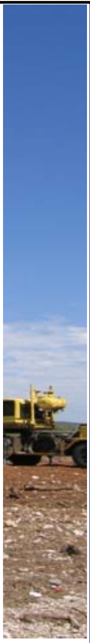
Site Investigation Standards

- SANS 1936-2: Dolomite land – geotechnical investigations
- SANS 633: Soil profiling and chip logging on dolomite land
- SANS 634: Investigations for township development
- SAICE Site Investigation Code: 2010

Site Investigation Standards

SANS 633: Soil profiling and chip logging

- Originally written as a code on soil profiling and borehole logging
- Fell well short of this mark!
- Changed to chip logging and profiling
  ON DOLOMITE LAND as a compromise.



Site Investigation Standards

- SANS 1936-2: Dolomite land – geotechnical investigations
- SANS 633: Soil profiling and chip logging on dolomite land
- SANS 634: Investigations for township development
- SAICE Site Investigation Code: 2010

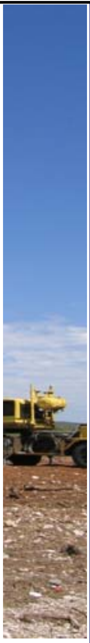
Site Investigation Standards

SANS 634: Investigations for Township Dev.

Sets our a 3-phase approach for investigation of undeveloped land for township development purposes

- Preliminary investigation (4.2)
- Phase 1 detailed investigation (4.3)
- Phase 2 detailed investigation (4.4)

SAICE Geotechnical Division Peter Day Site Investigation Codes & Standards



Site Investigation Standards

SANS 634: Investigations for Township Dev.

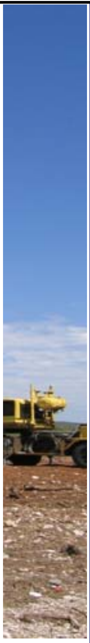
- Preliminary Investigation: (4.2)
  - Desk study
    - geology and geohydrology
    - mining
    - topography
    - terrain units (photo interpretation)
    - existing reports
    - seismicity
  - Identification of restraints
  - Reporting

Site Investigation Standards

SANS 634: Investigations for Township Dev.

Table 1 — Geotechnical constraints in urban development

1	2	3	4	5
Constraint		**Descriptor**		
Letter	**Description**	**1 (most favourable)**	**2 (intermediate)**	**3 (least favourable)**
A	Collapsible soil	Any collapsible horizon or consecutive horizons totalling a depth of less than 750 mm in thickness[a]	Any collapsible horizon or consecutive horizons with a depth of more than 750 mm in thickness	A "least favourable" situation for this constraint does not occur
B	Seepage	Permanent or perched water table more than 1,5 m below ground surface	Permanent or perched water table less than 1,5 m below ground surface	Swamps and marshes
C	Active soil	Low soil-heave potential anticipated[a]	Moderate soil-heave potential anticipated	High soil-heave potential anticipated
D	Highly compressible soil	Low soil compressibility anticipated[a]	Moderate soil compressibility anticipated	High soil compressibility anticipated
E	Erodability of soil	Low	Intermediate	High
F	Difficulty of excavation to 1,5 m depth	Scattered or occasional boulders less than 10 % of the total volume[a]	Rock or hardpan pedocretes between 10 % and 40 % of the total volume	Rock or hardpan pedocretes more than 40 % of the total volume
G	Undermined ground	Undermining at a depth greater than 200 m below surface (except where total extraction mining has not occurred)	Old undermined areas to a depth of 200 m below surface where stope closure has ceased	Mining within less than 200 m of surface or where total extraction mining has taken place



Site Investigation Standards

SANS 634: Investigations for Township Dev.

- Phase 1 Detailed Investigation: (4.3)
  - Near surface investigations
  - Dolomite investigation (where appropriate)
  - Field and laboratory testing
  - Identification/quantification of geotechnical constraints
  - Classification of excavation characteristics
  - Reporting

Site Investigation Standards

SANS 634: Investigations for Township Dev.

Table 3 — Minimum frequency of exploratory holes in near surface soil horizons

1	2
Study area ha	**Minimum number of holes per hectare**
≤ 1,0	4
> 1,0 ≤ 2,0	3
> 2,0 ≤ 4,0	2
> 4,0 ≤ 6,0	1,5
> 6,0 ≤ 10,0	1
> 10,0 ≤ 100,0	0,5
> 100 ≤ 500	0,35
> 500	0,3

Site Investigation Standards

SANS 634: Investigations for Township Dev.

Table 4 — Minimum test samples for different sizes of study areas

1	2	3	4
Study area ha	**Minimum number of test samples**		
	Foundation indicator	**Consolidometer/ swell**[a]	**Chemistry** (see 4.3.2.2)
< 5	3	2	2
> 5 ≤ 10	4	3	2
> 11 ≤ 20	6	4	3
> 21 ≤ 50	10	5	5
> 51 ≤ 100	15	6	10
> 101 ≤ 200	20	10	10
> 201 to 500	50	20	10

[a] When physically feasible

SAICE Geotechnical Division   Peter Day   Site Investigation Codes & Standards

Site Investigation Standards

SANS 634: Investigations for Township Dev.

Table 5 — Classification of material for machine excavation

1	2	3
Excavation	**Classification**	**Description**
Restricted	Soft	Material which can be efficiently removed by a back-acting excavator of flywheel power > 0,10 kW for each millimetre of tined bucket width.
	Intermediate	Material which can be removed by a back-acting excavator of flywheel power > 0,10 kW for each millimetre of tined bucket width, or with the use of pneumatic tools, before removal by a machine capable of removing soft material.
	Hard rock	Material that cannot be removed without blasting or wedging and splitting.
Non-restricted	Soft	Material which can be efficiently removed or loaded, without prior ripping, by any of the following: a) a bulldozer or a track-type front-end loader with an approximate mass of 22 tonnes and 145 kW flywheel power. b) a tractor-scraper unit with an approximate mass of 28 tonnes and 245 kW flywheel power, pushed during loading by a bulldozer equivalent to that described in (a) above.
	Intermediate	Material that can be efficiently ripped by a bulldozer with an approximate mass of 35 tonnes and 220 kW flywheel power.
	Hard rock	Material that cannot be efficiently ripped by a bulldozer with an

SAICE Geotechnical Division   Peter Day   Site Investigation Codes & Standards

Site Investigation Standards

SANS 634: Investigations for Township Dev.

- Phase 2 Detailed Investigation: (4.4)
  - Inspection during installation of services
    - Establish formal procedure
    - Observe and record soil profiles
    - undertake additional investigation / sampling if required
    - confirm / amend findings of Phase 1 detailed investigation
  - Reporting

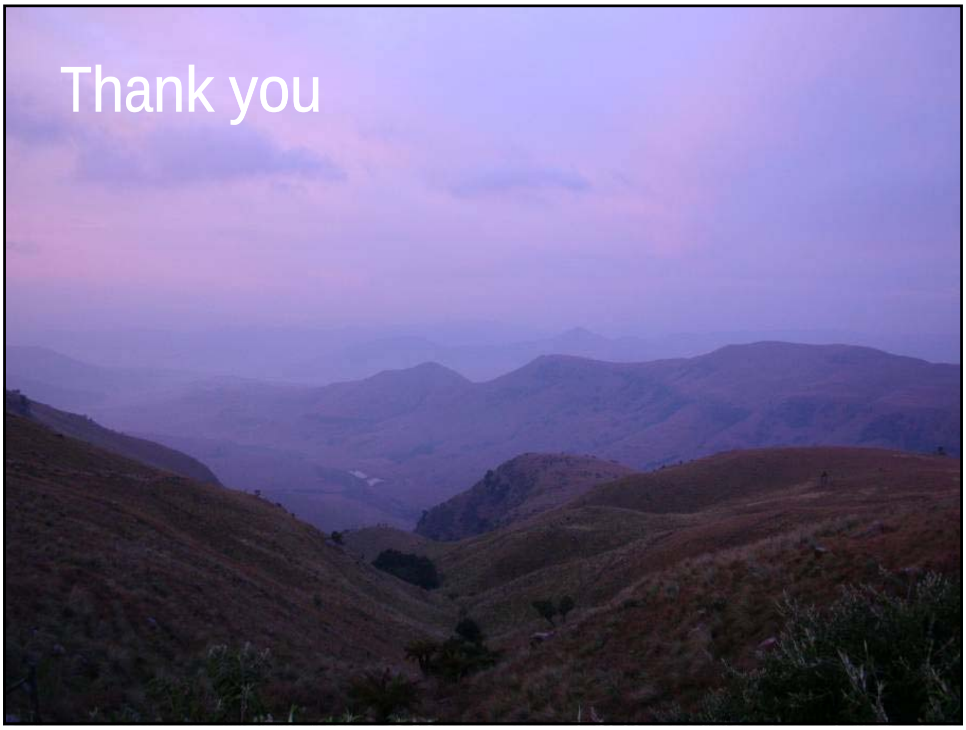
Site Investigation Standards

SANS 634: Investigations for Township Dev.

Contains most of the requirements of GFSH-2.

Other “code-status” documents

- Jennings, Brink and Williams
  - Jennings J.E., Brink A.B.A. and Williams A.A.B. (1973) Revised Guide to Soil Profiling for Civil Engineering Purposes in South Africa. The Civil Engineer in South Africa, January 1973.
- Brink & Bruin
  - Brink A.B.A. and Bruin R.M.H. (eds) (1990) Guidelines for Soil and Rock Logging in South Africa, 2nd Impression 2002. Proc. Geoterminology Workshop. SAIEG - AEG - SAICE 1990.
- SA AEG
  - S.A. Section of the Association of Engineering Geologists. (1976) A Guide to Core Logging for Rock Engineering. Symposium on Exploration for Rock Engineering, Johannesburg, November 1976.


Thank you