Site Assessment and Feasibility Study of the Nubarashen Burial Site of Obsolete and Banned Pesticides in Nubarashen, Armenia

Contract № ARM/01/2013

Phase 1 and 2 investigation report

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Responsibility

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Executive Summary

The fenced landfill site at Nubareshen, comprising of a landfill body and surrounding land, is 0.85 hectares large. The landfill body is enclosed at three sides by concrete runoff drains made out of prefab elements. At several places the drains are tunnelled by runoff water and drain elements are dislocated due to lateral mass movements, leaving open joints between the elements. Two 1 m deep trenches of approximately 18x1.5 m, collecting runoff water with sediments, are located 10 m down slope from the landfill body. The landfill body itself is one trench covered by a hillock of approximately 0.15 hectare (1.5 m high and 104x15 m). The topsoil of the fenced area is heavily contaminated with pesticides till a depth of 0.5 m; the surface area is around 0.7 hectare. The in-situ volume of the surrounding contaminated top soil is estimated at around 3,500 m^3. The landfill body has a relatively clean (DDT concentrations below or just above the Dutch I-value) 40 cm top cover of clay lying on top of a 2 mm ruberoid liner. The estimated in-situ volume of this top cover is around 600 m^3. Traces of pesticides, remains of packaging materials and erosion features are observed in the top cover. Below this liner is a 0.5 m soil layer, covering the dumped pesticides. From archives it is known that 512 ton of pesticide waste supposedly was dumped in the Nubarashen landfill. Based on the assessment of all field data it is assumed that the layer of dumped pesticides in the trench on average is 1.7 m deep, and covers an estimated area of 80 x 8 m. The estimated in-situ volume of the soil cover of the dumped pesticides is around 1,100 m^3 and the estimated in-situ volume of dumped pesticides is on an average around 1,200 m^3. The estimated in-situ volume of contaminated soil (soil in contact with the dumped pesticides in the trench) is estimated at around 75 m^3. The groundwater and the surface water downstream the landfill site is not impacted by the contaminants present at the landfill site.

A pond and a dirt road with (probably leaking) water main are located uphill from the landfill site. The water main is blocking the natural drainage pathway of the uphill catchment area which results in standing water (pond). A blocked culvert installed under this dirt road drains (very slowly) the runoff water when the water level in the pond is higher than the water main and the water from the leaking water main. The water in the pond and the water from the leaking water main infiltrate in the soil and percolates laterally in the catchment area of the landfill. This is causing extra water to accumulate in the active landslide body above the landfill site. Slope movement upstream of the landfill site is the mechanism behind the observed mass movement at the landfill site and its surrounding area. The stability of the upstream area of the landfill site is influenced by the perched ground water levels. By lowering the perched ground water table by reducing the influx of water into the slope, the stability of the landslide will improve.

A Tier 2 risk assessment concluded that only the people entering/ working at the landfill site and a buffer zone of 100 m around the landfill site have direct contact risk with the contaminated soil.

Direct contact can be avoided when proper personal protective equipment is used when entering the buffer zone and site. The fence has to be maintained to prevent animals and unauthorized people to enter the site. Warning signs, warning trespasses for the risk when entering the buffer zone and/or the site have to be installed. The other possible receptor pass way are the air born contaminated fine soil particles, however direct severe impact is currently not expected.
The receptor pathways of runoff water and percolating rainwater are not established.

Before the best site rehabilitation option can be selected the estimated volume of dumped waste has to be confirmed with an additional site survey revealing the actual depth, length and width of the trench with the dumped waste. This additional survey will be carried out be installing around 36 - 40 boreholes in a longitudinal and four cross section of the landfill body.

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1 Introduction

1.1 General

The Nubarashen landfill was used mid-1970's as a disposal site for Persistent Organic Pollutants (referred to as POPs), Obsolete Pesticides (referred to as OPs), and other chemicals and is located in a valley subject to severe erosion processes (gully, sheet and landslides). A small village comprising summer cottages is located around one kilometre down slope from the burial site, and two other villages (Verin Jrashen and Mushavan) are also located in the area at around four km distance.
Although a drainage system and fencing were implemented around the site in 2004, these safeguarding measures were not maintained. Illegal excavation activities in March 2010 left the upper cover of the burial site completely damaged.
The Government of Armenia (GoA) has set up the Emergency Working Group led by the Ministry of Emergency Situations (MoES) in July 2010. Around USD 100,000 has been allocated from a special fund for an ad hoc closure. However, the risks still exist and the GoA through the MoES therefore decided with the funds of the Organization for Security and Co-operation in Europe (OSCE) to perform investigations and a feasibility study supporting the selection of a long term sustainable solution for the elimination of risks for the OPs and POPs waste at the landfill. In addition, a review of the health situation will be made, in order to assess which steps have to be taken on the health issues.

The Request for proposal for this investigations and a feasibility study was published in June 2012. The contract for this assignment (**Contract no ARM/01/2013**) was signed between the OSCE and Tauw on January 2013.
An overall Health & Safety (H&S) Plan was written shortly after the OSCE order to Tauw.
This **H&S Plan Site Assessment and Feasibility Study of the Persistent Organic Pollutants (POP) and Obsolete Pesticides (OP) Burial Site in Nubarashen, Armenia**, with the Tauw Reference **R001-1210169BFF-beb-V03-NL**, was issued on 25 February 2013. This H&S Plan is one of the first deliverables of this project.
The inception mission took place between 18 and 28 of February 2013. The **Final Inception Report** with the Tauw Reference **R002-1210169BKT-beb-V04-NL** was issued on 15 April 2013. This Inception report is also one of the first deliverables of this OSCE project. This document concerns the Phase 1 and Phase 2 report and is the next deliverable of this OSCE project.

1.2 Objectives

1.2.1 Introduction

The overall objective of the assessment and feasibility study is to provide a structured framework for a comprehensive site rehabilitation plan mitigating the environmental site risks. The result of the investigation will be an overview of the horizontal and vertical extent of the landfill, the environmental soil and groundwater quality and the identification of migration pathways and potential receptors.
To reach this objective the assessment and feasibility study is split in three project phases. Phase 1 is the initial site assessment; Phase 2 is the detailed site assessment and Phase 3 concerns the comprehensive site rehabilitation plan mitigating the environmental site risks.
This report elaborates on the results of Phase 1 and 2. After Phase 1 and 2 are completed the best option for the site rehabilitation, Phase 3, can be selected. Phase 3 will be reported in a separate report.

1.2.2 Phase 1 initial site assessment

Phase 1 contains the following three main tasks:
- Health and safety planning
- Start up stakeholder involvement
- Verification design of landfill location and construction

The H&S planning, which is a project cross cutting issue, is addressed in the earlier mentioned H&S Plan and reference is made to this project report for H&S issues. Stakeholder involvement is also a project cross cutting issue and is addressed in section 3 of this report. The Phase 1 verification of the layout of the landfill was carried out with a desktop study of available literature, interviews of staff that was involved in the construction of the landfill in the old days and fieldwork such as a Ground Penetrating Radar (GPR) campaign, a surface three dimensional (3D) laser scanning of topography of the landfill and its surroundings and Dynamic Cone Penetration Tests (DCPTs) to establish the soil structure. This information is used to make a Digital Terrain Model (DTM). With the DTM the volume of the different elements of the site including the landfill body can be assessed / calculated. The waste characterization will be carried out by evaluation of data already presented in the ToR, available data from the interviews, archive studies and the gathered fieldwork data during the inception mission.

1.2.3 Phase 2 Detailed site assessment

Phase 2 is the soil and ground investigations and risk assessment of the catchment area of the landfill. This phase comprises:
- An environmental baseline assessment of the catchment area of the landfill
- A geophysical assessment of the catchment area of the landfill
- A risk assessment of the catchment area of the landfill

1.2.4 Phase 3 Selection and pre-design the best rehabilitation option

Phase 3 is a stepwise process and starts with the description of five viable options.

- One option reflects the proposed mitigation measures when there are no funds available within the coming 20 years to remove, repack and safely store the repacked chemicals from Nubarashen awaiting the final destruction
- The second option describes the mitigation measures when funds are available to remove, repack and safely store the repacked chemicals from Nubarashen awaiting the final destruction within 10 years
- The third and fourth option describe the proposed measures when funds are available for the mentioned activities within 5 years
- The last option gives the same but now funds are available within 2 years

The second step comprises a Multi-Criteria Decision Analysis (MCDA) of the five options and the best two options will be selected and pre-designed. The third step is the recommendation of the best option including an assessment of the remaining risks.

1.3 Contents of the report

This report describes in details the activities and results of Phase 1 and 2 of the Site assessment and feasibility study of the Nubarashen burial site of obsolete and banned pesticides in Nubarashen, Armenia. This complete report is actually the complete update Conceptual Site Model of the Nubarashen burial site.
To obtain a comprehensive idea of the results of the Phase 1 and Phase 2 of this feasibility study without reading this complete report an executive summary is given as first section of this report.
Following the Executive Summary and this introductory Chapter, Chapter 2 describes the Phase 1 of this feasibility study. The Quick Scan Stakeholder involvement is elaborated in Chapter 3. Chapter 4 describes the Phase 2 detailed site assessment. The geophysical assessment of both phases is presented in Chapter 5.
The Tier 2 risk assessment is detailed in Chapter 6 and this report concludes with a listing of conclusions and recommendations based on the Phase 1 and Phase 2 of this feasibility study in Chapter 7.
Throughout this document reference is made to 8 appendices of this report.

2 Phase 1 Initial site assessment

2.1 Methodology

The project started with an inception mission, this mission was held between 18 and 28 of February 2013. The inception was reported in the already mentioned Inception Report.
During this mission Phase 1, the initial site assessment, was kick-started. Phase 1 comprises:

1. Health and safety planning; reported in the earlier mentioned H&S Plan
2. A verification of the burial site design
3. An assessment of the current top cover
4. A characterization of the buried waste
5. A preliminary (Tier 1) risk assessment of the catchment area of the burial site reported in Chapter 6 the Tier 2 risk assessment

This chapter reports the carried out Phase 1 fieldwork in section 2.2, the fieldwork results are presented in section 2.3 and the evaluation of these data are in section 2.4. The evaluation is split up in the landfill site layout (section 2.4.1), the layout of the landfill body (section 2.4.2) and the dumped waste (section 2.4.3). This chapter ends with a separate section giving conclusions on the current understanding of layout of the landfill.

2.2 Fieldwork activities

The Phase 1 fieldwork was carried during the inception mission. Tauw gathered field data to update the initial Conceptual Site Model (CSM). The updated CSM is needed to establish the environmental and human risks. The results of the risk assessment will direct the design of the possible remedial options and finally the selection of the complete set of rehabilitation measures to eliminate the human health and environmental risks related to the landfill. To update the CSM, a 3D laser scanning of the terrain of landfill and part of the Nubarashen valley, a Ground Penetrating Radar (GPR) campaign to reveal the layout of the landfill body and Dynamic Cone Penetration Tests (DCPTs) to establish the soil structure were carried out.

2.2.1 3D Laser Scanning

The current topography of the landfill and relevant surrounding area are measured in a very high detail using 3D terrestrial laser scanning (see figure 2.1). The 3D laser scanning will be used to:

- Make a topographical baseline map.
- Update the CSM, the CSM is the basis for the risk assessment
- Produce a DTM, the DTM gives the information to establish the landfill body layout and to calculate the current quantities of the different components of the landfill body
- Hydrological and geo-morphological modelling

A FARO Laser Scanner Focus 3D was used to scan the fenced landfill area and the direct surrounding downstream and the upstream the landfill. The complete scan is made with several individual. Each scan was geo-referenced with 9 fixed points and each scan is overlapping 3 points of the adjacent scan. In total around 10 hectares are scanned. The actual scanning took place in 3 days.

2.2.2 Ground Penetrating Radar

For verification of the structure of the landfill it was planned to apply GPR in a grid over the landfill body and the fenced area with a GSSI 400 MHz GPR antenna, with gridlines of 1 x 1 m (see figure 2.1). Because the soil conditions were far from optimal, the measurements started with the most important area, the landfill body itself and the area between the concrete surface runoff drains. The total area covered with the GPR is around 0.5 hectare.
Since the area is not that large and the expected top layer is about 50 cm thick, measurements were taken at 2 different settings; one for detailed recording of the top layer (about 1.5 m max, depending on soil type and moisture content) and one for deeper (but less detailed) penetration (up to about 4 m, depending on soil type and moisture content). Because it was not known whether a good enough quality of GPS is available, the choice was made to position the measurements using a survey wheel; the device driven by one wheel of the survey cart measures the exact distance from a known starting point, thereby generating a local grid. Points along this grid are acquired using a hand-held GPS. The GPS recordings and the local grid are converted to a geo-referenced grid afterwards.

Due to the weather conditions (in the early morning the surface was frozen and during the day the frozen surface melted) fieldwork turned out to be very difficult. The moisture content of the clay soil varied and formed a large obstacle in conducting proper GPR measurements.
The sticky clay was obstructing the performance of the equipment during the day. Especially when the temperature raised and the frozen surface melted. It caused the wheels of the survey cart to jam and made an accurate positioning impossible (see figure 2.1). The survey cart had to be cleaned continuously which consumed an enormous amount of time. It also was seen from the online reflection of the radar signal that the penetrating depth was shallow. It also was observed in the field that the difference in height of the landfill body and its surrounding is more than 1 m.

It was concluded that the combination of the weather condition, the clay and the moisture content and the top cover thickness of more than 1 m did not produce GPR results as expected. It was decided not to survey the remaining area (the Northern part between the concrete drain and the fence) but to concentrate on the area between the concrete drains by performing different runs on the longitudinal axel of the landfill body to get the best possible results under the given conditions. The survey report with an addendum of the subcontractor Medusa is presented in appendix 1.

Figure 2.1 Left the 3D Lasser scanning and right the GPR survey cart

2.2.3 Dynamic Cone Penetration Tests

17 DCPTs were carried out in one longitudinal and three cross sections to establish the surrounding soil structure of the landfill body. Figure 2.2 gives a field setup of a DCPT and the locations of the DCPTs are given in figure 2.3. The DCPTs are performed using a standard 60 degree apex cone connected to' A size' drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPTs are not performed in the landfill body because the cone can easily penetrate a drum or container with liquids without knowing. If a drum of container is perforated the soil will be contaminated. The risk of causing soil contamination by the DCPTs is seen as unacceptable and therefore not taken.

Figure 2.2 A Left the DCPT Geotool and right a DCPT measurement

The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil profile (layering) and the depth of the slip surface for landslide. The DCPT is a relatively simple and portable ground investigation technique that can be easily used on the slopes of the valley. The amount of force needed to push the cone into the ground is a measure of the soil type. All observation points are geo-referenced and added to the 3D model.

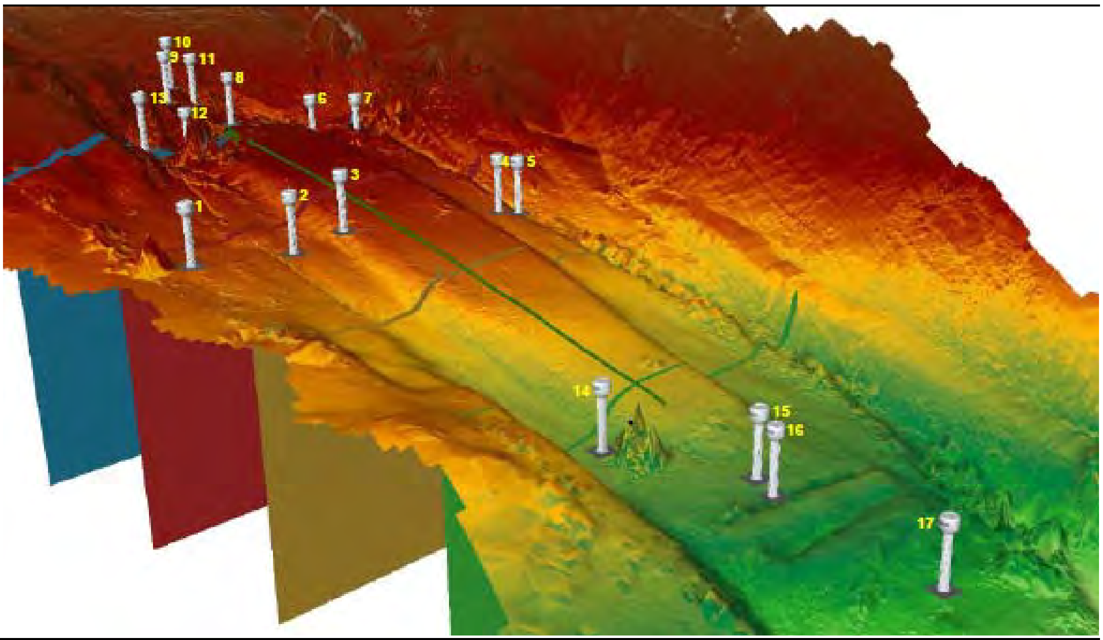

Figure 2.3 The landfill and area topogarphy and locations of the DCPT

2.3 Fieldwork results

2.3.1 3D Laser Scanning

The 3D Laser Scanning resulted in a computer file of a large number of points; each point has a record on the x, y, and z coordinates. This file is loaded in a Geographic Information System (GIS). This GIS was filled with Geo data on the soil composition and the layout of the landfill body. This filled GIS is used to produce of images from the site, using different layers, to calculate the volume of contaminated soil at the landfill, the top cover and the volume of the landfill body. The results of the 3D scan can be visualized with different images. An example of such image is presented in figure 2.3.

Figure 2.4 is the same image but now with a satellite image from Google Earth. With the results of the scan longitudinal and cross sections can be produced at any position. These cross sections support the description of the CSM. Appendix 2 gives a topographical map made with the information from the laser scan, the longitudinal and cross sections of the landfill body.

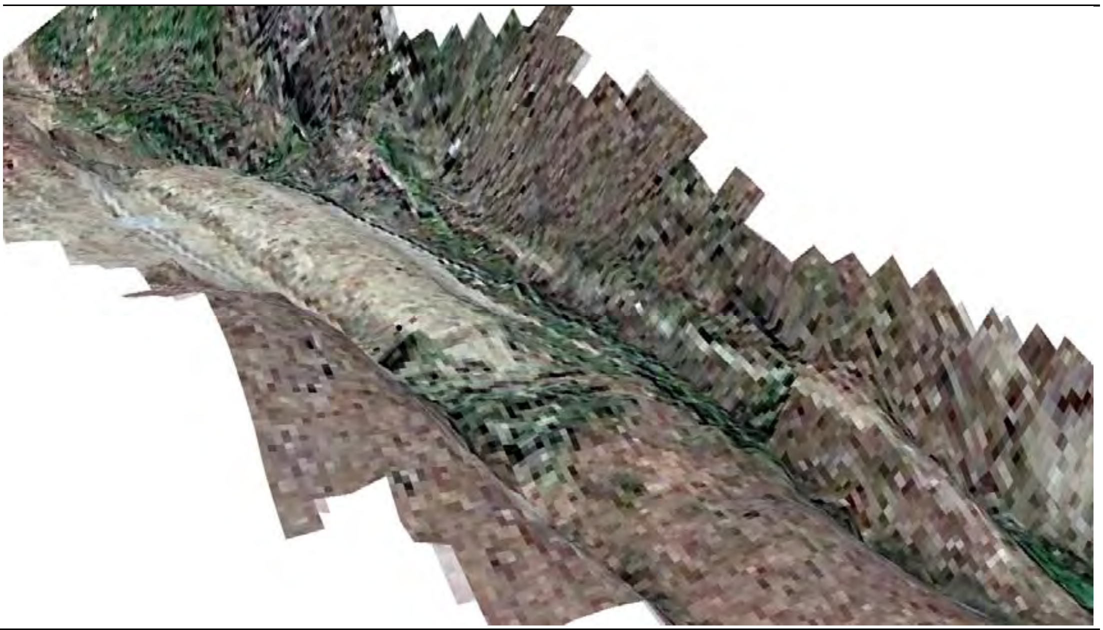

Figure 2.4 Google eath image overlaying the landfill and area topogarphy

2.3.2 Ground Penetrating Radar

It was anticipated that the GPR produces a spatially detailed map of variations in (soil) structure till a depth of approximately 1 to 2 m and with less detailed a spatially map of variations in (soil) structure from 2 to around 4 m. The different (soil) structures in the top 4 m of the landfill body are:

1. The top cover of clay
2. A liner made out of ruberoid
3. Possibly isolated clay cells divided by clay dams filled with pesticide waste
4. Possibly concrete structure of sarcophagi filled with pesticide waste
5. Pesticide waste (bags, drums and barrels)
6. Undisturbed soil, bottom of waste dumped

The different (soil) structures in the top 4 m outside the landfill body are:

1. Top soil consisting of colluvial material (heterogeneous soil with stones and boulders)
2. Undisturbed soil

While the chosen GPR setup was suited to look into the subsurface for up to about 4 m deep, the first data analysis gave images that are blurred at this depth. In the reflection scans slight variations can be noted, but a relation to any of the concrete bunkers/sarcophagus or clay cells or clay structures, is speculative. In the reflection scans only slight variations in the top 0.5 m can be noted. The reasons for these variations are not clear. It appears that the top layer of the landfill consists of a relatively homogenous material. The thickness of the clay body covering the waste appears to be about 1.0 m instead of expected 0.5 m. The top layer of the surrounding area consists of more heterogeneous material with many small objects that are most likely rocks.
No signs of buried material have been found in the surrounding area. The weather conditions, the high clay content, the varying high moist percentage and the thicker top-layer have led to high radar-signal absorption and therefore poor GPR results in the initial data analysis.

However, by using a rigorous frequency filtering (and thereby removing 90 % of the signal), a layering on the landfill body that differs significant from the layering in the area outside the landfill body was observed (figure 2.5). Based on the travel time and the expected velocity in the soil material the minimum and maximum thickness of the layers is calculated (see table 2.1).
The landfill body appears to be constructed by the following layers:

1. **0.00 m - 0.72 m:** The top layer is clay and contains small objects (e.g. stones) and has a thickness a maximum 0.70 m. This maximum thickness is based on the GPR reading and an expected velocity in the medium of 12 cm/ns, common in frozen soil. The minimum thickness of 0.40 m, used in table 2.1, is based on field observations and seen as correct and therefore used to calibrate the velocity of the GPR signal in the clay layer, resulting in a velocity of 6.7 cm/ns, which is not unlikely for wet clays
2. **0.72 m - 1.22 m:** The different reflection in this horizon is unclear, but can be the lower boundary of the frozen layer; can be the change to other soil material; or can reflect the presence of a liner. The material does not contain visible structures and has a thickness of around 0.50 m
3. **1.22 m - 1.92 / 2.90 m:** This layer shows a very clear banding. The initial interpretation of this banding was a false response of the radar system, which led to the conclusion that the results were inconclusive. However, the fact that below this layer discordant layers are present and that the banding is absent in the transect with undisturbed soil has led to this new interpretation. This banding is the response of the GPR to unknown, reflective material. The radar wave velocity in this layer is unknown, but will be between 5 cm/ns and 12 cm/ns, resulting in a thickness of 0.70-1.70 m
4. **1.92 / 2.90 m - 1.92 / 3.90 m (at least):** This last measured horizon is composed of layers that are discordant positioned below the horizontal banding of the layer above (horizon 3). The nature of the layering can point to the presence of natural soil. The thickness of this layer is at least 1.00 m

The area next to landfill body appears to be constructed by the following two horizons:

1. **0.00 m - 0.72 m:** The top layer is clay and contains small objects (e.g. stones) and has a thickness of around 0.70 m
2. **1.92 / 2.90 m - 1.92 / 3.90 m (at least):** Horizon 2 is composed of layers that are discordant positioned below horizon 1. The nature of the layering can point to the presence of natural soil. The thickness of this layer is at least 2.00 m

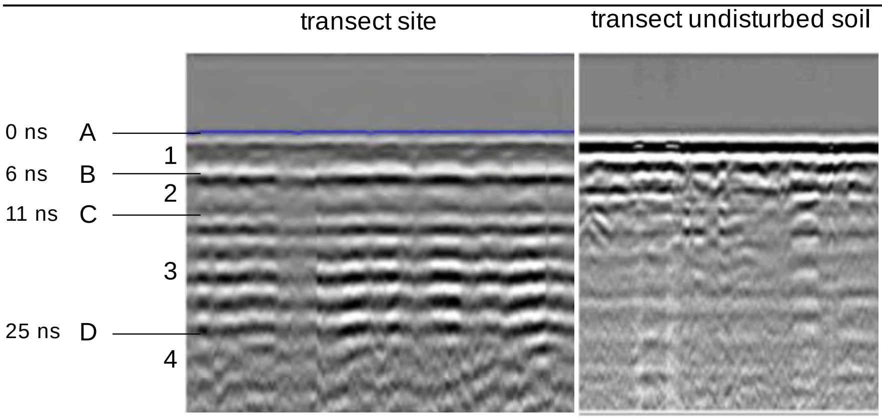

Figure 2.5 Left: GPR image landfill body. Right: GPR image outside landfill body

The landfill body shows a construction that is homogeneous in both length and width. Within the radar data, no evidence of concrete construction and/or constructed clay dams and/or isolated cells was found within the top 2.00 m.

Table 2.1 Overview of the max and min thickness of the various layers observed in the GPR data

Layer	Thickness (ns)	Minimum Expected velocity (cm/ns)	Minimum Thickness (cm)	Minimum Accumulated depth (cm)
1	6	6.7	40.0	40.0
2	5	10.0	50	90.0
3	14	5.0	70	160.0
4	10	10	100	260.0
Layer	**Thickness (ns)**	**Maximum Expected velocity (cm/ns)**	**Maximum Thickness (cm)**	**Maximum Accumulated depth (cm)**
1	6	12.0	72.0	72.0
2	5	10.0	50	122.0
3	14	12.0	168	290.0
4	10	10	100	390.0

It seems there is only one trench with a depth of around 2.6 - 3.9 m deep including the top cover of around 0.9 m. The results of second data analysis are better than the first data analysis, but still there are some uncertainties such as the exact extend in vertical and horizontal directions of the waste. Section 1.4.2 evaluates all the data and section 2.4.4 discusses the uncertainties and the need for field verification.

2.3.3 Dynamic Cone Penetration Tests

The numbers and GPS locations of the 17 DCPTs are presented in appendix 3. Table 2.2 gives the depth of each DCPT.

Table 2.2 Depth in m minus groundlevel of the DCPTs

Number	Depth DCPT m minus ground level	Number	Depth DCPT m minus ground level	Number	Depth DCPT m minus ground level
DPT01	3.37	DPT07	4.79	DPT13	2.67
DPT02	2.69	DPT08	1.19	DPT14	4.59
DPT03	4.09	DPT09	0.38	DPT15	2.29
DPT04	3.39	DPT10	0.99	DPT16	5.57
DPT05	2.39	DPT11	1.29	DPT17	5.58
DPT06	4.48	DPT12	1.09		

The number of strokes needed to penetrate 1 inch of soil is recorded and these records are also given in appendix 3 in tabular form and in a graph for each DCPT. For the interpretation the reference values used, are presented in table 2.3.

Table 2.3 Classification of DCPT results body

Classification	SPT or N value	Cohesion, C or Su	Consistency
1	< 2	< 500 psf	Very soft
	2 – 4	500 – 1,000 psf	Soft
2	5 – 8	1,000 – 2,000 psf	Firm
	9 – 15	2,000 – 4,000 psf	Stiff
3	16 – 30	4,000 – 8,000 psf	Very stiff
4	> 30	> 8,000 psf	Hard

Figure 2.8 gives the graphs of the DCPT 3 and 15 including the classification. The very soft and soft soil horizons (pink) are taken as one class. The soil horizons that have a firm to stiff consistency (green) are the second class. The horizons with the consistency very stiff are the third class (purple). The horizons with the consistency hard are the last class (brown).

The DCPTs results demonstrate that the topsoil outside the landfill body is very soft to soft till 0.20 - 0.50. This very soft to soft horizon is overlaying a soil horizon that is firm to stiff till a depth varying from 0.50 - max 2.00 m below ground level. Below this layer consistency of the soil horizon is varying from firm to very firm till a depth of 2.00 - 3.00 m, overlaying a hard soil horizon starting at a depth varying from 2 - 3 m below ground level. From the graphs in appendix 3 it also can be seen that in all DCPT profiles the consistency increases with the depth except for DCPT 9, 16 and 17 these are probably locations where the soil is cracked.

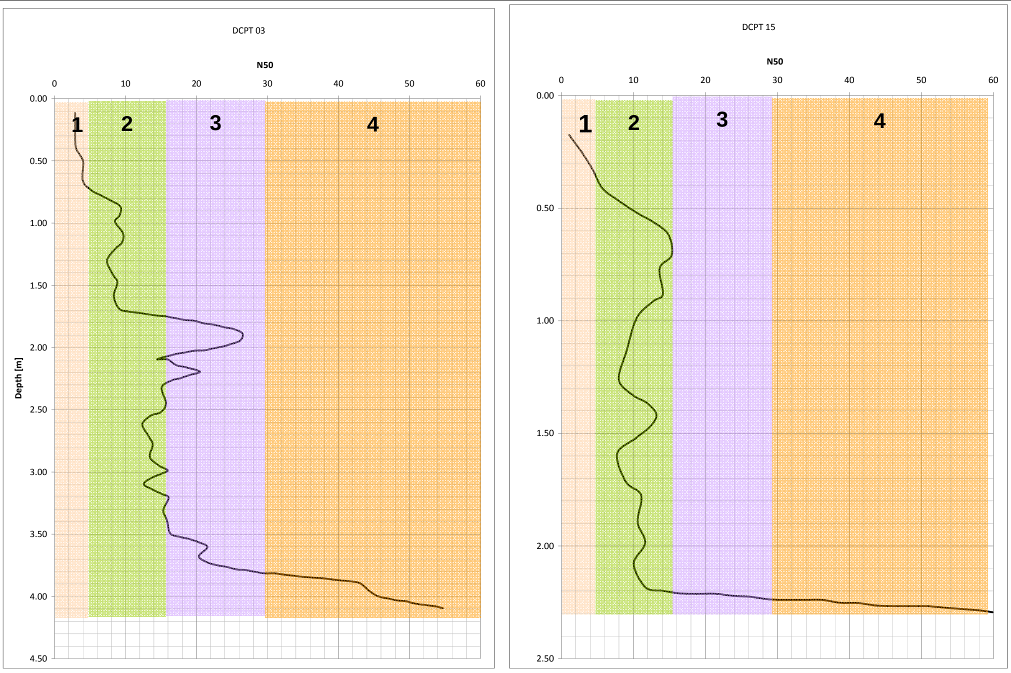

Figure 2.6 DCPT 03 and 15

2.4 Evaluations

This section describes the layout of the landfill, the layout of the landfill body and the dumped waste in three different subsections using the:

- Information given in the tender documents
- Data gathered during the different visits
- Old and recent taken pictures
- Google satellite images from the different years
- The site 3D laser scanning
- Results of the GPR exercise
- Results of the 17 DCPTs

2.4.1 The landfill site

The Nubarashen landfill site can be reached from Yerevan by the highway M 15. At the village Nubarashen is a dirt road of approximately 4 km leads to the landfill site. One kilometre downhill the landfill is barrier. This barrier is locked and the watchman appointed by the MoES is holding the key. A portable watchman cabin stands a few yards from this barrier.
A bit higher up the hill is a permanent watchman's house.

Uphill the landfill site itself is a dirt road passing the site 300 - 400 m east. A culvert installed under this dirt road drains the runoff water from a large uphill separate catchment area.
This culvert is nearly filled up with sediments. Parallel on the north side of this road runs a water main with a diameter of half a meter (see figure 5.1). This water main is probably leaking and is blocking the natural drainage pathway of the uphill catchment area. Because the drainage way is blocked, Pond 1 is having standing water till the top of the water main. If the water level is higher water flows to the blocked drain and percolates through the culvert. Water from the pond and the pool in front of the blocked culver infiltrates in the soil.

The dirt road has is connected with the landfill site by a very steep dirt road just east of Pond 1 The landfill site can be reached by both ways preferably with 4x4 car when the clayey top soil is dry. When wet it is very difficult to reach the site even with a 4x4. Trucks can only reach the site in dry periods.

The landfill site itself, is a barb wired fenced area of 165 m long and 50 m wide enclosing an area of 0.85 hectares. The steel fence poles are approximately 2.5 m high and are placed in a concrete blocks. The fence has a lockable gate were trucks can enter. This key is also with the watchman. Inside the fence area is the landfill body. The landfill body is surrounded by three concrete runoff drains. One on the North of 114 m, one on the South of 120 m and one upstream the landfill of 30 m connecting both ends to the other two drains. The drain is a culvert, allowing trucks to pass the drain and approach the landfill body, in front of the gate. The drains are made out of prefab elements and the joints between elements are sealed with a concrete slab. The drains are installed to prevent runoff water to percolate the waste and to reduce the risk for site erosion. At several places the drains are tunnelled by runoff water and the drain elements are dislocated leaving open joints (see figure 2.9) between the elements. The drain to the South is connected to a gully of the natural dendritic drainage system. An embankment guides the runoff water from the Northern drain to a lower laying natural gully. The site drainage and other features of the catchment area of the landfill are discussed in section 5.

West, 10 m down slope the landfill body, are two trenches of approximately 1 m deep, 18 m long and 1.5 m wide. These trenches are probably remains of a construction were in the old days liquid pesticides were burned to reduce the volume of the waste to be dumped. Currently these trenches function as runoff traps and are filling up wit runoff material.
The landfill body itself is a hillock of approximately 1.25 m high uphill, 2 m high in the middle and 1.50 m high at the down hill part with respect of the surrounding surface level of the enclosed area. The hillock is 104 m long and 12 m wide uphill, 10 m wide in the middle and 18 m wide at the down hill part. The total area of the hillock is around 1.640 m^2. The topsoil of this hillock covering the dumped pesticides is clayish and traces of pesticides and remains of packaging are observed at the surface. The top cover of the landfill body is getting eroded and at a few places the top cover has cracks (see figure 2.7).

Figure 2.7 Left: Dislocated drainage element. Right: Eroded topcover landfill body

The fenced area has a grass/herbs cover and there are a few small trees and bushes. During the fieldwork bare patches of land were observed. The vegetation of the surrounding is also grass with few trees and bushes in the gullies. Reed is growing at flat areas which are pools with standing water during wet periods. The area is used for grazing; the pools are used for watering cattle. Women and children are picking flowers looking for herbs and mushrooms in the surrounding of the landfill. The surrounding area has many features of soil erosion such as gullies, landslips and landslides. The landfill body is located on an active landslide, the landslide debris. The site erosion features are discussed in Chapter 5.

2.4.2 Landfill body layout

The layout of the landfill body is discussed in several documents attached to the project TOR. These documents and the information gathered in the scope of this project are used to discuss the layout of the landfill body. If the layout of the landfill body is known the quantity of the waste dumped at this site can be assessed.

Although the **1977** design prescribed the planed disposal of the pesticides in concrete containers, it is clear from the documentation that there are most likely no concrete construction build (sarcophagi) for the disposal of the pesticides waste. It was said that the containers have instead been made out of clay. The assumption of what the transect of the landfill body is expected to look like is presented in figure 2.8.

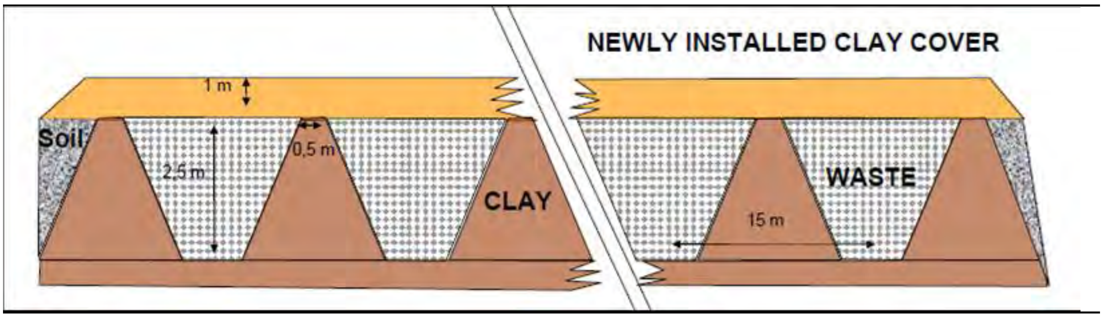

Figure 2.8 Assumption of what a transect of the landfill body is expected to look like

Geophysical investigations in **2005** did not reveal any concrete structures in the designated burial area, however the test boreholes have only been made down to approximately 2 m of the layer of the burial site, hence the bottom construction of the burial site has not been confirmed by the conducted investigations. Further in the surroundings a number of boreholes have been made with a depth of up to 6 m. The information from theses boreholes combined with the geophysical investigations in the areas, gives a relatively clear picture of the near-surface geology but not of the landfill body itself. In **June 2010 after the new cover was installed** the MoES installed a borehole in the centre of the landfill body, up to 5.5 m below surface. The borehole reached in the 'healthy soil'. The information available on the borehole is that the top soil is 1 m thick covering a layer of waste from 1.3 - 5 m below surface.
The updated landfill body layout in this survey report will be discussed by addressing the top cover and the compartment(s) with the pesticide waste.

Top cover
In total 24 shallow boreholes were made to establish the environmental quality and the thickness of the top cover. From the 24 boreholes it is concluded that a 0.40 m top cover is overlaying a ruberoid liner. This liner is observed in several boreholes but not perforated during this survey. From the information from the TOR it is concluded that the 2 mm ruberoid liner is overlaying a liner support sand layer of 5 cm followed by a 20 cm thick clay layer covering the waste (see figure 2.9). Table 2.4 reconstructs the profile of the top cover based on the evaluation of all available information. The last column in this table is used to discuss the status of the evaluation.

Table 2.4 Composition top cover landfill body

Component top cover	Information from	Status of information
Surface 0.2 ha	3D laser scanning	Excepted to be correct
Protective clay layer 40 cm Protective clay layer 72 cm	24 boreholes GPR	**The 40 cm thickness is correct** The 72 cm is based on assumed travel time of 12.0 cm/ns. The actual travel time based on borehole observation is 6.7 cm/ns.
Hydrological runberoid barrier 2 mm	Appendix 3 TOR and 24 boreholes	**The presence of liner of 2 mm ruberoid is correct**
Liner support sandy layer 5 cm	Appendix 3 TOR	**Excepted to be correct**
Profile layer of clay 20 cm Profile layer of clay 50 cm	Appendix 3 TOR GPR	**Expected depth varies from 20 – 50 cm. Exact depth needs verification by borings**
The minimum thickness complete top cover 0.95 m The maximum thickness complete top cover 1.20 m	Calculation	**The total thickness is varying 0.95 m to 1.20 m and needs verification by borings**

Considering the evaluation the quantities of the different components of the top cover differ. The in-situ volume and the maximum and minimum volumes when excavated of the top cover are presented in table 2.5. The excavated volume of soil is around 20 % more than the in-situ volume.

The top cover waste is most likely covering one trench and calculated in-situ volume of the top cover is probably around 1,680 m^3.

Table 2.5 Minimum and maximum quantities top cover landfill body according to the given information

Components of top cover	Length	Width	Height	Surface	Volume in-situ	Volume excavated
	m	m	m	m^2	m^3	m^3
Minimum quantities top cover						
Protective clay layer	104.00	15.00	0.40	1,560.00	624.00	**748.80**
Hydrological runberoid barrier	104.00	15.00	0.002	1,560.00	3.12	
Liner support sandy layer	104.00	15.00	0.05	1,560.00	78.00	**93.60**
Profile clay layer	104.00	15.00	0.20	1,560.00	312.00	**374.40**
Total minimum quantities			**0.65**			**1,216.80**
Maximum quantities top cover						
Protective clay layer	104.00	15.00	0.40	1,560.00	624.00	748.80

Components of top cover	Length	Width	Height	Surface	Volume in-situ	Volume excavated
	m	m	m	m^2	m^3	m^3
Hydrological runberoid barrier	104.00	15.00	0.002	1,560.00	3.12	
Liner support sandy layer	104.00	15.00	0.05	1,560.00	78.00	93.60
Profile clay layer	104.00	15.00	0.45	1,560.00	702.00	842.40
Total maximum quantities			**0.90**			**1,684.80**

The compartment(s) with the waste

Base on the available information the surface of the pesticide waste is:

- **225 m^2** - The drawing presented in the appendix 2 of the TOR indicates that the waste is dumped in five compartments of 8 x 5 m (200 m^2) and one compartment of 5 x 5 m (25 m^2)
- **720 m^2** - The GPR did not give any indication of subsurface structures. Based on the GPR the waste is dumped in one long trench. The DTM gives a surface for the top cover of 1,560 m^2 (104 m long x average 15 m wide). The total surface of the dumped waste is therefore expected to be smaller. The drawing of the appendix 2 of the TOR gives a width of the trench of 8 meters. The estimate dimension of the trench with waste is 8 m wide and around maximum 90 meter long. The surface of the trench with waste is estimated to be 720 m^2

Base on the available information the height of the pesticide waste is:

- **2.5 m** - The assumption of what the transect of the landfill body is expected to look like as presented in figure 2.8, the given height of the dumped waste is 2.5 m
- **3.7 m** - The information available on the borehole installed by the MoES and reported in the minutes of the pre-proposal meeting, is that a 1 m topsoil covers a layer of waste from 1.3 – 5 m below surface
- **0.70 - 1.68 m** - The GPR results do not give an exact depth because the velocity of the radar signal travelling through waste is estimated to be 5 to 12 cm/ns

The maximum and minimum in-situ and when excavated volumes of the pesticides waste are presented in table 2.6. The excavated volume is around 20 % more than the in-situ volume.

The waste is most likely dumped in one trench and calculated in-situ volume in this trench is probably around 1,210 m^3.

Table 2.6 The quantities in the landfill body when dumped in cells or in one trench

Measurements	Length	Width	Height	Surface	Volume In-situ	Volume excavated
	m	m	M	m^2	m^3	m^3
Waste in cells						
Height given in TOR			2.50	225.00	562.50	675.00
Height from MES bore hole			3.70	225.00	832.50	999.00
Minimum height from GPR			0.70	225.00	157.50	189.00
Maximum height from GPR			1.68	225.00	378.00	453.60
Waste in one trench						
Height given in TOR	90.00	8.00	2.50	720.00	1,800.00	2,160.00
Height from MES bore hole	90.00	8.00	3.70	720.00	2,664.00	3,196.80
Minimum height from GPR	90.00	8.00	0.70	720.00	504.00	604.80
Maximum height from GPR	90.00	8.00	1.68	720.00	1,209.60	1,451.52

2.4.3 The buried waste

Reportedly a total of 512 tons of pesticides have been disposed (powders and liquids in original packaging) at the site. All substances reported are listed in appendix 4 and for each substance the characteristics are given. It is expected that the waste was originally packed in:

- Paper bags
- Cardboard drum of 20-30 litters
- Cardboard boxes
- Metal drum of 60-200 litters
- Plastic bags
- Glass bottles

Because the waste is for more than 40 years buried the metal drums will be rusted and too weak to be taken out without risk of breaking. The paper bags and cardboard packaging will also be decayed and will not hold the content when lifted.
The pesticide waste in the top part of the trench will be mixed with clay/soil because of the illegal waste mining and the 2010 emergency measures, the (re)capping the waste.
The first 0.05 – 0.10 m original clay soil of the bottom and the sides of the excavated cell or trench are most likely heavily contaminated with pesticide and are seen as pesticides waste.
The volumes of contaminated soil for the two possibilities, waste dumped in six cells and waste dumped in one trench, are given in table 2.7.

The waste is probably dumped in one trench and therefore it should be taken into account that around 75 m^3 of original soil, soil in contact with the dumped waste, is contaminated.

Table 2.7 Quantity of contaminated original soil in contact with dumped waste

Components of landfill body	number	Length	Width	Height	Contaminated soil	Surface	In-situ volume	Volume excavated
		m	m	m	M	m^2	m^3	m^3
Soil contaminated when waste dumped in six cells								
Bottom cell 5x8	5	8.00	5.00	1.68	0.07	200.00	14.00	16.80
sides cell 5x8	10	8.00	5.00	1.68	0.07	134.40	9.41	11.29
Head sides cell 5x8	10	8.00	5.00	1.68	0.07	84.00	5.88	7.06
Bottom cell 5x5	1	5.00	5.00	1.68	0.07	25.00	1.75	2.10
sides cell 5x5	2	5.00	5.00	1.68	0.07	16.80	1.18	1.41
Head sides cell 5x5	2	5.00	5.00	1.68	0.07	16.80	1.18	1.41
Total						**477.00**	**33.39**	**40.07**
Soil contaminated when waste dumped in one trench								
Bottom	1	90.00	8.00	1.68	0.07	720.00	50.40	60.48
Sides	2	90.00	8.00	1.68	0.07	302.40	21.17	25.40
Head sides	2	90.00	8.00	1.68	0.07	26.88	1.88	2.26
Total						**1,049.28**	**73.45**	**88.14**

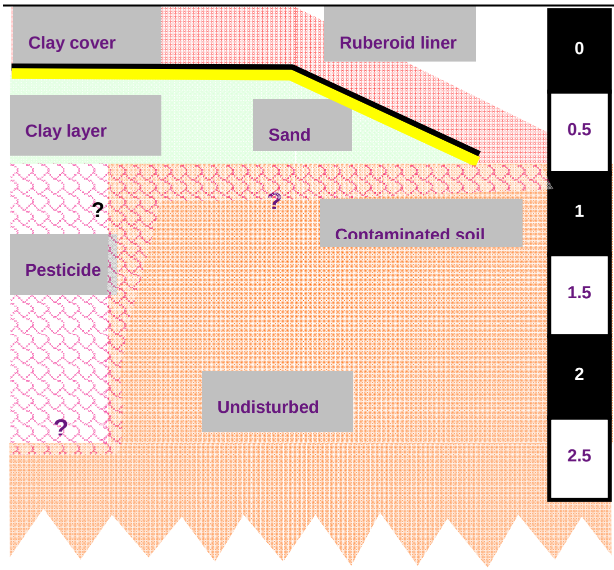

Figure 2.9 Schematic reconstruction landfill body

2.4.4 Conclusions

Based on the evaluation of all the data it is concluded that:

- Originally at least 512 ton of pesticide waste is dumped in the Nubarashen landfill
- The pesticide waste is dumped in a 1.68 m deep trench of 90 m long and 8 m wide
- The dumped pesticide is covered with a top cover of 0.90 meter thick layer including a liner
- The dimensions of top cover are 104 x 15 m and the in-situ volume is around 1,680 m^3
- The estimated in-situ volume of dumped waste is 1,210 m^3
- The estimated in-situ volume of contaminated soil in the trench is 75 m^3
- The estimated volume of dumped waste has to confirmed with additional site survey revealing
  - The actual depth of the trench with the dumped waste
  - The length and width of the trench with the dumped waste

Figure 9.2 gives a schematic detail of the landfill body construction. Figure 9.3 is a longitudinal section of the landfill with a schematic detail of the landfill body construction. The question marks needs verification in the field.

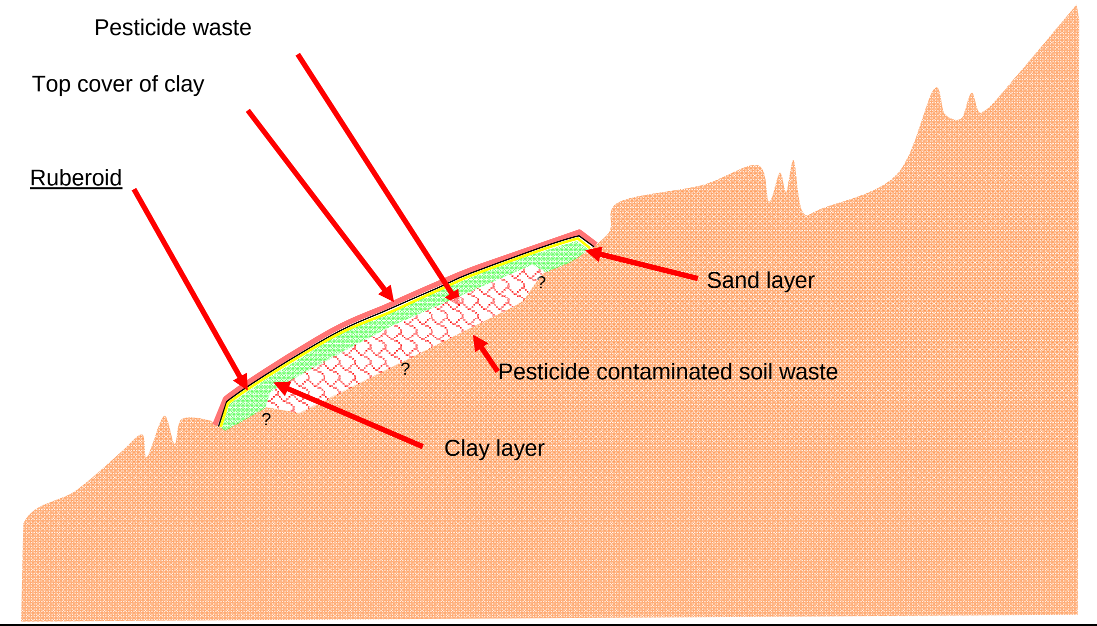

Figure 2.10 Longitudinal section of the landfill

3 Stakeholder involvement

Besides the technical data gathering the stakeholder involvement is one of the important cross cutting issues of this project. The stakeholder involvement was initiated with a Quick Scan Stakeholder Analysis made during the inception mission. This Quick Scan was used during the stakeholder workshop on 22 March 2013 to gather information for the stakeholder involvement plan to be made in Phase 3 of this project.

3.1 Quick Scan Stakeholder Analysis

In the frame of different international POPs and hazardous waste projects the Tauw consortium developed the Quick Scan Stakeholder Analysis - a tool to indicate how problems in society are handled by stakeholders. For solving the problems around the landfill Nubarashen, Ministries, local and regional departments, business, institutes for higher education and NGOs need to cooperate on a high level. A Quick Scan analysis of project stakeholders helps to establish a better understanding of:

- The level of information among stakeholders
- The different roles that the different stakeholders play to solve the social, environmental and public health problems around the landfill and eliminate existing risks
- The position of the different groups that face direct risks

Directly at the start of the project the AWHHE, the local representative of Tauw, sent out an official request to Nubarashen Stakeholders to fill in the Quick Scan Stakeholder Analysis for their own organization. As stakeholders the following 26 organizations where identified:

a. State bodies: Ministry of Nature Protection, Ministry of Agriculture, Ministry of Health, Ministry of Emergency Situations, Ministry of Economy, Ministry of Foreign Affairs, Ministry of Territorial Administration, Ministry of Defense, State Police Department, National Security Service, State Revenue Committee, Yerevan Municipality, local authorities (Nubarashen community of Yerevan)
b. International organizations: OSCE, UNDP, UNIDO
c. National research centers: Center for Ecological-Noosphere Studies of the National Academy of Sciences, ‘Waste research center’ SNCO, Ministry of Nature Protection, Scientific Research Institute on General Hygiene and Occupational Diseases
d. National companies: Engineer-Geologist Ltd.
e. National NGOs: AWHHE, Ecolur, Khazer, Ecoglobe, Association for Human Sustainable Development

As a special stakeholder group the following Groups at Risk where identified:

a. Workers maintaining the site
b. Inspecting officer (from governmental and from NGO background)
c. Police officers
d. Population living downstream the site
e. Herdsmen
f. Children playing in the neighborhood
g. Women collecting herbs in the neighborhood
h. Women using surface water for irrigation
i. Tourists that stay in the summerhouse direct down slope the landfill

Fourteen organizations responded by filling in the Quick Scan; of those twelve organizations took part in the project workshop on 22 March 2013 at the office of the OSCE in Yerevan where the outcomes of the Quick Scan were discussed and formulated.

3.2 The stakeholder workshop

After an update on the technical process of the project by project manager Boudewijn Fokke, Wouter Pronk from Milieukontakt International gave a presentation on the backgrounds of stakeholder involvement and the expected gains in sustainability of project results through involvement of NGOs, farmers' organizations and social initiative groups. This presentation is annexed to the report as Appendix 5.1. Then Gohar Kojayan from AWHHE followed with a presentation on the outcomes of the Quick Scan based on the reactions received thus far.
This presentation is annexed to the report as Appendix 5.2. The first outcomes of the Quick Scan caused some confusion and disagreement, but after the participants sat down and fine tuned their statements for the Quick Scan a general agreement could be reached.
On the next day AWHHE and Milieukontakt formulated the outcomes in a document. This document 'Results of the Nubarashen Quick Scan stakeholder Analysis' is annexed to the report as Appendix 5.3. A summary of this document is presented below.
AWWHE sent out official letters with a summary Quick Scan analysis to all the participants of the 22 March stakeholder meeting. The organization addressed official letters to the newly appointed officials in the aftermath of the recent presidential elections. The first reactions are positively agreeing with the analysis. Final Feedback is to be expected later in June.

3.3 Summary Preliminary Quick Scan Stakeholder Analysis

This section summarizes conclusions of the Preliminary Quick Scan Stakeholder Analysis for the Nubarashen Burial Site for Obsolete and Banned Pesticides in Armenia.

3.3.1 Key Stakeholders

- Overall, it is very positive that there is quite a diverse group of key stakeholders that have the formal objective to solve the problems around the Nubarashen Burial Site for Obsolete and Banned Pesticides
- The key stakeholders are active to solve the issue around the Nubarashen Burial Site for Obsolete and Banned Pesticides
- There is a lack of technical capability to solve the problem and there is a strong need to build technical capacity in Armenia
- There is a lack of financial capacity to solve the problems around the Nubarashen Burial Site for Obsolete and Banned Pesticides. Funding projects to solve the problems around the Nubarashen Burial Site for Obsolete and Banned Pesticides is a serious problem in Armenia. International funding is strongly required to solve the problem
- There is coordination to solve the problems around the Nubarashen Burial Site for Obsolete and Banned Pesticides. It is recognized that only in case of further improvement in coordination it is possible to solve such a complicated issue
- There is a need to raise the awareness at all levels about the need to solve the problems around the Nubarashen Burial Site for Obsolete and Banned Pesticides

Armenia has an adequate policy to tackle the problem. There is a need for the key stakeholders to clarify if the Armenian policy is in line with the international best practice of policies for POPs management.

Armenia has appropriate legislation and decision-making around the issue. There is a need for the key stakeholders to clarify if the Armenian legislation is in line with the international best practice of POPs legislation.

- Armenia needs to improve law enforcement in this area
- There is a strong need for international funding to solve the problem
- To solve the issue, there is a strong commitment to build on

3.3.2 General Conclusion

There are some positive prerequisites such as strong key Ministries, appropriate legislation, and high awareness of the issue among many of the key stakeholders, which attests to the fact that the issue of the Nubarashen Burial Site for Obsolete and Banned Pesticides is gaining higher priority on the political agenda in Armenia.

3.3.3 Themes for Stakeholder Involvement

1. Raise awareness among politicians in order to prioritize the issue of the Nubarashen Burial Site for Obsolete and Banned Pesticides in the national political agenda
2. Develop technical capacities among key stakeholders to solve the issue
3. Organize advocacy among donors to prioritize the issue on their funding agenda
4. The Steering Group meetings of the OSCE and UNDP projects can be used as an active inter-agency coordination and working group to channel the efforts to find sustainable solutions for the problem
5. Identify the needs among state bodies and target groups to improve the awareness about the issue
6. Identify the gaps in law enforcement and based on best practices propose improvements
7. Identify the gaps in funding implementation and based on best practices propose improvements

3.3.4 Groups at Risk

- There is a lack in information about the threats of POPs pesticides for all the groups listed in this analysis. Stakeholders have to be very well informed
- There is a lack of safety measures in order to protect the different groups listed in this analysis against negative health impacts of the Nubarashen Burial Site for Obsolete and Banned Pesticides
- There is a good basis to build awareness raising campaigns around the issue and there is an urgent need to protect the different groups against negative impacts of the Nubarashen Burial Site for Obsolete and Banned Pesticides

3.3.5 The Themes for Stakeholder Involvement

Activities around the Nubarashen Burial Site for Obsolete and Banned Pesticides

1. Develop awareness raising campaigns for the different groups at risk
2. Ensure proper protection for each group at risk to avoid negative impacts of the Nubarashen Burial Site for Obsolete and Banned Pesticides

3.4 The stakeholder involvement plan

Based on the final results of the Quick Scan Stakeholder Analysis Milieukontakt and AWHHE will draw up a stakeholder involvement plan and present this in Phase 3 of this project.

4 Phase 2 Detailed Site Assessment

4.1 Methodology

The investigation of the catchment area comprised:

1. An assessment of the current soil quality of the landfill site; reported in section 4.3 (soil quality)
2. An environmental baseline assessment of the catchment area of the burial site (reported in section 4.3) verifying the potential spreading (receptors pathways) of the contaminants from the landfill to the soil and groundwater and determines potential migration risks, risks to humans and the environment. The environmental baseline assessment assess:
   - The soil quality up and down gradient from the landfill
   - The shallow groundwater quality up gradient from the landfill
   - The shallow and deep groundwater quality down gradient from the landfill
3. A Geo physical assessment ; reported in chapter 5 (erodability, soil texture and geo-stability)
4. A risk assessment of the burial site (reported in section 6.2) including:
   - An environmental Tier 2 risk assessment)
   - An erosion study of the catchment area

4.2 Fieldwork activities

The Phase 2 fieldwork was conducted from 6 to 18 May, 2013. The shallow boreholes and the boreholes at the difficultly accessible reed ponds were performed by manual augering. The deep boreholes were performed by a mechanical rotary core Zil drilling rig, from the Armenian company ‘Engineer-geologist’ Ltd (see figure 4.1). A total of nine monitoring wells have been installed. The monitoring wells consist of HDPE filter pipes with filter screen (equipped with water traps and filter gauze) and PVC risers. Each monitoring well is labeled and finished with a plastic cap or metal well head and a weatherproof label providing technical details (see figure 4.2).
For an overview of the drilling locations and samples, please refer to section 4.3. The soil profile of each borehole has been described (for descriptions see Appendix 6) and relevant soil horizons were sampled. The soil at the site mostly consists of heavy clay. Further details on the soil composition can be found in Chapter 5.

After the fieldwork, the soil, standing- and groundwater samples were analyzed in the NEN-EN-ISO/IEC 17025 accredited laboratory of AL-West in Deventer, the Netherlands. Analyzed substances in soil were Heavy metals (As, Cd, Cr, Cu, Hg, Pb, Ni and Zn), and Organochlorine pesticides. Some of the soil samples have also been analyzed for geo-physical parameters: a) the soil texture (grain size distribution) to assess the vertical and horizontal infiltration rate (for geo-hydrological modeling of the catchment area), b) the field capacity and c) an indication of the erodability. This reported in a separate chapter, Chapter 5.

Figure 4.1 Left: The Zil mechanical drill rig in action. Right: Well tubing, clean water, filter gravel and bentonite were transported to the site from Yerevan

Figure 4.2 Left: Monitoring well 8, protected by rocks. Right: Monitoring well 9, protected with steel well head. All monitoring wells are equipped with weather proof labels providing details on the monitoring wells

Analyzed substances in ground- and pond water were Heavy metals (As, Cd, Cr, Cu, Hg, Pb, Ni and Zn), Organochlorine pesticides, Total Petroleum Hydrocarbons C10-C40 (TPH) and BTEX (Benzene, Toluene, Ethyl Benzene and Xylenes).

4.3 Results - chemical analyses

4.3.1 Testing framework

By absence of a local testing frame, the analytical results were evaluated against the different limit values defined in the Dutch Circular on Soil Remediation 2009 (*Circulaire bodemsanering 2009*), and the Decree on Soil Quality (*Besluit bodemkwaliteit*) of 1 July 2008. This so called STI evaluation frame is widely used internationally to get a first impression on contaminant levels and imminent risks.

The STI evaluation frame distinguishes between background values (***A**chtergrond**w**aarden, AW*) for soil, reference values (**S**treefwaarden) for groundwater, and intervention values (***I**nterventiewaarden*) for both soil and groundwater. The testing values (***T**ussenwaarden*) are defined as **T** = ½ (**AW** + **I**) for soil and **T** = ½ (**S** + **I**) for groundwater.

The used indications for the soil and groundwater assessment in the following sections are given in table

Table 4.1 indications for the assessment of the soil and groundwater sample concentrations

Concentration level	Indication	Meaning
≤ AW / S value (or < detection limit)	-	Not contaminated
> AW / S value ≤ T value	+	Slightly contaminated
> T value ≤ I value	++	Moderately contaminated
> I value	+++	Strongly contaminated

The limit values for soil are depending on soil texture, specifically clay content *(% **L**utum*) and organic matter content (*% **H**umus*). For the interpretation and assessment of the soil analytical data, clay and organic matter content have been analyzed for eight representative samples.
The calculated limit values applicable are presented in Appendix 7. The analytical reports of the soil and water samples are included in Appendix 7.

4.3.2 Analytical results and interpretation top cover

Below table 4.2 lists the samples taken from the top cover of the landfill body (see figures 4.3 and 4.4). The motivation for taking these samples is to assess the soil quality, as well as the erodability and soil texture (reported in section 5). Appendix 2 presents maps with the sample locations. The analytical results are given in the tables 4.3.

Table 4.2 Samples from the topcover of the landfill body

Sample	Composition	Location (on top-cover landfill body)
201	CSS[1] of 6 drilling points	Most easterly quarter section of the landfill body
202	CSS of 6 drilling points	Quarter east of the middle of the landfill body
203	CSS of 6 drilling points	Quarter west of the middle of the landfill body
204	CSS of 6 drilling points	Most westerly quarter of the landfill body

Figure 4.3 Composite soil samples topsoil dumpsite are presented in red (from right - east- to left - west - 201 to 204. The areas in the orange coloured section are discussed in section 4.3.3

Figure 4.4 Left: the landfill body seen in a westerly direction. Right: drilling point on topcover

[1] Composite Soil Sample: the analyzed sample was composed from a number of individual samples/ sample locations

Table 4.3 Analytical results soil (mg/kg) topcover landfill body

Sample description	201		202		203		204	
Depth (m bgl)	**(0-0.5)**		**(0-0.4)**		**(0-0.4)**		**(0-0.4)**	
Clay size fraction (%)	**30**		**30**		**30**		**30**	
Organic matter (%)	**7**		**7**		**7**		**7**	
METALS								
Arsenic (As)	5.8	-	5.4	-	5.8	-	6.8	-
Cadmium (Cd)	< 0.1	-	0.1	-	< 0.1	-	0.12	-
Chromium (Cr) ###	21	-	25	-	25	-	20	-
Copper (Cu)	51	+	57	+	50	+	47	+
Mercury (Hg) ##	< 0.05	-	< 0.05	-	< 0.05	-	0.05	-
Lead (Pb)	18	-	20	-	19	-	17	-
Nickel (Ni)	24	-	29	-	27	-	24	-
Zinc (Zn)	66	-	74	-	70	-	61	-
CHLORINATED HYDROCARBONS								
Hexachlorobenzene (HCB)	< 0.05	-	< 0.1	-	< 0.05	-	< 0.05	-
PESTICIDES								
Sum of 2,4 and 4,4 DDD	< 0.05	-	< 0.1	-	< 0,05	-	0.25	+
Sum of 2,4 and 4,4 DDE	< 0.05	-	< 0.1	-	< 0.05	-	0.31	+
Sum of 2,4 and 4,4 DDT	0.74	++	1.6	+++	0.57	+	4.9	+++
Aldrin	< 0.05	-	< 0.1	-	< 0.05	-	< 0.05	-
Alpha-Endosulfan	< 0.05	-	< 0.1	-	< 0.05	-	< 0.05	-
Alpha-HCH	< 0.05	-	< 0.1	-	< 0.05	-	< 0.05	-
Beta-HCH	< 0.05	-	< 0.1	-	< 0.05	-	< 0.05	-
Gamma-HCH	< 0.05	-	< 0.1	-	< 0.05	-	< 0.05	-
Heptachlor	< 0.05	-	< 0.1	-	< 0.05	-	< 0.05	-
Not in STI-list of the SPA								
Dieldrin	< 0.05		< 0.1		< 0.05		< 0.05	
Endrin	< 0.05		< 0.1		< 0.05		< 0.05	
delta-HCH	< 0.05		< 0.1		< 0.05		< 0.05	
T-Chlordane	< 0.05		< 0.1		< 0.05		< 0.05	
Endosulfan Sulphate	< 0.05		< 0.1		< 0.05		< 0.05	
Cis-Heptachloroepoxide	< 0.05		< 0.1		< 0.05		< 0.05	
Isodrin	< 0.05		< 0.1		< 0.05		< 0.05	
Telodrin	< 0.05		< 0.1		< 0.05		< 0.05	
Dry matter (Dm) (%)	74.2		74.6		75		76.9	

##: compared to the I-value for an-organic Mercury

###: compared to the I-value for Chromium (III)

The clay cover of the landfill body is relatively clean, with DDT present in concentrations below or just above the Dutch I-value. This is likely caused during the installation of the top cover as some contamination may have mixed into the clay cover. Visual inspection of the top cover indicated presence of some remnants of product containers, supporting this hypothesis.
The measured concentrations are much lower as compared to these measured in the top soil of the direct vicinity of the landfill body (see section 4.3.3), indicating that it is not likely that impacts from the landfill body top cover to the surrounding soil currently take place.
A layer of ‘ruberoid’ was encountered at approximately 0.4 m bgl, at which depth the drilling was stopped as not to penetrate the cover.

4.3.3 Analytical results and interpretation direct vicinity of the landfill body

Below table 4.4 lists the top soil samples taken in the direct vicinity of the landfill body, within the fence. The motivation for taking these samples is to assess if the top soil is impacted. These impacts could be the result of run-off of rainwater from the landfill body or from historic impacts during the filling of the landfill or during the period that the landfill was not covered and the pesticides may have spread in an uncontrolled way.
Some of the analysed samples from the top soil were collected from areas with plant cover (CSS 102, 104, 106), and some from areas with bare soil (CSS 103, 105 and 107). This is illustrated in figure 4.5. Appendix 7 presents maps with the sample locations. The analytical results are given in the tables 4.5 and 4.6.

Figure 4.5 Surface areas with - and without - plant cover, within the fence, next to the landfill body

Table 4.4 Samples in the direct vicinity of the landfill body, within the fence

Sample	Composition	Location
101	CSS of 5 drilling points	Up gradient from the landfill body
102	CSS of 3 drilling points	North from the landfill body, with plant cover
103	CSS of 4 drilling points	North from the landfill body, bare soil
104	CSS of 5 drilling points	Directly north from the landfill body, with plant cover
105	CSS of 4 drilling points	Directly north from the landfill body, bare soil
106	CSS of 5 drilling points	South from the landfill body, with plant cover
107	CSS of 5 drilling points	South from the landfill body, bare soil
108	CSS of 5 drilling points	Down gradient from the landfill body
109	CSS of 4 drilling points	Down gradient from the landfill body, in the trenches

Table 4.5 Analytical results soil (mg/kg) direct surroundings landfill body, within fence boundary

Sample description	**101**		**102**		**103**		**104**		**105**	
Depth (m bgl)	**(0-0.2)**		**(0-0.2)**		**(0-0.2)**		**(0-0.2)**		**(0-0.2)**	
Clay size fraction (%)	**30**		**30**		**30**		**30**		**30**	
Organic matter (%)	**7,3**		**7,3**		**7,3**		**7,3**		**7,3**	
METALS										
Arsenic (As)	7.1	-	5.2	-	8	-	7.5	-	12	-
Cadmium (Cd)	0.11	-	0.12	-	0.42	-	0.13	-	0.23	-
Chromium (Cr) ###	27	-	29	-	28	-	27	-	27	-
Copper (Cu)	55	+	49	+	110	+	53	+	160	++
Mercury (Hg) ##	< 0.05	-	0.16	+	1.8	+	< 0.05	-	22	++
Lead (Pb)	20	-	16	-	20	-	20	-	19	-
Nickel (Ni)	27	-	29	-	28	-	31	-	28	-
Zinc (Zn)	84	-	64	-	410	+	69	-	310	+
CHLORINATED HYDROCARBONS										
Hexachlorobenzene (HCB)	< 0.05	-	< 0.05	-	< 5	-	< 0.05	-	7.1	+++
PESTICIDES										
Sum of 2,4 and 4,4 DDD	0.36	+	0.37	+	52	+++	0.09	-	73	+++
Sum of 2,4 and 4,4 DDE	2.44	+++	1.52	++	<5	-	0.29	+	18.3	+++
Sum of 2,4 and 4,4 DDT	5.8	+++	6.1	+++	910	+++	1.87	+++	1400	+++
Aldrin	< 0.05	-	< 0.05	-	< 5	-	< 0.05	-	< 5	-
Alpha-Endosulfan	< 0.05	-	< 0.05	-	< 5	-	< 0.05	-	< 5	-
Alpha-HCH	< 0.05	-	< 0.05	-	20	+++	< 0.05	-	29	+++
Beta-HCH	< 0.05	-	< 0.05	-	< 5	-	< 0.05	-	< 5	-
Gamma-HCH	< 0.05	-	< 0.05	-	< 5	-	< 0.05	-	10	+++
Heptachlor	< 0.05	-	< 0.05	-	< 5	-	< 0.05	-	< 5	-

Sample description	101	102	103	104	105
Depth (m bgl)	(0-0.2)	(0-0.2)	(0-0.2)	(0-0.2)	(0-0.2)
Clay size fraction (%)	30	30	30	30	30
Organic matter (%)	7,3	7,3	7,3	7,3	7,3
Not in STI-list of the SPA					
Dieldrin	< 0.05	< 0.05	< 5	< 0.05	< 5
Endrin	< 0.05	< 0.05	< 5	< 0.05	< 5
Delta-HCH	< 0.05	< 0.05	< 5	< 0.05	< 5
T-Chlordane	< 0.05	< 0.05	< 5	< 0.05	< 5
Endosulfan Sulphate	< 0.05	< 0.05	< 5	< 0.05	< 5
cis-Heptachloroepoxide	< 0.05	< 0.05	< 5	< 0.05	< 5
Isodrin	< 0.05	< 0.05	< 5	< 0.05	< 5
Telodrin	< 0.05	< 0.05	< 5	< 0.05	< 5
Dry matter (Dm) (%)	76.1	78.3	74.8	75.6	75.7

##: compared to the I-value for an-organic Mercury

###: compared to the I-value for Chromium (III)

Table 4.6 Analytical results soil (mg/kg) direct surroundings landfill body, within fence boundary

Sample description	106		107		108		109	
Depth (m bgl)	(0-0.2)		(0-0.2)		(0-0.2)		(0-0.2)	
Clay size fraction (%)	30		30		30		30	
Organic matter (%)	7.3		7.3		7.3		7.3	
METALS								
Arsenic (As)	6.6	-	11	-	7.3	-	6.6	-
Cadmium (Cd)	< 0.1	-	< 0.1	-	< 0.1	-	0.12	-
Chromium (Cr) ###	35	-	28	-	37	-	31	-
Copper (Cu)	50	+	120	++	62	+	56	+
Mercury (Hg) ##	0.08	-	3.5	+	0.31	+	0.15	-
Lead (Pb)	14	-	15	-	16	-	17	-
Nickel (Ni)	38	-	29	-	40	-	32	-
Zinc (Zn)	58	-	140	-	69	-	68	-
CHLORINATED HYDROCARBONS								
Hexachlorobenzene (HCB)	< 0.05	-	< 5	-	< 10	-	< 10	-
PESTICIDES								
Sum of 2,4 and 4,4 DDD	0.48	+	< 5	-	< 10	-	< 10	-
Sum of 2,4 and 4,4 DDE	0.71	+	< 5	-	< 10	-	< 10	-
Sum of 2,4 and 4,4 DDT	7.1	+++	115	+++	31	+++	30	+++
Aldrin	< 0.05	-	< 5	-	< 10	-	< 10	-
Alpha-Endosulfan	< 0.05	-	< 5	-	< 10	-	< 10	-
Alpha-HCH	< 0.05	-	210	+++	< 10	-	< 10	-
Beta-HCH	0.087	+	17	+++	< 10	-	< 10	-
Gamma-HCH	< 0.05	-	51	+++	< 10	-	< 10	-
Heptachlor	< 0.05	-	< 5	-	< 10	-	< 10	-

Sample description	106	107	108	109
Depth (m bgl)	**(0-0.2)**	**(0-0.2)**	**(0-0.2)**	**(0-0.2)**
Clay size fraction (%)	**30**	**30**	**30**	**30**
Organic matter (%)	**7.3**	**7.3**	**7.3**	**7.3**
Not in STI-list of the SPA				
Dieldrin	< 0.05	< 5	< 10	< 10
Endrin	< 0.05	< 5	< 10	< 10
delta-HCH	< 0.05	23	< 10	< 10
T-Chlordane	< 0.05	< 5	< 10	< 10
Endosulfan Sulphate	< 0.05	< 5	< 10	< 10
Cis-Heptachloroepoxide	< 0.05	< 5	< 10	< 10
Isodrin	< 0.05	< 5	< 10	< 10
Telodrin	< 0.05	< 5	< 10	< 10
Dry matter (Dm) (%)	81.9	78	80.8	72.9

##: Compared to the I-value for an-organic Mercury

###: Compared to the I-value for Chromium (III)

At some locations, the shallow top soil in the direct vicinity of the landfill body (within the fence) contains high levels of DDT, DDD and DDE, as well as HCH isomers. The contamination is present in a very heterogenic way. Aside from a certain ‘background level’ for this area, most of the measured contaminant levels are likely associated with a ‘hit or miss’ of pesticide particle(s) in the soil matrix. This was also observed during the fieldwork campaign, as in some drillings outside of the landfill body, pure product was observed (white and lumpy: probably DDT or HCH; purple-pink: probably Granosan, a coloured preparation containing 2 % Ethylmercuric Chloride (see figure 4.6); yellow: Sulphur - colour and texture match exactly - not the orange-yellow colour of DNOC). Samples from boreholes in which pure product was observed were not collected for analysis based on the rationale that contamination in high levels has already been identified, and not to damage sensitive laboratory equipment. Only samples from -apparent- visually unaffected soil were submitted for analysis.

The presence of pure product outside of the landfill body is explained by the photos taken in April 2010 (Appendix 4 of the ToR) before the top cover was (re)-installed, that clearly show pure product was laying scattered around the current landfill body perimeter (see figure 4.6).
Another observation is the presence -or absence- of plant cover. Some of the analysed samples from the topsoil were collected from areas with plant cover (CSS 102, 104, 106), and some from areas with bare soil (CSS 103, 105 and 107). The analytical results indicate much higher contaminant levels in the ‘bare soil’ composite soil samples as compared to the ‘plant cover’ composite soil samples. Although the absence of plant cover may not necessarily be related to only POPs pesticides, it does relate to the presence of some of the substances buried in the landfill such as herbicides.

Figure 4.6 Left: pure product particle on auger head (likely Granosan) Right: The situation (April 2010) before closing of the landfill, with pesticide waste scattered around the current landfill body

4.3.4 Analytical results and interpretation sediments in the reed ponds

Below table 4.7 lists the samples taken from the sediments in the reed ponds down-gradient from the landfill body in a gully that was anticipated to carry run-off water from the landfill down to the valley. The first reed pond, Pond 1 is located up-gradient from the landfill and serves as a baseline situation for the other, (down-gradient) ponds. Appendix 7 presents maps with the sample locations. Figure 4.3 presents a birds' eye view that is very useful in understanding the situation of the ponds and gullies. The analytical results are given in the table 4.8.

Table 4.7 Samples of the sediments in the reed ponds in site surroundings

Sample	Composition	Location
Pond 1	CSS of 3 drilling points	Up gradient from the landfill body
Pond 5	CSS of 3 drilling points	In a gully, 100m down-gradient from the landfill
Pond 6	CSS of 3 drilling points	In a gully, 300m down-gradient from the landfill
Pond 7	CSS of 3 drilling points	In a gully, 630m down-gradient from the landfill
Pond 8/9[2]	CSS of 3 drilling points	In a gully, 720m down-gradient from the landfill

[2] Pond '8/9' is actually the same pond. The name was chosen for reason of consistency as it corresponds with drilling numbers 8 and 9, both located at the side of pond 8/9. The other drilling numbers do not have corresponding ponds

Table 4.8 Analytical results soil (mg/kg) reed ponds in site surroundings

Sample description	**Pond 1**		**Pond 5**		**Pond 6**		**Pond 7**		**Pond 8/9**	
Depth (m bgl)	**(0-0.2)**		**(0-0.2)**		**(0-0.5)**		**(0-0.2)**		**(0-0.2)**	
Clay size fraction (%)	**28**		**33**		**20**		**20**		**19**	
Organic matter (%)	**9,1**		**7,5**		**6**		**6**		**5,9**	
METALS										
Arsenic (As)	19	-	6,2	-	7,7	-	6,8	-	8,6	-
Cadmium (Cd)	0.13	-	0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Chromium (Cr) ###	79	+	43	-	31	-	51	+	37	-
Copper (Cu)	99	+	62	+	65	+	52	+	56	+
Mercury (Hg) ##	< 0.05	-	< 0.05	-	< 0.05	-	< 0.05	-	< 0.05	-
Lead (Pb)	34	-	17	-	21	-	18	-	18	-
Nickel (Ni)	93	++	47	+	42	+	48	+	45	+
Zinc (Zn)	110	-	65	-	75	-	62	-	63	-
CHLORINATED HYDROCARBONS										
Hexachlorobenzene (HCB)	< 0.001	-	< 0.001	-	< 0.05	-	< 0.001	-	< 0.05	-
PESTICIDES										
Sum of 2,4 and 4,4 DDD	0.011	-	0.031	+	< 0.05	-	0.0016	-	< 0.05	-
Sum of 2,4 and 4,4 DDE	0.005	-	0,056	-	< 0.05	-	0,0019	-	< 0.05	-
Sum of 2,4 and 4,4 DDT	< 0.001	-	0.33	+	0.48	+	0.0082	-	1.44	+++
Aldrin	< 0.001	-	< 0.001	-	< 0.05	-	< 0.001	-	< 0.05	-
Alpha-Endosulfan	< 0.001	-	0.0023	+	< 0.05	-	< 0.001	-	< 0.05	-
Alpha-HCH	< 0.001	-	< 0.001	-	< 0.05	-	< 0.001	-	< 0.05	-
Beta-HCH	< 0.001	-	0.0015	+	< 0.05	-	< 0.001	-	< 0.05	-
Gamma-HCH	< 0.001	-	< 0.001	-	< 0.05	-	< 0.001	-	< 0.05	-
Heptachlor	< 0.001	-	< 0.001	-	< 0.05	-	< 0.001	-	< 0.05	-
Not in STI-list of the SPA										
Dieldrin	< 0.001		< 0.001		< 0.05		< 0.001		< 0.05	
Endrin	< 0.001		< 0.001		< 0.05		< 0.001		< 0.05	
Delta-HCH	< 0.001		< 0.001		< 0.05		< 0.001		< 0.05	
T-Chlordane	< 0.001		< 0.001		< 0.05		< 0.001		< 0.05	
Endosulfan Sulphate	< 0.001		< 0.001		< 0.05		< 0.001		< 0.05	
Cis-Heptachloroepoxide	< 0.001		< 0.001		< 0.05		< 0.001		< 0.05	
Isodrin	< 0.001		< 0.001		< 0.05		< 0.001		< 0.05	
Telodrin	< 0.001		0.004		< 0.05		< 0.001		< 0.05	
Dry matter (Dm) (%)	55.2		74.2		68.5		68.8		74.6	

##: compared to the I-value for an-organic Mercury
###: compared to the I-value for Chromium (III)

DDD and DDE were measured in detectable levels (below the ‘slightly contaminated’ limit value) in the sediments of pond 1 (up-gradient from the landfill).

The sediments of the ponds 5 and 6 contain slightly elevated levels of DDD, as well as slightly elevated levels of HCH and Endosulfan in pond 5 which is located closest (100m) to the landfill. The levels in the sediment of pond 5 are relatively low, as one would expect that part of the run-off water from the landfill would end up in pond 5.
Based on visual inspection in the field, Ponds 6 and 7 (and possibly 8/9) appear not to be directly connected to the potential surface run-off from the landfill area (see figure 4.4). Concentrations of DDT, range from detectable (below the 'slightly contaminated' limit value) in pond 7, to slightly contaminated in pond 6. The sediments in pond 8/9 were measured to contain the highest levels of DDT of the five ponds. The second gully meets the first gully (with ponds 6 and 7) at pond 8/9. The second gully (the left one in figure 4.3) also does not appear to be directly connected to the potential surface run-off from the landfill area, based on visual inspection of the terrain topography (see figure 4.3). It does however drain the upper part of the valley close to the landfill. Although the gullies appear to not be directly connected to the runoff water from the landfill, it cannot be excluded that one or both gullies are (also) fed with water that has infiltrated into the landslide area.

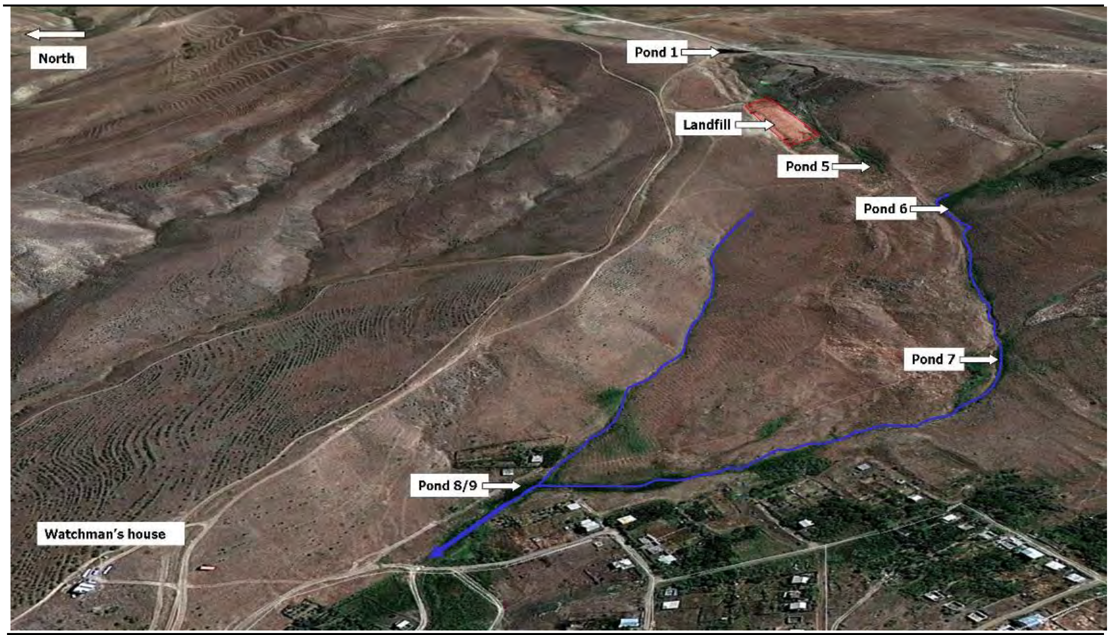

Figure 4.3 Bird eye's view image of the area. Both gullies merge at Pond 8/9

Figure 4.4 Left: Reed pond 8/9 with the drilling rig installing monitoring well 9. Right: Reed pond 6. This photo indicates that the gully is likely not connected to the landfill run-off. The landfill is located up-gradient, to the left, from the Tauw colleague walking in the top left of the picture, whereas the water feeding the gully appears to come from the top right of the picture

4.3.5 Analytical results and interpretation: samples from the landfill surroundings

Below table 4.9 lists the samples taken from the soil arisings from the drillings in the surroundings of the landfill. Appendix 2 presents maps with the sample locations. The analytical results are given in the tables 4.10 and 4.11.

Table 4.9 Samples from drilling points in the site surroundings

Sample	Composition	Location
2	2 (0-0.5m bgl)	5 m up gradient from the landfill body perimeter
3	3 (0-0.5m bgl)	5 m down gradient from the landfill body perimeter
4	4 (4-5m bgl)	5 m down gradient from the landfill body perimeter, in a trench intercepting run-off
5	5 (1-1.5m bgl)	At pond 5, in a gully, 100m down-gradient from the landfill
5	5 (4-4.5m bgl)	At pond 5, in a gully, 100m down-gradient from the landfill
9	9 (4-5 m bgl)	In a gully, near pond 8/9, 720m down-gradient from the landfill

Table 4.10 Analytical results soil (mg/kg) site surroundings

Sample description	**2**		**3**		**4**		**5**		**5**	
Depth (m bgl)	**(0-0.5)**		**(0-0.5)**		**(4-5)**		**(1-1.5)**		**(4-4.5)**	
Clay size fraction (%)	**37**		**25**		**42**		**25**		**30**	
Organic matter (%)	**6,7**		**5,9**		**5,2**		**6,3**		**7**	
METALS										
Arsenic (As)	6.7	-	7.6	-	4.5	-	7.3	-	7.6	-
Cadmium (Cd)	0.12	-	0.14	-	0.2	-	< 0.1	-	< 0.1	-
Chromium (Cr) ###	20	-	37	-	21	-	39	-	45	-
Copper (Cu)	55	+	54	+	51	+	56	+	61	+
Mercury (Hg) ##	0.09	-	< 0.05	-	< 0.05	-	< 0.05	-	< 0.05	-
Lead (Pb)	18	-	16	-	18	-	15	-	18	-
Nickel (Ni)	24	-	42	+	27	-	43	+	46	+
Zinc (Zn)	67	-	60	-	64	-	59	-	67	-
CHLORINATED HYDROCARBONS										
Hexachlorobenzene (HCB)	< 0.05	+	< 0.05	-	< 0.001	-	< 0.05	-	< 0.001	-
PESTICIDES										
Sum of 2,4 and 4,4 DDD	0.366	+	0.34	+	0.0047	-	< 0.05	-	0.0113	-
Sum of 2,4 and 4,4 DDE	1.32	++	2.95	+++	0.064	-	< 0.05	-	0.0053	-
Sum of 2,4 and 4,4 DDT	6.8	+++	8.6	+++	0.0739	-	0.49	+	0.187	+
Aldrin	< 0.05	-	< 0.05	-	< 0.001	-	< 0.05	-	< 0.001	-
Alpha-Endosulfan	< 0.05	-	< 0.05	-	< 0.001	-	< 0.05	-	0.0071	+
Alpha-HCH	< 0.05	-	< 0.05	-	< 0.001	-	< 0.05	-	0.0031	+
Beta-HCH	< 0.05	-	< 0.05	-	< 0.001	-	< 0.05	-	< 0.001	-
Gamma-HCH	< 0.05	-	< 0.05	-	< 0.001	-	< 0.05	-	< 0.001	-
Heptachlor	< 0.05	-	< 0.05	-	< 0.001	-	< 0.05	-	< 0.001	-
Not in STI-list of the SPA										
Dieldrin	< 0.05		< 0.05		< 0.001		< 0.05		< 0.001	
Endrin	< 0.05		< 0.05		< 0.001		< 0.05		< 0.001	
Delta-HCH	< 0.05		< 0.05		< 0.001		< 0.05		< 0.001	
T-Chlordane	< 0.05		< 0.05		< 0.001		< 0.05		< 0.001	
Endosulfan Sulphate	< 0.05		< 0.05		< 0.001		< 0.05		< 0.001	
Cis-Heptachloroepoxide	< 0.05		< 0.05		< 0.001		< 0.05		< 0.001	
Isodrin	< 0.05		< 0.05		< 0.001		< 0.05		< 0.001	
Telodrin	< 0.05		< 0.05		< 0.001		< 0.05		< 0.001	

##: compared to the I-value for an-organic Mercury

###: compared to the I-value for Chromium (III)

Table 4.11 Analytical results soil (mg/kg) site surroundings

Sample description	**9**	
Depth (m bgl)	**(4-5)**	
Clay size fraction (%)	**37**	
Organic matter (%)	**6**	
METALS		
Arsenic (As)	3.9	-
Cadmium (Cd)	< 0.1	-
Chromium (Cr) ###	35	-
Copper (Cu)	50	+
Mercury (Hg) ##	< 0.05	-
Lead (Pb)	15	-
Nickel (Ni)	27	-
Zinc (Zn)	60	-
CHLORINATED HYDROCARBONS		
Hexachlorobenzene (HCB)	< 0.05	-
PESTICIDES		
Sum of 2,4 and 4,4 DDD	< 0.05	-
Sum of 2,4 and 4,4 DDE	< 0.05	-
Sum of 2,4 and 4,4 DDT	0,47	+
Aldrin	< 0.05	-
Alpha-Endosulfan	< 0.05	-
Alpha-HCH	< 0.05	-
Beta-HCH	< 0.05	-
Gamma-HCH	< 0.05	-
Heptachlor	< 0.05	-
Not in STI-list of the SPA		
Dieldrin	< 0.05	
Endrin	< 0.05	
Delta-HCH	< 0.05	
T-Chlordane	< 0.05	
Endosulfan Sulphate	< 0.05	
Cis-Heptachloroepoxide	< 0.05	
Isodrin	< 0.05	
Telodrin	< 0.05	

##: compared to the I-value for an-organic Mercury
###: compared to the I-value for Chroom(III)

The samples taken from the soil arisings from the drillings in the site surroundings generally contain slightly, to strongly elevated levels of DDT. The strongly elevated levels were measured in the topsoil of drillings 2 and 3. There is no significant difference between the concentrations in drilling 2 (5 m up-gradient from the landfill body) and 3 (5 m down-gradient from the landfill body), which is explained by the fact that all soil in the direct vicinity of the landfill is impacted, as concluded in section 4.3.3.
The sample from drilling 4 (4-5 m bgl) contains only detectable levels of DDT/DDD/DDE, whereas a shallower sample from nearby drilling 41 (0.8-1.0) likely contains very high concentrations of pesticides (visual observation and strong smell), but for this reason was not submitted for chemical analysis.

The samples from drillings 5 and 9 exhibit slightly elevated concentrations of pesticides, mainly DDT. It cannot be ruled out that the samples from the greater depths (4-5 m) are false positives that have been caused by accidental cross-contamination during the drilling. This is supported by the low permeability of the soil.

4.3.6 Analytical results and interpretation: groundwater and standing water

Below table 4.12 lists the samples taken from the groundwater from the monitoring wells that yielded water, and from the reed ponds containing water. Appendix 7 gives the sample locations.

Table 4.12 Analytical results groundwater and standing water in the reed ponds (µg/L)

Location Filter depth (m bgl)	**M.Well 1 (4-5)**		**Pond 1**		**M.Well 7 (3-4)**		**Pond 7**		**M. Well 9 (18.3-22.3)**	
METALS										
Arsenic (As)	20.8	+	< 5	-	< 5	-	< 5	-	< 5	-
Barium (Ba)	160	+	97	+	11	-	110	+	41	-
Cadmium (Cd)	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Cobalt (Co)	< 2	-	< 2	-	7,1	-	2.5	-	< 2	-
Copper (Cu)	9.2	-	3.9	-	3	-	4.3	-	< 2	-
Mercury (Hg) ##	0.12	+	0.04	-	< 0.03	-	< 0.03	-	0.1	+
Lead (Pb)	7.8	-	< 5	-	< 5	-	< 5	-	50	++
Molybdenum (Mo)	24	+	23	+	5.3	+	20	+	7.8	+
Nickel (Ni)	9.8	-	< 5	-	19	+	5.4	-	< 5	-
Zinc (Zn)	9.1	-	< 2	-	< 2	-	< 2	-	2.1	-
AROMATIC COMPOUNDS										
Benzene	< 0.2	-	< 0.2	-	< 0.2	-	< 0.2	-	0.5	+
Ethyl benzene	< 0.5	-	< 0.5	-	< 0.5	-	< 0.5	-	5.2	+
Toluene	< 0.5	-	< 0.5	-	< 0.5	-	< 0.5	-	6.1	-
Sum of Xylenes									25	+
Naphthalene	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	2.6	+

Location Filter depth (m bgl)	M.Well 1 (4-5)		Pond 1		M.Well 7 (3-4)		Pond 7		M. Well 9 (18.3-22.3)	
CHLORINATED HYDROCARBONS										
Hexachlorobenzene (HCB)	< 0.1	+	< 0.1	+	< 0.1	+	< 0.1	+	< 0.1	+
PESTICIDES										
Sum of 2,4 and 4,4 DDD	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Sum of 2,4 and 4,4 DDE	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Sum of 2,4 and 4,4 DDT	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Aldrin	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Dieldrin	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Endrin	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Alpha-Endosulfan	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Alpha-HCH	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Beta-HCH	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Gamma-HCH	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
Heptachlor	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-	< 0.1	-
OTHER COMPOUNDS										
TPH C10-C40	< 50	-	< 50	-	< 50	-	< 50	-	53	+
Not in STI-list of the SPA										
Delta-HCH	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	
T-Chlordane	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	
Endosulfan Sulphate	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	
Cis-Heptachloroepoxide	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	
Isodrin	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	
Telodrin	< 0.1		< 0.1		< 0.1		< 0.1		< 0.1	

##: compared to the I-value for an-organic Mercury

The groundwater from monitoring wells 1 (filter 4-5 m bgl), 7 (filter 3-4 m bgl) and 9 (filter 18.2-22.2 m bgl) does not contain detectable levels of the analysed range of pesticides. Nor does the standing water from ponds 1 and 7 contain detectable levels of the analysed range of pesticides.
The other installed monitoring wells (2, 3, 4, 5 and 8) did not contain groundwater. Ponds 5, 6 and 8/9 also did not contain standing water and hence could not be analysed.
The slightly elevated levels of mineral oil (TPH) and Aromatic Hydrocarbons in monitoring well 9 (filter 18.2-22.2 m bgl) are likely caused by the mechanical drilling operation.

It is concluded that significant (i.e. long distance) migration of pesticides via the groundwater appears unlikely, although it is difficult to support this conclusion given the limited number of monitoring wells containing groundwater (especially close to the landfill body).

The fact that the (semi-permanent) groundwater table is present at relatively great depth makes the ‘spreading by groundwater migration’ pathway very unlikely or at least insignificant. With few exceptions, all substances stored at the landfill are very poorly water soluble, and would need to travel through a thick clay layer (i.e. low permeability) before reaching the (semi-permanent) groundwater in the first place. Nevertheless the presence of a volume of contaminated water (held in the pores) directly down-gradient from the landfill (where the concrete drains discharge) is not unlikely.

5 Geophysical assessment

This Chapter elaborates on the geo-physical characteristic of the landfill, its surrounding and the catchment area of this landfill in three sections. The first section gives a description of the catchment area of the landfill. The second section elaborates on the soil permeability. The last section deals with the geo-stability of the landslide body with landfill.

5.1 Drainage system and catchment area

The catchment area of the landfill is formed by the valley enclosed by the surrounding ridges. The drainage pattern of the catchment area is (unstable) dendritc. Due to very active erosion process such as landslides and gully erosion, drainage gullies are blocked and new gullies are formed, initiated cracks and cavities in the surface.
Upstream just across the watershed is Pool 1 (see figure 4.3) This pool has for a large part of the year standing water because the water main is forming a barrier for pool to drain completely. If the water level in the pool is higher than the top of the water main (see figure 5.1), the water flows towards the culvert under the road passing 300 - 400 meter upstream the landfill. This culvert is half blocked with sediments and prevents rapid drainage of the standing runoff water.
The standing water in the pool and the water between the water main and the blocked culvert infiltrate in the soil and percolates lateral in the landslide body in the catchment area of the landfill site, contributing to the instability of this landslide body.
The runoff in the catchment area is deviated to the concrete drains of the landfill site enclosing the landfill body. The runoff water from the Southern concrete drain ends in Pond 5 and the water in Pond 5 drains lateral in the landslide debris. The runoff water from the Northern concrete drain deviated to the gully draining the water to Pond 5. This runoff water also infiltrates and flows lateral in the in the top 4 meter of the landslide debris towards pond 8/9.

Figure 5.1 Left: The water main preventing the water to flow to the colvert Middle: The blocked culvert Right: Pond 1, the water main, the blocked culvert and the dirt road

5.2 Permeability and soil characteristics

The local geo-hydrology and soil characteristics on the site were determined by means of the following data:

- The nine borehole logs of the installed boreholes
- The 17 DPT-probings
- The four soil permeability tests
- The four soil sampling and grading curves

The Nubarshen landfill site is situated on the landslide debris of an active landslide. These debris comprise of silty clays with volcanic toof stone stones, boulders and blocks at various depths. From DPT-probing it can be seen that the stiffness of the top layer and landfill body is soft to firm. Generally from 2 to 4 m bgl and deeper the soil stiffness becomes very stiff to hard.

Soil samples from the four boreholes where the permeability tests are carried out are analyzed for the grain size distribution. The results and the classification of the texture according to the USDA classification are presented in Appendix 8. The soil texture in the top soil (0.0 - 0.5 m bgl) varies from clay loam to loam, the soil texture of the deeper soil horizons vary from clay to sandy clay loam.

The four soil permeability tests were conducted to determine the hydraulic conductivity of the soil at various depths. The soil permeability test used was the inverse auger borehole method.
The principle of this test is to fill a well or borehole with an amount of water and measure the rate of fall of the water level in the well or bore hole. For the test, four wells were used to determine the hydraulic conductivity of the soil at the screened interval. The results of the tests are presented in table 5.1.
The values as presented in table 5.1 are quite high for the clay soils. This is especially true at well 3 where a hydraulic conductivity value is measured of 1.96 m/day which is far too high for a clay soil. Generally for soils consisting of clays and silt values for the primary permeability between 0.05 and 0.001 m/day are more common. The detected permeability values that are much higher are seen as the secondary permeability values.

Table 5.1 Results inversed auger hole tests

Well	Screened interval (m bgl)	Soil type at screened interval	Hydraulic conductivity (m/day)
1	4 – 5	Clay	0,15
2	3 – 4	Sand, stones and clay	8,55
3	3 – 4	Clay	1,96
7	4 – 5	Clay	0,14

This high hydraulic conductivity is explained by the cracks, cavities and/or other heterogeneities of the landslide debris in the soil have influenced the measurements. It can also be seen that the hydraulic conductivity at the sandy and stony parts at well 2 is much higher than the other measurements. If a horizontal layer of this sandy or stony layer and meso and macro pores are present over a larger area, a significant amount of lateral transport can take place in this layer of landslide debris. This phenomenon is supporting the described lateral drainage of the runoff water from Pond 5 and the Northern concrete drain of the landfill.
Given the soil stiffness and the low permeability of the silty clays underlying the landfill body, it can be concluded that at around 2 tot 4 m bgl there will be a significant increase in resistance to vertical infiltration of water into the underlying soil. As a result of this a perched water table can be formed in the top layer and landfill body during wet seasons. This causes horizontal transport of water through the top layer of the landfill body and can also cause overland flow during periods of heavy rainfall causing gully erosion when flowing through cracks and cavities.
The formation of a perched water table in the top layer also influences the activity of the landslide. This is schematically represented in figure 5.2.

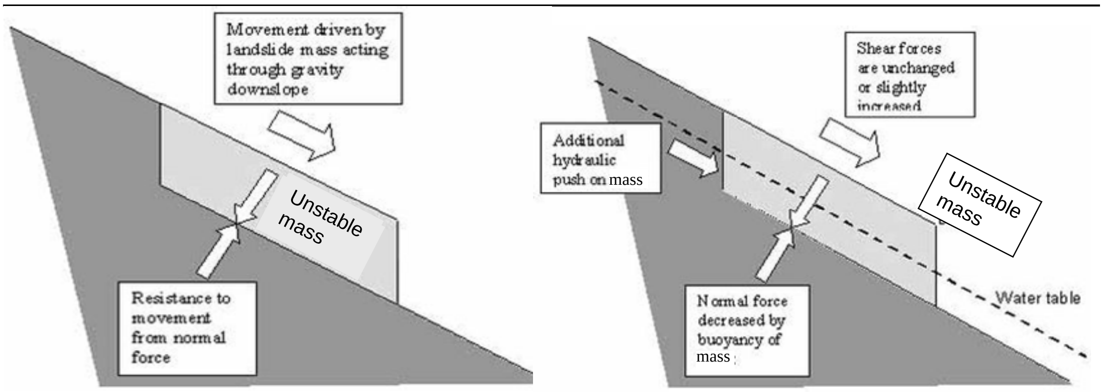

Figure 5.2 Diagram illustrating the resistance to, and causes of, movement in a slope system consisting of an unstable mass

5.3 Geo stability of the landslide

5.3.1 Introduction

Observations in the field and the site assessment results as described above indicate that the landfill area is located on an unstable landside. The landfill site itself (fenced area) is relatively flat but is surrounded by steeper terrain. Especially upstream of the landfill site, the terrain is steep and shows signs of previous landslides in the form of terraces (see Figure 5.3). It is assumed that the driving force of the lateral mass movement in the flatter terrain is the slope instabilities upstream. The slope stabilities upstream appear to be activated by the inflow of water from the small (man-made) pool 1 (see figures 4.3 and 5.1) at the top of the slope.
In order to confirm that the upstream mass movement is the mechanism behind the mass movement in the landfill site (as described in section 5.2), a numerical stability analysis is carried out. The stability analysis is performed based upon 'Bishops' method.

The leading failure plane is assumed to have a circular type of shape (see figure 5.3 red dashed lines). The trials that analyse the stability analysis are based on a grid of centre points of slip circles and a set of horizontal tangent lines of the corresponding slip circles. The centre of the leading slip circle is normally situated near the top of a slope at a fictive position in the air. Prior to the stability analysis an area wherein the centre of the leading slip circle is situated has to be defined. The input of the expected zoning is presented by all the black crosses in figure 5.4. However, the leading slip circle might very well be situated outside the prior defined zone.

In such case, it is possible to perform a stability analysis whereby the leading slip circle is calculated in an iterative way. The slip circle analysis automatically migrates towards the location where the safety factor is considered minimal. Therefore, the red crosses in figure 5.4 embody the final zones wherein the centre of the leading slip circle is calculated.
The lines characterize the zoning of the base of the slip circle. The base of the leading slip circle also needs to be estimated. In other words, the location of the deepest position of the leading slip circle needs to be defined prior to the stability analysis (green lines). In consequence the deepest position of the leading slip circle actual might be situated at a different position. The final zoning is defined by the red lines.

The importance of the water level is demonstrated by varying the pore water pressures in the stability analysis. The water pressure is simulated by the water level of the perched water table. The following scenarios are analyzed:

1. Perch water level at 133 meter blow surface level
2. Perch water level at 1.21 meter below surface level
3. Perch water level at 1.06 meter below surface level
4. Perch water level at 0.90 meter below surface level

5.3.2 Assumptions

In the overall stability analysis the following assumptions are made:

- The landfill body is slightly elevated
- The overall slope at the landfill site is considered low
- The landfill site is a relative flat part of the terrain
- On a local level the landfill body is considered stable
- The terrace levels above the landfill site are the result of mass movement
- These terraces are the result of earlier massive slope failure (figure 5.3)

Stability requires that the sum of the driving moments is equal to a certain resisting moment. The driving moment is usually defined as the sum of soil moment (unit weight), water moment (water levels), and loads moment (weight by building, truck, et cetera).
The resisting moment (M_r) is defined as the moment caused by the shear stresses along the circular arc around the centre of the slip circle. In practice the shear (τ) is dependent on effective cohesion (c') and internal friction angle (ϕ).
Unit weight and strength parameters are estimated based upon engineering judgement and soil description and are given in table 5.2.

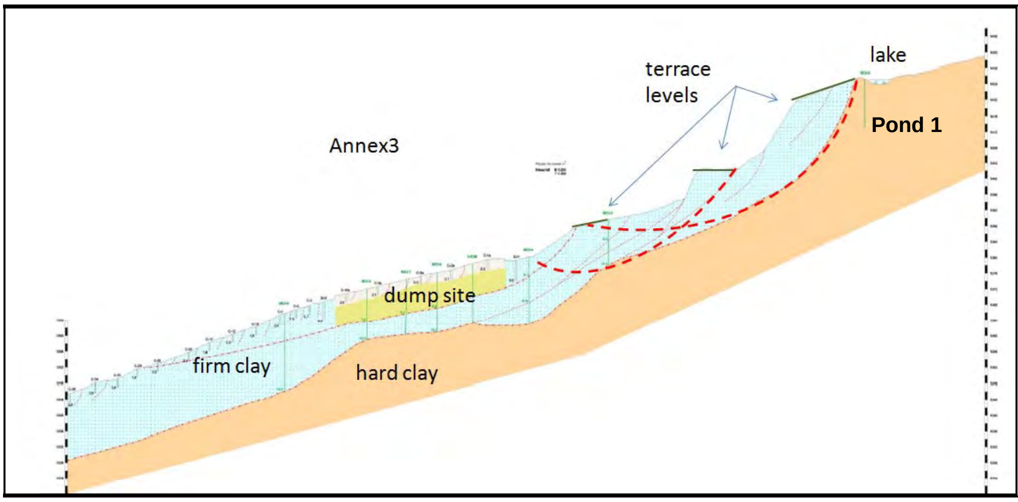

Figure 5.3 Geotechnical interpretation of section (ref. annex 3 by Dr. Yadoyan)

Table 5.2 Assumed geotechnical parameters

Soil name	Unit weight g/g_{sat} [kN/m^3]	Cohesion c'[kN/m^2]	Internal friction angle [°]
Waste dump	15/15	2,50	15,00
Firm clay	19/19	15,00	22,50
Hard clay	19/19	15,00	22,50

5.3.3 Stability analysis

An overall stability analysis is performed with the Bishop Slip Circle failure criterion (see appendix 8 for the results). Three critical sections are analysed. The governing slip circle is determined. In practice, the leading safety factor of the soil body above the landfill site is determined. Fluctuation in dry/wet soil conditions alternated the stability factor as the vertical effective stress (σ'_V) is adjusted. To gain insight in the stability factor two scenarios are analysed:

1. Saturated slope - Groundwater level 0.5 m below grade over the entire slope
2. Drained slope - Groundwater level 9.0 m below grade over the entire slope

In addition, a water level at the lake on top of the slope is maintained. The results of the overall stability analysis are presented in table 5.3.

Table 5.3 Overall stability waste dump area

Appendix	Stability Factor [-] Saturated conditions	Stability Factor [-] Dry conditions)
8-5	0.91	1.33
Chart 6	0.70	1.01
Chart 7	0.99	1.49

These stability results can be summarised as follows:

- If the slope is completely saturated the slope is not stable in any of the sections (Safety Factor average = 0.86). In this scenario deep seeded sliding plane would result in a slope failure above the waste dump area. As a result the newly created surface above the landfill would decrease the stability of the landfill body
- If the slope is dry the overall stability is guaranteed in all three sections (Safety Factor average = 1.28). In all three sections the safety factor changes with fluctuating water levels. Clearly, the water level of the slope (more specific: the top slope area near the lake) has a major impact on the slope stability

5.3.4 Conclusions and recommendations

Slope movement upstream of the landfill site is the mechanism behind the observed mass movement in the landfill site and its surrounding area. The stability of the upstream area of the landfill site is controlled by the perched ground water levels. By lowering the perched ground water table or reducing the influx of water into the slope, the stability of the landslide will improved and the risk for erosion such as mass movement will be reduced significantly. A simple measure is to drain Pond 1 by making a passage for the standing water under the water main and opening the culvert under the road and repair possible leaks in the water main that runs along the between Pond 1 and the road. This and other recommendations will be taken into consideration in the design of the landfill rehabilitation in the next phase of the project, Phase 3.

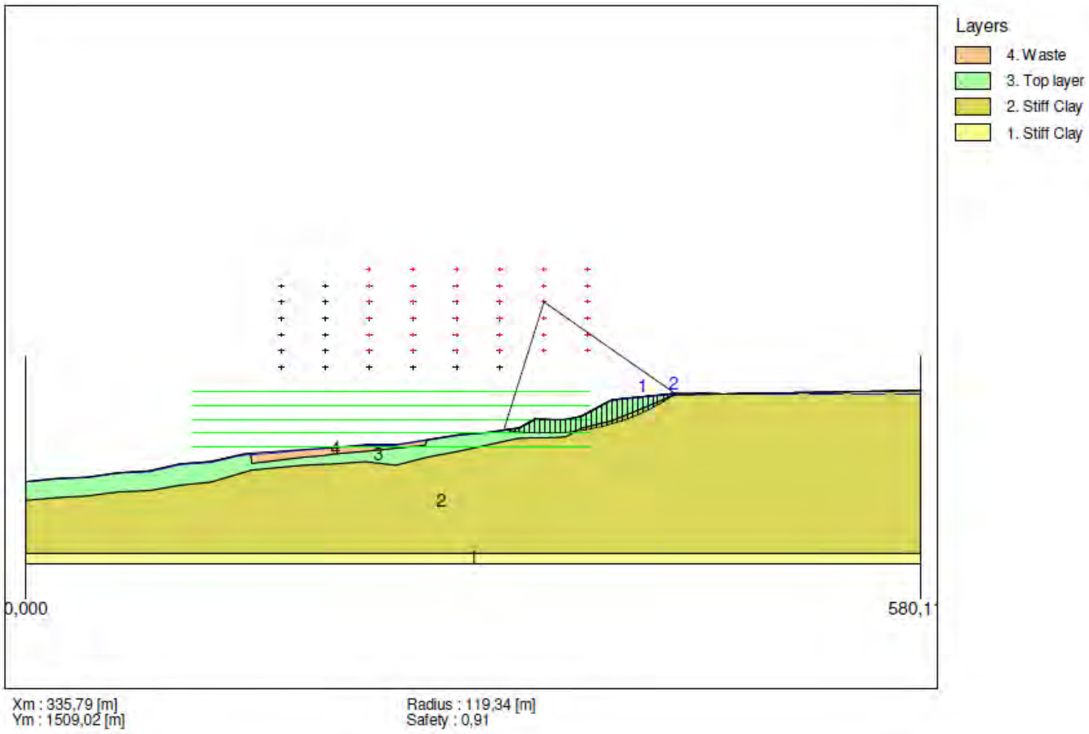

Figure 5.4 Critical Circle Bishop

6 Tier 2 risk assessment

This chapter gives in the first section the source of the contamination, the potential receptors pathways are discussed in the second section. The third section elaborates on the results of human health risk assessment. The conclusions of the Tier 2 risk assessment are presented in the last section of this Chapter.

6.1 Source of contamination

Based on the information presented in chapter 4 of this report, it can be concluded that the topsoil within the fence is contaminated with pesticides; the soil contamination seems to be very heterogeneous. There are areas with relatively uncontaminated topsoil and areas with very high levels and also small spots with pure product of pesticides present in the topsoil within the fence. So the main source of contamination is contaminated topsoil and pure product which is occasionally present in topsoil.

The other potential source of contamination is the dumped pesticides waste in the landfill body. Leaching of pesticides from the landfill body into ground- and surface water is not confirmed by the current data and therefore not taken into account in this human health risk assessment.

Elevated levels of pesticide are reported in the topsoil outside the fence in an earlier soil investigation (Dvorska at al. (2012)). Based on available data it cannot be excluded that locally in the area outside the fence strongly contaminated soil or pure pesticide is present (possibly historic origin from the time when landfill was filled or due to the illegal opening of the landfill body in 2010). Therefore it is suggested to set-up a buffer zone of around 100 m around the fenced area. It is suggested to restrict access to the buffer zone to avoid contact of residents/farmers and agricultural animals to contamination spots. For the risk assessment the area within the buffer zone will be treated in the same way as the area within the fence.

The topsoil in the downstream ponds is not contaminated and therefore not seen as (secondary) source and therefore not taken into account in this human health risk assessment.

6.2 Relevant pathways and receptors

Table 6.1 gives an overview of the sources, pathways and receptors taken into account in the Tier 2 human health risk assessment. Potential receptors taken into account in this human health risk assessment are:

- Workers on-site (adults) with the following exposure pathways:
  - Via direct contact to contaminated topsoil and spots of pure product
  - Possible contact with airborne contaminated fine soil particles
- Farmers and residents (adults and children) with exposure pathways:
  - Mainly via direct contact to contaminated topsoil
  - Possible contact with airborne contaminated fine soil particles

– Via animal products e.g. from cattle or poultry roaming freely over contaminated soil in the direct surroundings of the landfill site

Table 6.1 CSM for the human health risk assessment of the Nubarashen burial site

Contaminated source media	Exposure routes	Receptors	Explanation
Topsoil within fence and buffer zone	− Direct contact − Run off − Wind erosion − Leaching	− Workers	− Direct contact with contaminated topsoil − Airborne contaminated soil particles
Topsoil outside buffer zone	− Direct contact − Run off − Wind erosion − Leaching	− Residents − Farmers	− Direct contact with contaminated topsoil − Airborne contaminated soil particles − Animal products from animals that have contact with contaminated soil
Vegetation growing on topsoil outside buffer zone	− Direct contact − Ingestion	− Residents − Farmers	− Consumption of plant products grown on contaminated soil − Consumption of eggs, milk and cream
Groundwater	− Leaching − Groundwater transport	− Downstream users	− Water used as drinking water for animals and gardening − **Currently significant transport not confirmed by data presented here**
Surface water in ponds downstream	− Run off − Surface water transport	− Downstream users	− Water used as drinking water for animals and gardens − **Currently significant transport not confirmed by data presented here**

The chemicals of concern which are taken into account in the risk assessment are DDT, DDD and DDE as well as α-HCH and γ-HCH. The toxicity assessment of these chemicals of concern is given in Appendix 9.1. According to Dutch risk assessment guidelines for contaminated sites DDT, DDD and or DDE as well as α-HCH and γ-HCH are assessed based on threshold effects (as non-carcinogens). In some countries (some) of these compounds are considered (probable human) carcinogens (e.g. US-EPA IRIS database).

In a study about POP release to the environment Dvorska et al. (2012) calculated cumulative cancer risk probabilities for adults for the surroundings of the Nubarashen pesticide burial site based on concentrations of DDT and related compounds in two composite egg samples and one sample of cow's milk and cream, respectively. With the information supplied in the study (including the supplementary material) the calculations could not be reproduced. The information regarding POPs concentrations in animal products published in the study of Dvorska and co-authors is valuable, however the number of the samples is limited and the study does not give evidence for a causal relationship between the current condition of the landfill site and the concentrations of POPs in animal products in the surroundings of the landfill site. Further research is needed to find out whether to include or exclude cancer risks for residents in the risk assessment.

In this risk assessment, a quantitative Tier 2 risk assessment was performed for two scenarios: workers on site, exposed to pesticides mainly via topsoil with very high concentrations and residents in the surroundings exposed to pesticides mainly via topsoil and also via food (home grown vegetables). The human health risks were quantified using the CSOIL model (CSOIL2000, RIVM 2001). Calculations were performed evaluating DDT as threshold substance with a maximum permissible risk limit of 0.5 µg/kgd.

6.3 Results of human health risk assessment

For workers on the site (fenced area including buffer zone), CSOIL2000 calculates a human health risk limit of about 1,500 mg/kg for DDT. So the maximum pesticide concentrations reported here are in the order of magnitude of the human health risk limit. As the calculations were performed for the maximum soil concentrations and taking into account that the distribution of the soil contamination is heterogeneous it can be concluded that these pesticide concentrations do not result in exposure above acceptable levels for workers, as there are no workers on the contaminated spots on regular (day-by-day) basis. However the results also show that access to the site should be restricted to prevent the access of unauthorized persons on the contaminated area. Soil concentrations higher than 50 mg/kg might require further action based on the technical guidelines related to the Stockholm Convention.

As locally pesticides with a high acute toxicity might be present in the topsoil also in the form of pure pesticide, health risks related to acute toxicity cannot be excluded for the fenced area including the buffer zone. The site and the buffer zone should not be accessed without adequate protective equipment, farmers, residents and agricultural animals should not access the site including the buffer zone.

For the residential scenario including home-grown vegetable consumption, CSOIL2000 calculates human health risk limits between 1 mg/kg and about 10 mg/kg for DDT for lifelong exposure, depending on the type of pesticide and the type of food produced in gardens and the proportion of home produced food. Details of the calculations are given in Appendix 9.2.

For agricultural soils where animal products are produced, lower values of POPs are required, however the values are difficult to quantify. Canadian Soil Quality Criteria for Environment and Human Health state a soil concentration of 0.7 mg/kg for (total) DDT in agricultural soil and 0.01 mg/kg for Lindane in agricultural soil. Based on current Soil Quality Criteria for POPs pesticides in topsoil (mostly between 1-10 mg/kg or lower in case animal products need to be included) and the calculations made with CSOIL, it is suggested to further clarify details regarding the concentrations of pesticide in eggs and milk products in the surroundings of the site.

6.4 Conclusions risk assessment

A summary of the risk assessment for the Nubarashen burial site is given in the table 6.2 below. The risks on the site are mainly determined by:

- The stability of the landfill (risk of sliding and spreading of the pesticides)
- Further events of illegal access/waste mining
- Heterogeneous distribution pattern of contamination and potential presence of pure pesticide in top soil

As risks to human health cannot be excluded for residents/farmers on the fenced area and in the buffer zone surrounding of the fenced area, it is suggested to take measures to increase stability of the landfill and to raise awareness regarding the toxicity of POPs to help prevent further damage of the safeguarding structures and to prevent contact of residents/farmers and farm animals with strongly contaminated topsoil and pure pesticide on topsoil.

Table 6.2 Summary of the results of the risk assessment for the Nubarashen burial site

Contaminated source media	Exposure routes	Receptors	Unacceptable risks?
Topsoil within fence and buffer zone	− Direct contact − Run off − Wind erosion − Leaching	− Workers	− No if PPE is used − Possible − Possible − Not confirmed by current data
Topsoil outside buffer zone	− Direct contact − Run off − Wind erosion − Leaching	− Residents/farmers	− No − Possible − Possible − Not confirmed by current data

Contaminated source media	Exposure routes	Receptors	Unacceptable risks?
Vegetation growing on topsoil outside buffer zone	– Direct contact – Ingestion of animal product	– Residents – Farmers	– Possible – Clarification needed
Groundwater	– Groundwater transport – Run off – Surface water transport	– Downstream users	– Currently significant transport not confirmed
Surface water	– Leaching – Run off – Surface water transport	– Downstream users	– Currently significant transport not confirmed

7 Conclusions and recommendation

7.1 Conclusions

- The fenced landfill site at Nubareshen:
  - Is 0.85 hectares large
  - Comprises of a landfill body (0.15 hectare) and surrounding land (0.7 hectare)
  - Is enclosed at three sides by concrete runoff drains
  - The 40 cm topsoil of the 0.15 hectare landfill cover is contaminated
  - The estimated in/situ volume of the contaminated landfill cover is at around 600 m^3
  - The topsoil of the surrounding 0.7 hectare is heavily contaminated till of 0.5 m
  - The estimated in/situ volume of the fenced contaminated top soil is at around 3,500 m^3
- The landfill body itself:
  - Is one trench of probably 1.7 m deep, of 80 x 8 m
  - Covered by a hillock of approximately 0.15 hectare (1.5 m high and 104 x 15 m)
  - Has a 2 mm ruberoid liner below the 40 cm top cover
  - Below this liner is a 0.5 m soil layer, covering the dumped pesticides
  - The environmental quality of this layer is expected to be contaminated
  - Possibly 512 ton of pesticide waste was dumped in the Nubarashen landfill
  - The estimated in-situ volume of:
    - The soil layer covering of the dumped pesticides is at around 1,100 m^3
    - The dumped pesticides is on an average around 1,200 m^3
    - Contaminated soil in the trench is estimated at around 75 m^3
- The groundwater and the surface water downstream the landfill site Is not impacted
- Uphill from the landfill site:
  - Are a pond and a dirt road with (probably leaking) water main
  - The run off water drainage is blocked by water main and a blocked culvert
  - The water in the pond and the water from the leaking water main infiltrate in the soil and percolates laterally in the catchment area of the landfill
- The perched groundwater table upstream is influencing the stability of the landslide
- Slope movement upstream of the landfill site is the mechanism behind the observed mass movement at the landfill site
- Lowering the perched ground water table reduces the influx of water into the slope and there the stability of the landslide will improve
- The Tier 2 risk assessment concluded that only the people entering/ working at the landfill site and in a buffer zone of 100 m around the landfill site have direct contact risk with the contaminated soil

- Direct contact can be avoided when proper personal protective equipment is used when entering the buffer zone and site

7.2 Recommendations

- Before the best option can be selected the volume of dumped waste has to be confirmed with additional site survey revealing
  - The actual depth of the trench with the dumped waste
  - The length and width of the trench with the dumped waste
- This additional survey will be carried out be installing around:
  - 12 boreholes in one longitudinal section crossing the landfill body
  - 8 boreholes in one cross section of the East part of the landfill body
  - 8 boreholes in one cross section of the middle of the landfill body
  - 8 boreholes in one cross section of the West part of the landfill body

Appendix

1

Geophysical mapping of a landfill Armenia Report 2013P413R2

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Geophysical mapping of a landfill, Armenia

Justification

General Information

Titel	Geophysical mapping of a landfill in Armenia
Medusa Project	2013-P-413
Client	Tauw
Medusa Report	2013-P-413R1
Assignment	Mapping of landfill
Medusa Projectleader	R. Koomans
Reporting	W. Rooke
Operators Medusa	W. Rooke
Date of measurement	Week 8, 2013

Site information

Locations	Armenie
Soil type	Clay
Conditions	-2 -10 degrees, wind 3, mainly dry, some snow on ground
Disruptive elements during fieldcampaign	Wet clay, steep slope

Technology

Sensors used	GSSI GPR 400 MHz
settings	depth interval 50 and 100 ns
Line spacing	1m
Positioning	Surveywheel, GPS measurements of corners of field
Accuracy of positioning	25cm

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Contents

1 Introduction

1.1 Framework

Nearby Yerevan, the capital of Armenia, lies a site where pesticides have been stored. These pesticides are placed inside so-called *bunkers*; rectangular holes in the subsurface. In this lolcation, these bunkers located on a sloping colluvial fan. The surface of this fan slowly slides down, taking what's buried inside with it. The soil seems to consists of a form of silt and signs of erosion are plenty.

On top of the presumably 6 bunkers (5 of which could measure 5x16m according to a drawing, and one on the lower side measuring smaller dimensions) a clay body was placed after attempts were made to steal the pesticides some years ago.

The Conceptual Model that was set up previously is shown below:

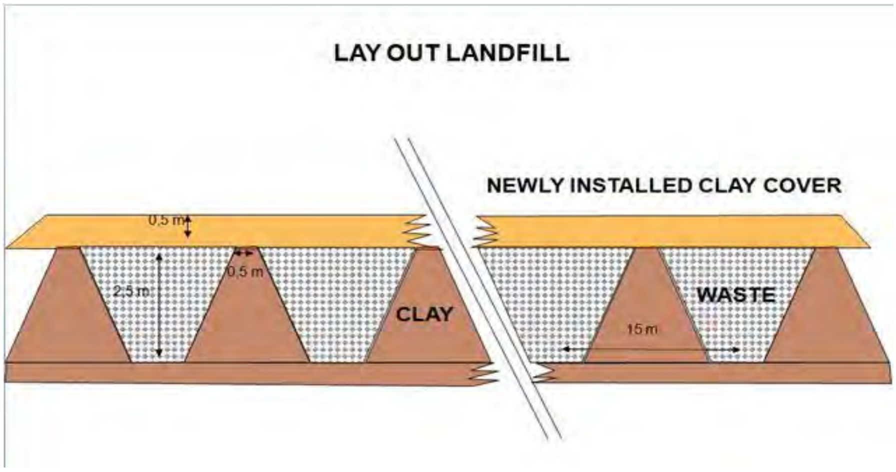


Figure 1: the Conceptual Model

1.2 Question

The research question was to determine the positions of these bunkers, in order to locate monitoring wells and to investigate the mobility of the bunkers.

In addition to this question, information is needed on anomalies in the clay body , the thickness of the clay body , and whether there are any signs of buried waste outside the clay body. Resulting in the following questions:

- What are the positions of the bunkers?
- Are there anomalies in the covering clay body?
- What is the thickness of the covering clay body?
- Are there signs of buried waste outside the clay body?

2 Basics

2.1 Location

The site is located in the hills located to the south-east of Yerevan Armenia at an elevation of about 1500m (Figure 2).

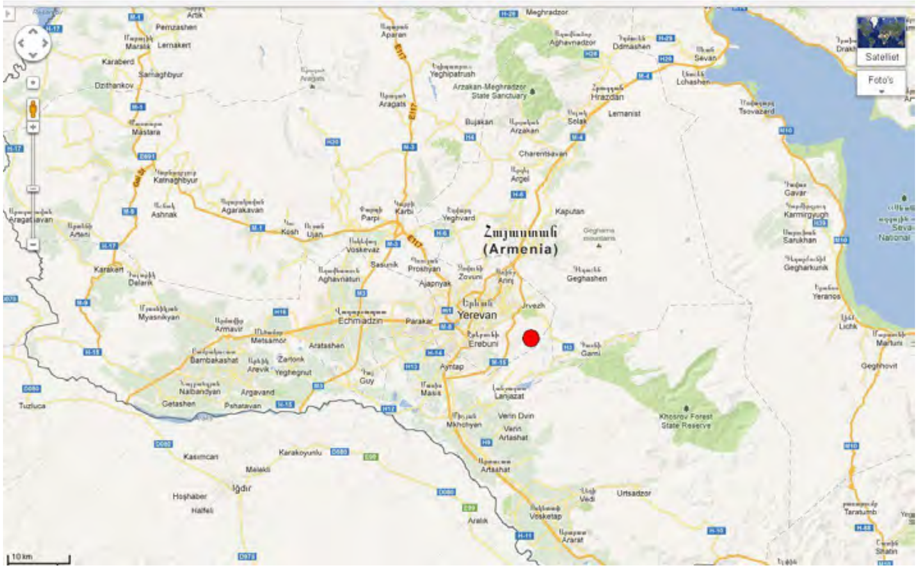


Figure 2: the location (marked as red dot). Source: Google Maps

2.2 Strategy

The strategy was to measure the whole area within the fencing with a GSSI 400 MHz GPR antenna, with gridlines of 1x1 meter.

Since the area is not that large and the expected top layer is about 50cm thick, measurements will be taken at 2 different settings; one for detailed recording of the top layer (about 1,5 m max, depending on soil type and moisture content) and one for deeper(but less detailed) penetration (up to about 4m, depending on soil type and moisture content).

Because it is not known whether a good enough quality of GPS is available, the choice was made to position the measurements using a *surveywheel*; this measures the exact distance from a known starting point, thereby generating a local grid. Points along this grid will be acquired using a hand-held GPS, that is held at a position for a longer period of time.

The GPS recordings and the local grid are converted to a geo-referenced grid afterwards.

3 Fieldwork

3.1 Execution

The execution of the fieldwork was difficult. The soil at the site formed a large obstacle in conducting the fieldwork. The soil consists of a type of silt or clay that sticked to the equipment. Depending on the time of day, it changed in substance and went from solid after frost in the morning, trough tough and sticky when cold and wet, to soft and sticky after warming up during the day. It caused the wheels of the surveycart to jam. The wheels became larger and heavier after each turn of the wheels so they had to be scraped clean almost continuously. Also, and more important, the surveywheel needed constant attention. For an accurate positiont is very important that the survey wheel keeps turning, and turning at the right speed. When the diameter of the surveywheel changes due to the clay sticking to it, it doesn't measure the correct distance. Therefore it had to be checked and cleaned many times during the execution of the fieldwork. Due to this not all physical contact with the soil could be avoided and it took some effort to get the critical parts like connectors and surveywheel parts cleaned at night.


Figure 3: the landfill seen from above


Figure 4: clay sticking to the equipment

Figure 5: cleaning the equipment

3.2 Used equipment

The structure of the soil is mapped with a ground penetrating radar system (GPR). A GPR consists of a set of electromagnetic sender and receiver antennae. This system emits a high-frequency radio pulse through the sending antenna which reflects on individual layers or objects in the soil. In surveys, the GPR system takes semi-continuous measurements whilst moving: pulses are emitted dozens of times per second while their reflection times are being recorded. This results in a cross-section showing different reflectors. The position of the system was recorded by using a surveywheel.

The data of a GPR survey show changes in layer structure and presence of objects. These measurements will be used to demarcate the extend of the dams, cells with landfill and concrete structures.

The examples below give an overview of potential deliverables of a geophysical site investigation.

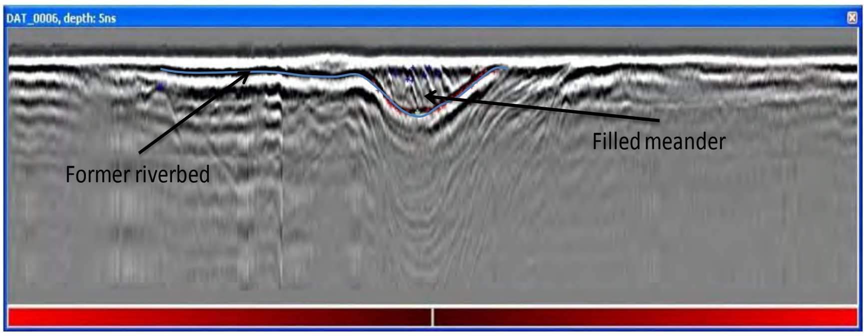


Figure 6: example of a GPR cross section showing structures in soil.

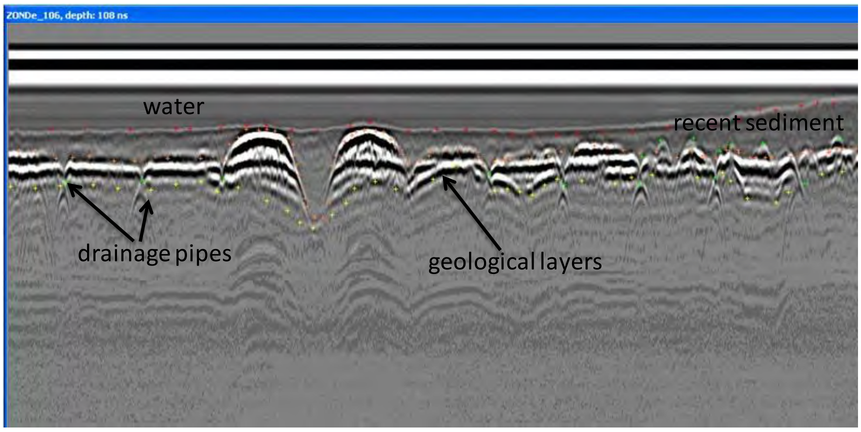


Figure 7: example of GPR cross section, showing geological layers and drainage pipes.

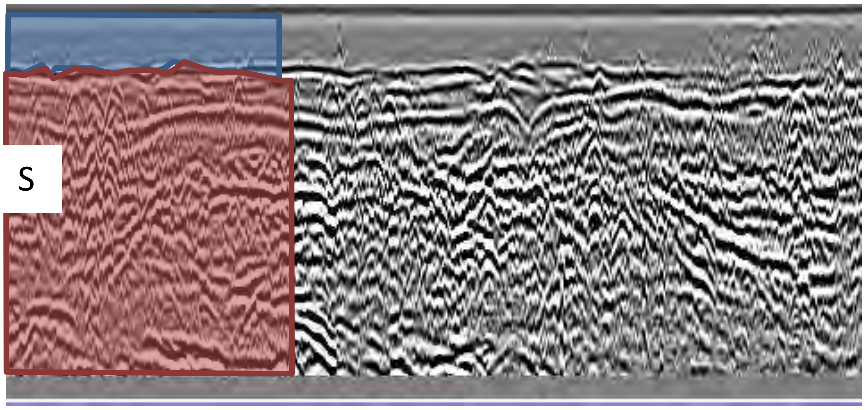


Figure 8: example of a GPR cross section showing the presence of a landfill

Figure 9: the 400Mhz antenna in Armenia

4 Results

4.1 Dataprocessing and analysis

The local grid data have been projected to a global coordinate system (UTM 38 North)

The data were manually analyzed by interpreting each radarprofile and marking the reflections of interest.

Both moist and clay are factors that cause the signal to be absorbed quickly and thus have a negative impact on GPR depth visibility.The quality of the data was poor due to these local circumstances. The high moisture content and high clay percentage prevented the radarsignal from penetrating the subsurface deep enough.

During the survey more information about the site appeared and it became likely that the layer of clay covering the bunkers is thicker than anticipated. The most recent insights suggest that the bunkers are located right below the surrounding surface, so that everything above ground level is actually the covering layer. This means that about 1,5 m of clay is on top of the bunker instead of 0,5 m.

So while the radarsignal in theory penetrates to roughly 4 meters deep, the local circumstances resulted in absorbtion of the signal before reaching the bunkers.

What is left of the signal is amplified and presented in a map showing local differences in reflection of the GPR signal (see appendix) in the top 0.5 m. In this analysis, the amount of reflection in different layers is presented. This map shows the reflections per datapoint along the survey lines. Red datapoints show a high reflection (e.g. obstacles, stones), blue points show a low reflection. Due to difficulties with the jamming of the surveywheel, not all lines have an equal length and the positioning in the northern part of the surveyed area has an uncertainty of about 5-10 m.

The map shows a remarkable zone of high reflection in the northern part of the site. This is probably due to the presence of the edge of the dump site. The large difference in reflection at the centre of the site, falls together with the shift in two measuring days. Apparantly, the large day-to-day differences in moisture between both days is reflected in the results.

The small scale variations in the scans probably reflect differences in soil texture and presence of debris. Although the data is hard to interpret, we suggest to use the small scale variations to place shallow corings to interpret the anomalies in the covering clay body. These locations are marked with circles in the map.

5 Conclusions and recommendations

5.1 Conclusions

The conditions of the site, notably the high clay content, moist percentage and thicker than expected top-layer thickness have led to a high radar-signal absorbtion and therefore poor results.

While the setup is suited to look into the subsurface for up to about 4 meters deep, the reality is that it the image is blurred at this depth.

5.1.1. What are the positions of the bunkers?

In the reflection scans slight variations can be noted, but a relation to any of the bunkers is speculative.The positions of the bunkers could not be determined with the GPR measurements

5.1.2. Are there anomalies in the covering clay body?

In the reflection scans slight variations in the top 0,5 m can be noted. The reasons wfor this variations are not clear, but locations for shallow corings are suggested to interpret these data.

5.1.3. What is the thickness of the covering clay body?

The thickness of the clay body is at least 0,5 m. The field visit led to conclude that the bunkers are located right below the surrounding surface, so that everything above ground level is actually the covering layer. This means that about 1,5 m of clay is on top of the bunker instead of 0,5 m.

5.1.4. Are there signs of buried waste outside the clay body?

The top layers of both dump-site and surrounding area consist of a relatively homogenous material with many small objects that are most likely rocks. No signs of buried material have been found in the surrounding area, and the the top layer on top of the actual dump site is preventing a view at what’s underneath.

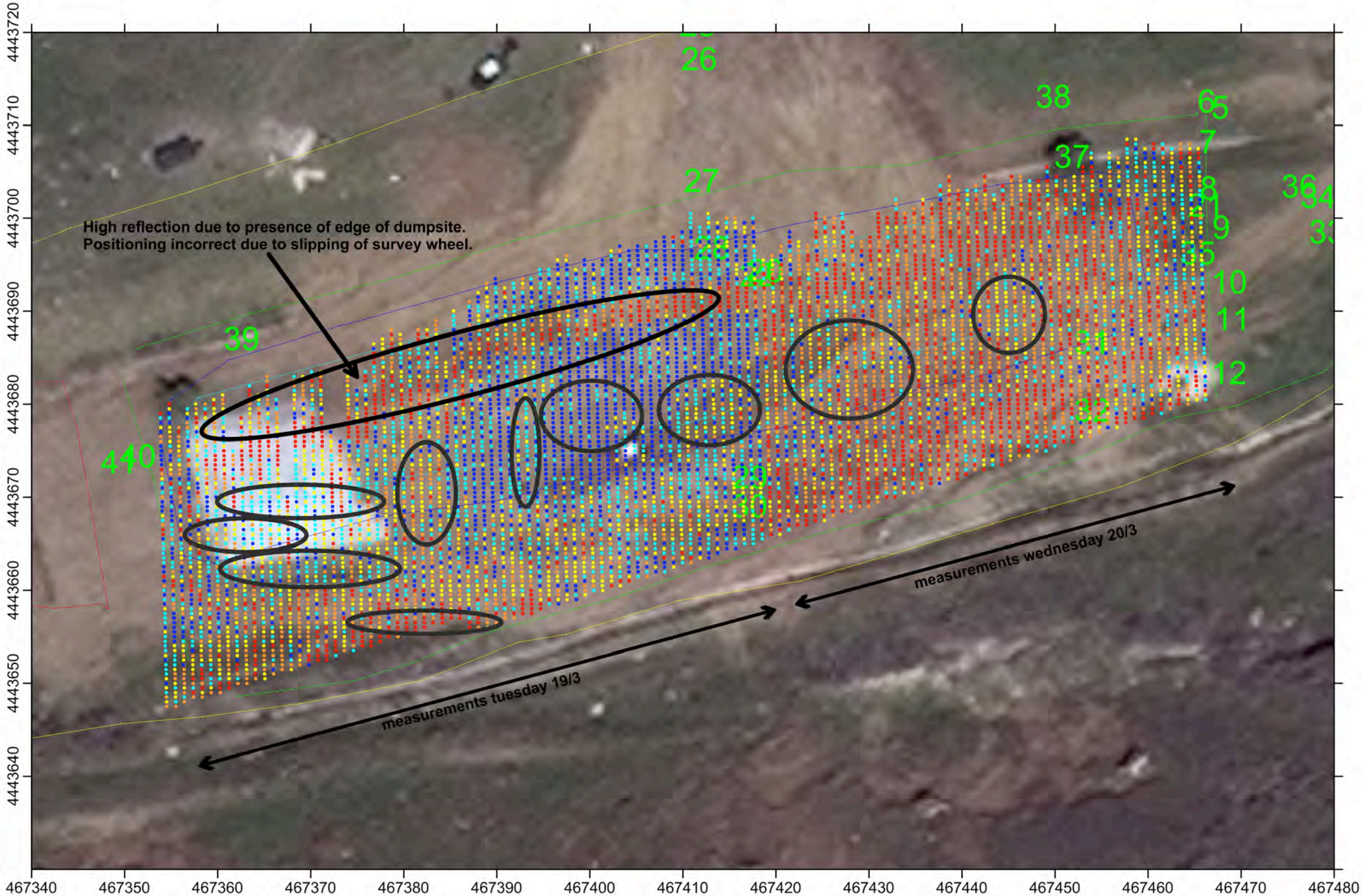
5.2 Recommendations

The field conditions and the, unexpected, potentially large clay cover did not result in a complete overview of the site. Although dry soil conditions would potentialy result in better penetration of the radar signal, the potential 1.5 m of clay will will difficult to penetrate.

Other methods for determining the structure of the bunkers below the clay could be EM or shallow seismics.

Appendix: Maps

Description maps	Map No.
Reflection scan	1



Maptype

Reflection scan

Legend

Relative amount of reflection
in the top layer (max 50 cm deep).

- 0.005 to 0.2
- 0.2 to 0.4
- 0.4 to 0.7
- 0.7 to 1
- 1 to 1E+001

homogeneous zone, suggested location for coring topsoil.

Location
Armenia

N

Scale
0 20 40
scale distance in m.

Map information

Client
Tauw BV Deventer

Date of survey	Projectcode	
19/22-02-2013	2013P413	1
Author	**Version**	**Projection**
W. Rooke	01	UTM 38 N WGS84

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Addendum Medusa Report 2013P413R2

The initial analysis of the data showed that due the conditions of the site (the high clay content, moist percentage and top-layer thickness which was thicker than expected) led to a potential high radar-signal absorption and response of the system that was attributed to an inconclusive measurement. However, by using a rigorous frequency filtering (and thereby removing 90% of the signal), we observed a layering on the site that differs from the layering present in undisturbed soil (Figure 1). In following discussion, the depth of the different layers is expressed in nanoseconds (ns): the one-way travel time for a radarwave in soil. To relate this travel time to distance, the velocity of a radar wave in the medium is needed. Without a calibration based on corings, this propagation velocity is based on theoretical values from literature, resulting in depths (in meters) that can have an uncertainty.

The site appears to be constructed by 5 horizons, numbered 1-5 (Figure 1).

1) Soil (containing small objects, e.g. stones)
   The top layer (ranging from 0-6 ns) contains small objects (e.g. stones) and has a thickness of 6 ns. If this layer is composed of frozen clay (v=12 cm/ns), the thickness of this layer is ±70 cm
2) Below horizon 1, a clear banding is visible. The origin of this banding is unclear, but can be the lower boundary of the frozen layer; can be the change to other soil material; or can reflect the presence of a liner. The depth of this banding is different in the section of undisturbed soil. The material in horizon 2 does not contain visible structures on the radargram. If we assume a velocity in this layer v=10 cm/ns, the thickness of this layer is ± 50 cm
3) Horizon 3 shows a very clear banding. Our initial interpretation of this banding was a false response of the radar system, which led to the conclusion that the results were inconclusive. However, the fact that:
   a. Below horizon 3 discordant layers are present
   b. The banding is absent in the transect with undisturbed soil

   Led to the new interpretation, that this banding is the response of the ground penetrating radar to unknown, reflective material present in horizon 3. The radar wave velocity in this layer is unknown, but will be between 5 cm/ns and 12 cm/ns, resulting in a thickness of 70-170 cm
4) Horizon 4 is composed of layers that are discordant positioned below the horizontal banding of horizon 3. The nature of the layering can point to the presence of natural soil/bedrock. The thickness of this layer is not known, but has at least a thickness of 10 ns. Assuming a velocity of 10 cm/ns, the thickness of this layer is at least 100 cm

Table 2 gives an overview of the thickness for each layer and the accumulated thickness of the different horizons on the Nuburren site. The accumulated depth of the covering layers appears to be ±120 cm, the depth of the top of the discordant layers appears to be 190-290 cm.

The site shows a construction that is homogeneous in both length and width of the site. We have not found any evidence that, within the top 200 cm, the construction is divided by concrete bunkers or e.g. linearly constructed dams of clay.

Figure 1: Typical examples of radar measurements

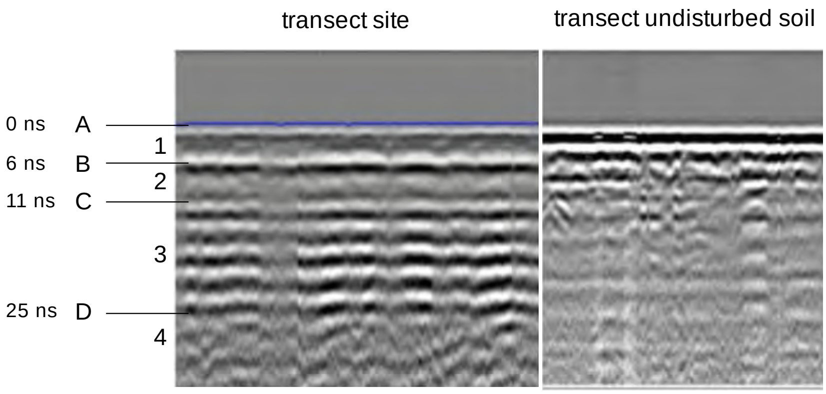

Table 1: Typical radar wave veolocities in materials that can be found on the site

Medium	velocity medium (m/ns)
Dry Clay	0.15
Dry Sands	0.13
Dry Sandy Soils	0.12
Frozen Soil / Permafrost	0.12
Volcanic Ash	0.08
Wet Sandy Soils	0.06
Wet Clay	0.06
Peats	0.04

Table 2: Overview of thickness (in time and depth) of the various layers observed in the GPR data

Layer	thickness (ns)	expected velocity (cm/ns)	thickness (cm)	accumulated depth (cm)
1	6	12	72	72
2	5	10	50	122
3	14	5-12	70-168	192-290
4	>10	10	>100	292-390

Appendix

2

Topographical map and Digital terrain Model

- **Topographical map**
- **Overview DTM**
- **View of the dump site based on the GPR Results**

Access road
Gate
N
0 10 20 m
Legend
Existing soil boring
Soil boring
Monitoringwell
Fence
Concrete drainage
Landfill body
Trench
Client
OSCE
Scale
1:500
Status
CONCEPT
Project
Feasibility Study POPs Burial Site Nuba
Format
A3
Projectnumber
1210169
Subject
lay out map
Date 27-06-13
Des. AAT
App. BFF
Drawingnr.
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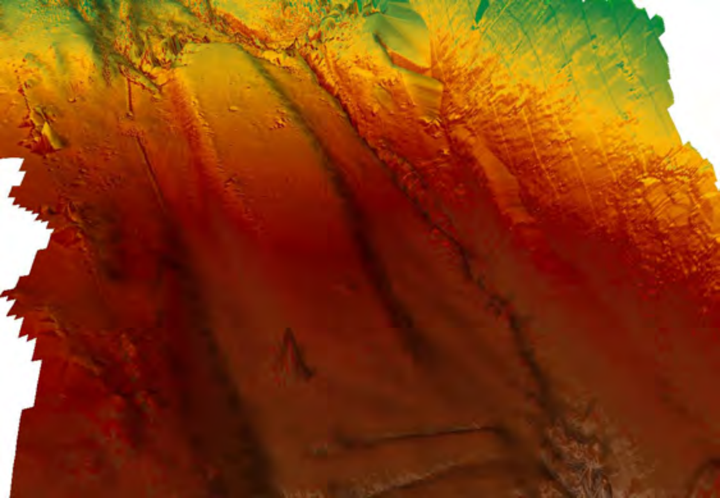
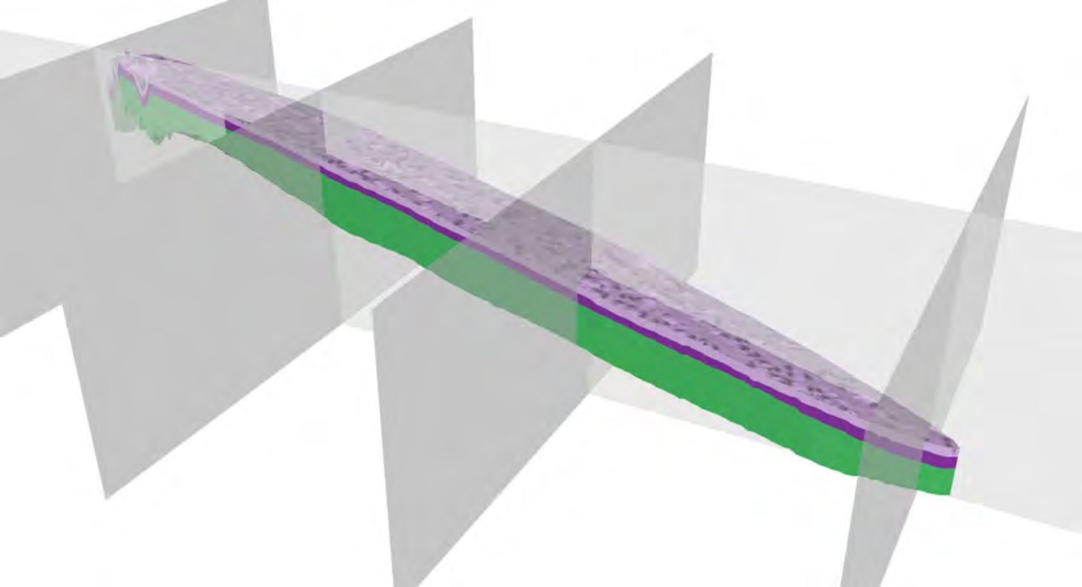
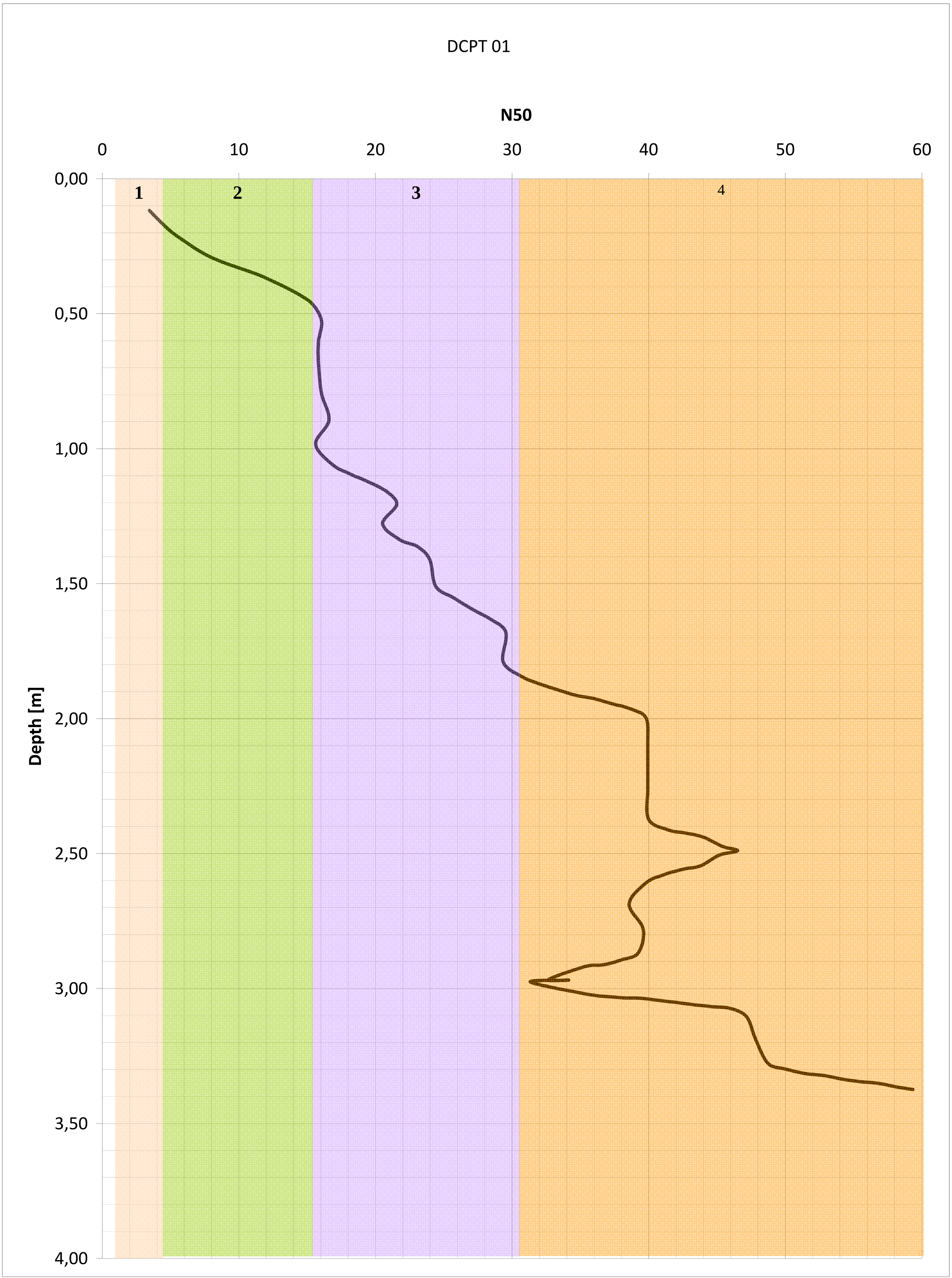




Appendix 3

DCPT results

BORE	LAT	LON	ELEV_GPS	ELEV_LASER	DEPTH	XUTMWGS84	YUTMWGS84
DPT01	40,143151	44,617402	1369,58	tbd	3,37	467409,80	4443715,92
DPT02	40,143033	44,617406	1371,67	tbd	2,69	467410,09	4443702,83
DPT03	40,142968	44,617419	1370,60	tbd	4,09	467411,17	4443695,61
DPT04	40,142746	44,617468	1369,60	tbd	3,39	467415,24	4443670,95
DPT05	40,142718	44,617468	1366,42	tbd	2,39	467415,22	4443667,84
DPT06	40,142878	44,617899	1366,91	tbd	4,48	467452,01	4443685,44
DPT07	40,142812	44,617900	1372,20	tbd	4,79	467452,07	4443678,12
DPT08	40,142965	44,618032	1374,82	tbd	1,19	467463,38	4443695,05
DPT09	40,143020	44,618184	1377,26	tbd	0,38	467476,36	4443701,10
DPT10	40,142986	44,618195	1376,33	tbd	0,99	467477,28	4443697,32
DPT11	40,143030	44,618160	1377,99	tbd	1,29	467474,32	4443702,22
DPT12	40,143058	44,617873	1374,41	tbd	1,09	467449,88	4443705,43
DPT13	40,143116	44,617849	1371,46	tbd	2,67	467447,87	4443711,88
DPT14	40,142878	44,616826	1361,72	tbd	4,59	467360,61	4443685,84
DPT15	40,142764	44,616696	1361,42	tbd	2,29	467349,48	4443673,23
DPT16	40,142758	44,616672	1361,30	tbd	5,57	467347,44	4443672,58
DPT17	40,142681	44,616470	1358,66	tbd	5,58	467330,19	4443664,10



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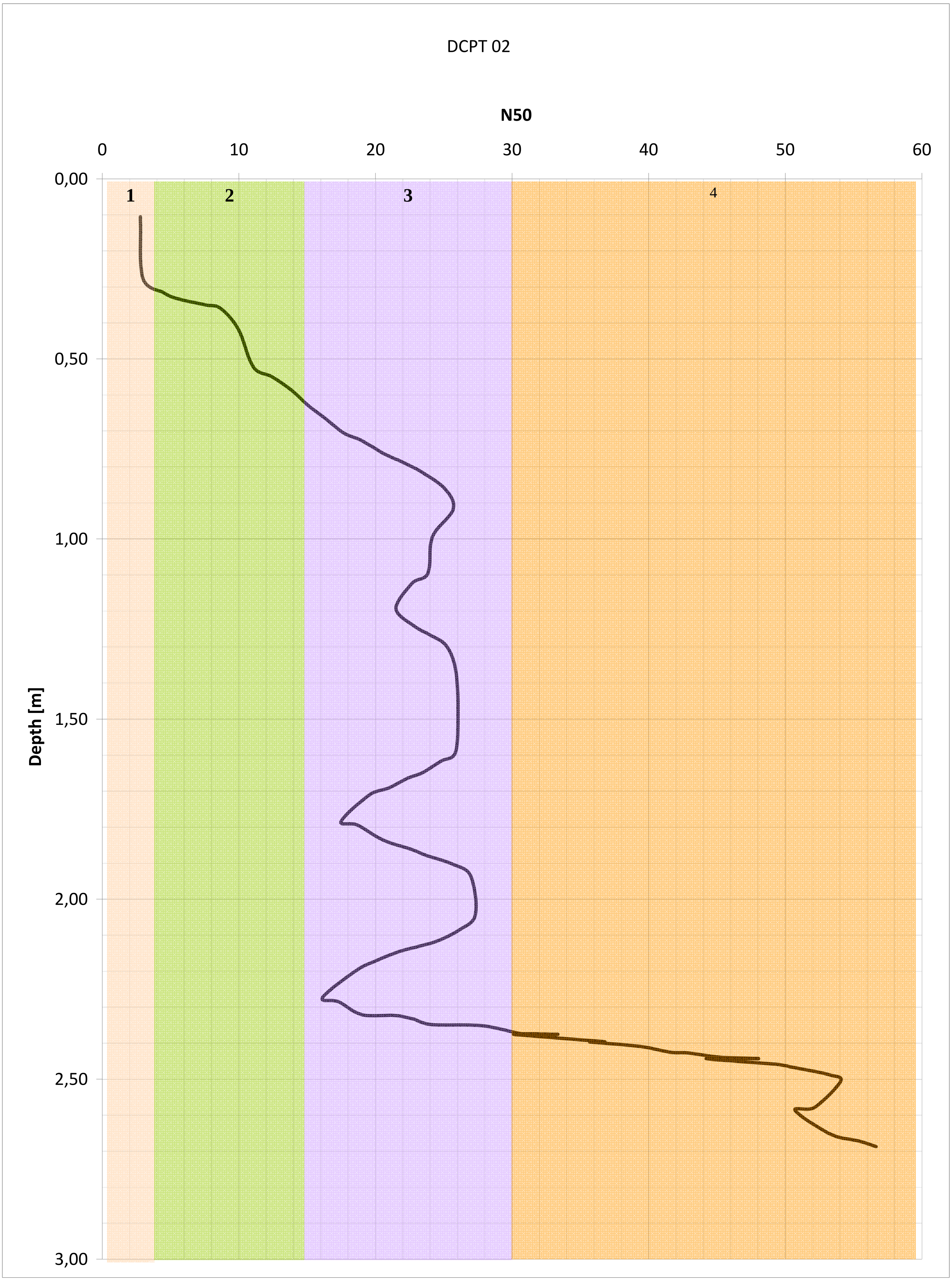
2
3
4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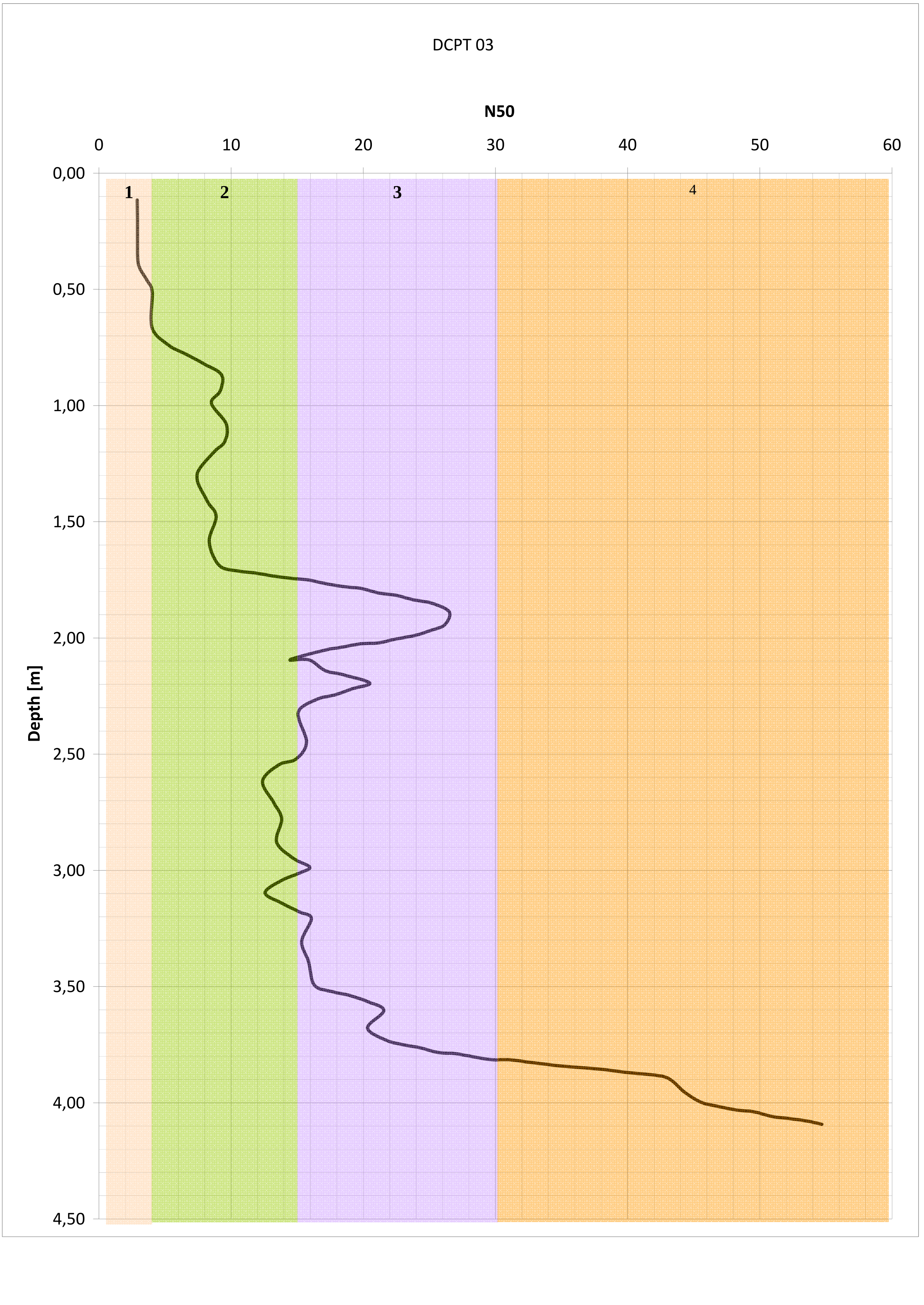
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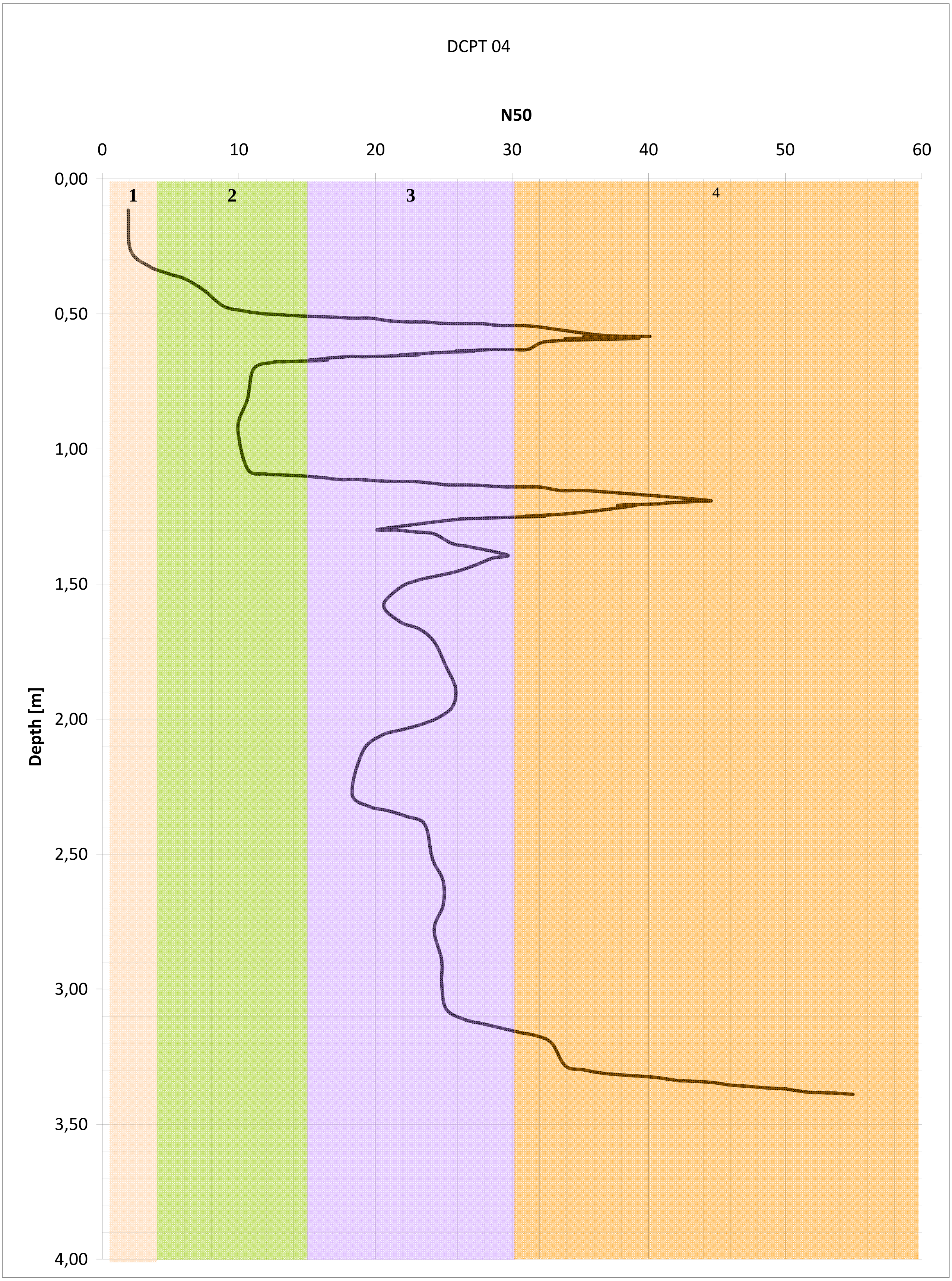

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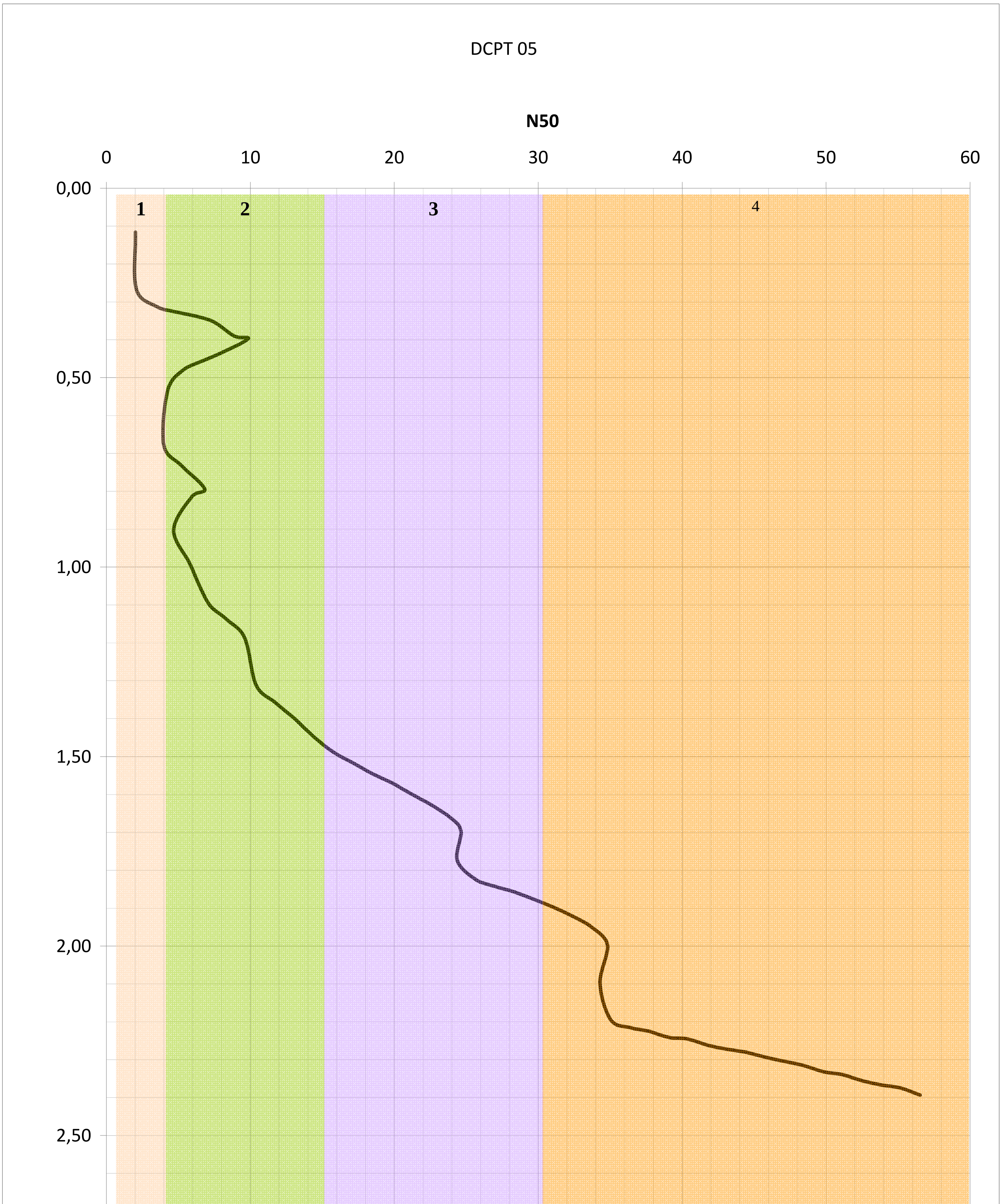
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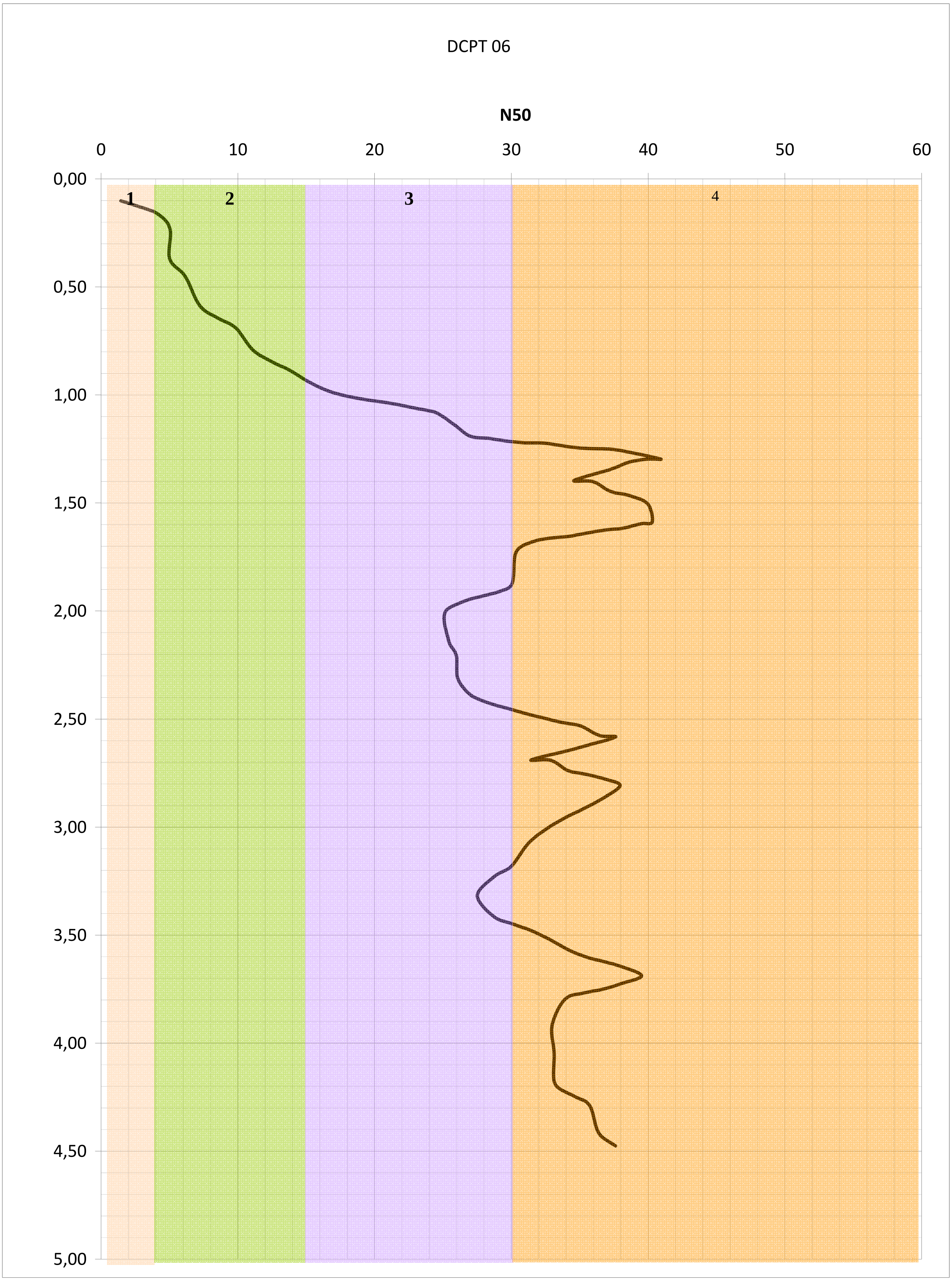

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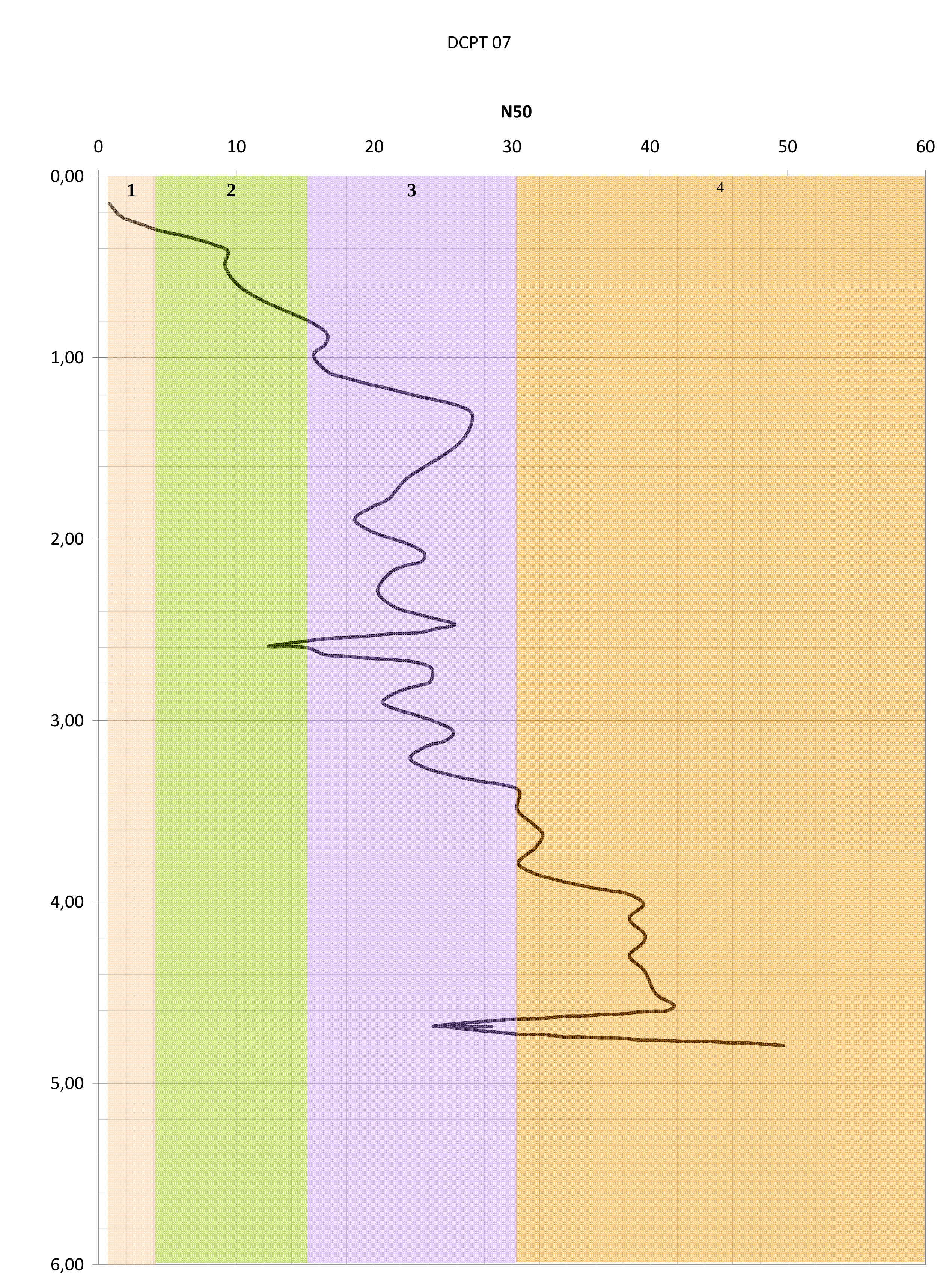

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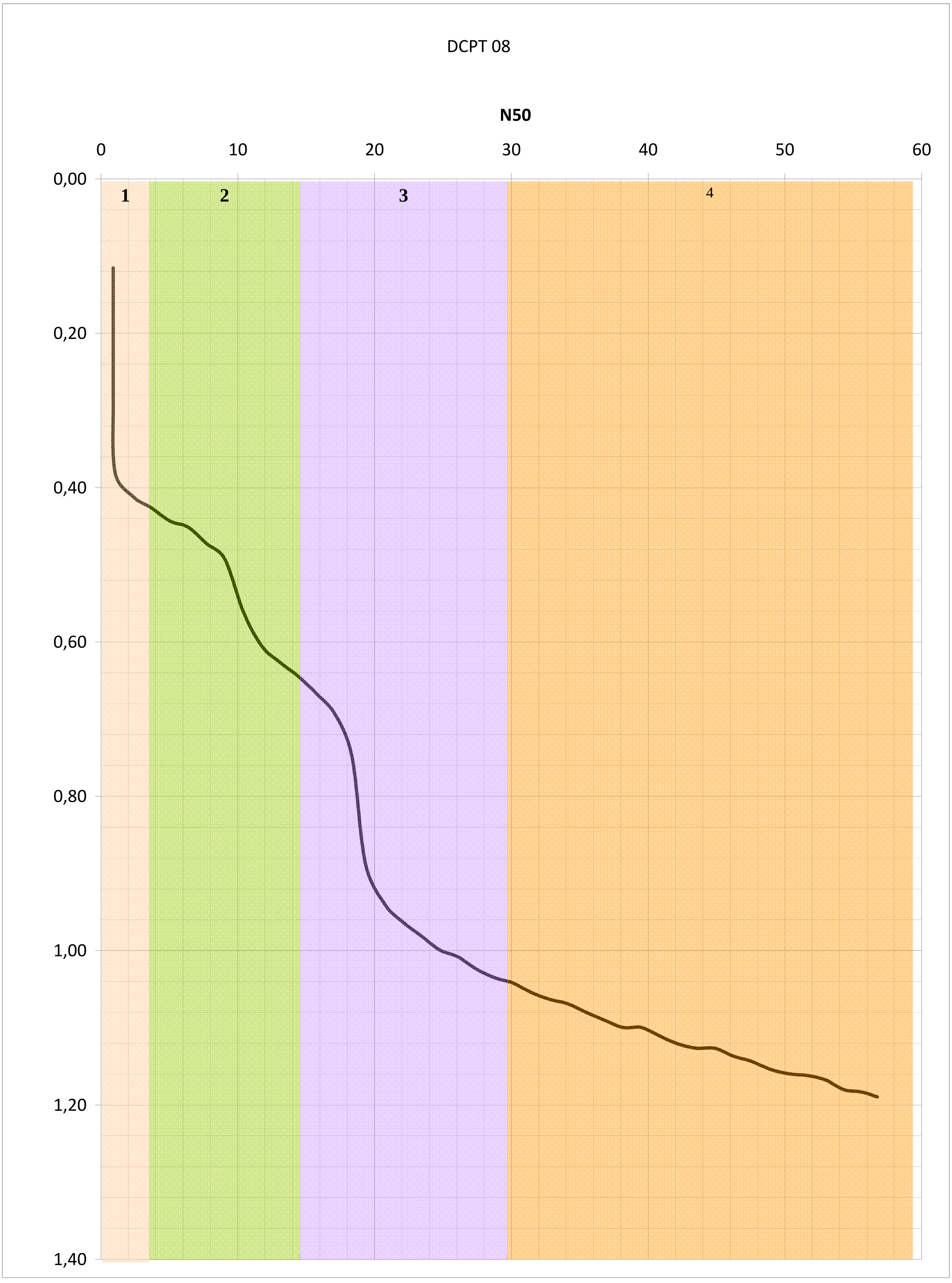

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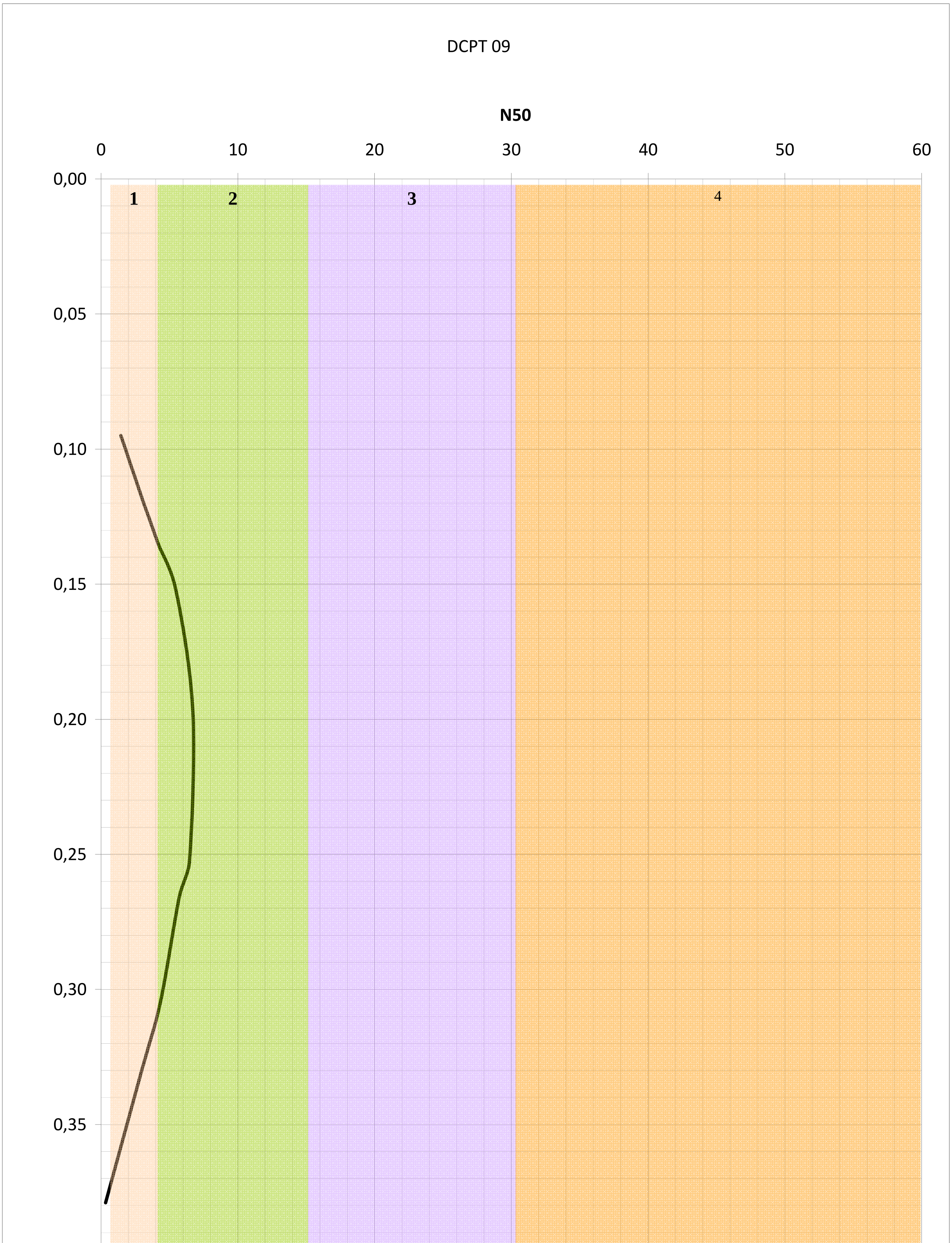
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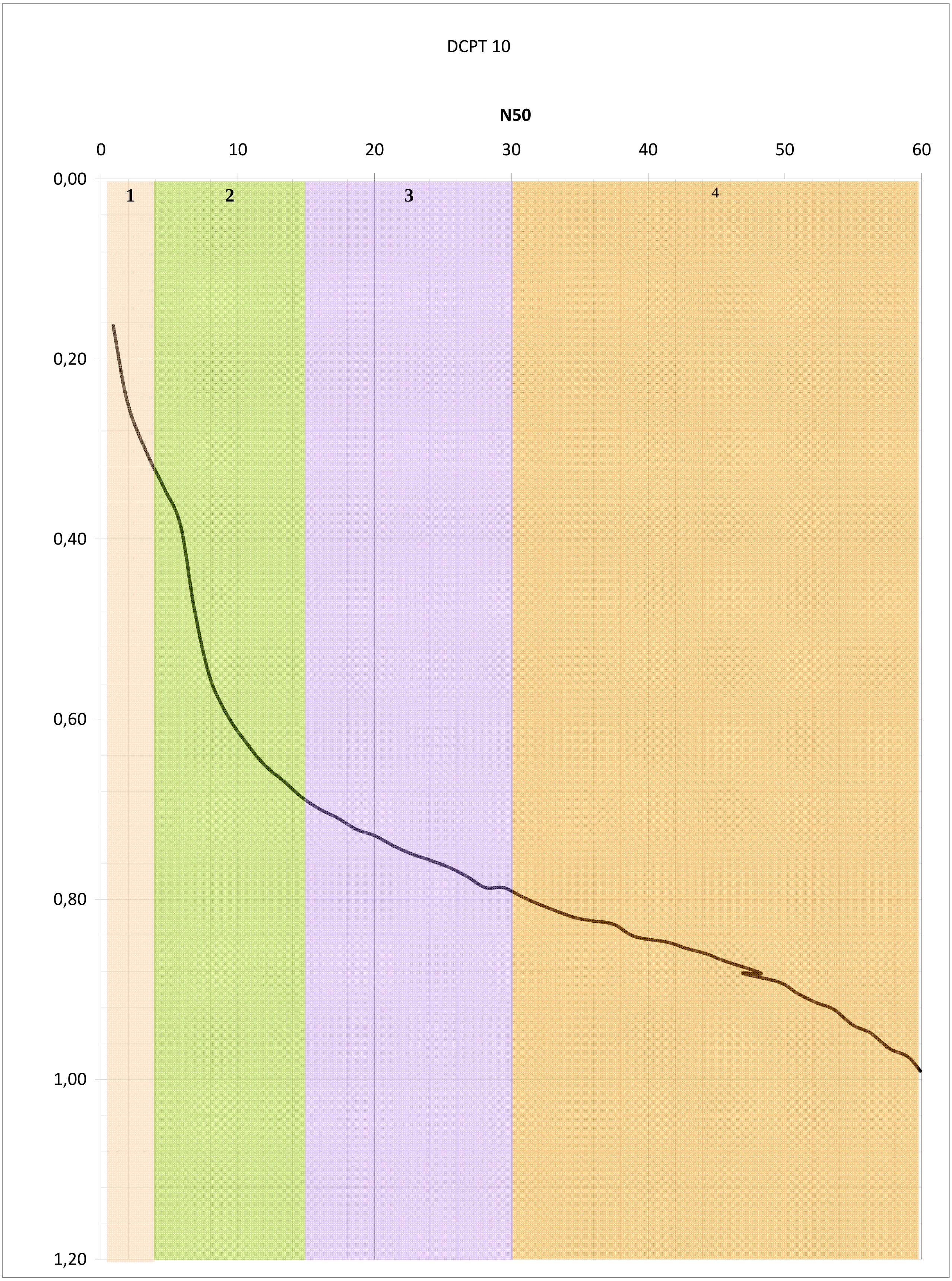
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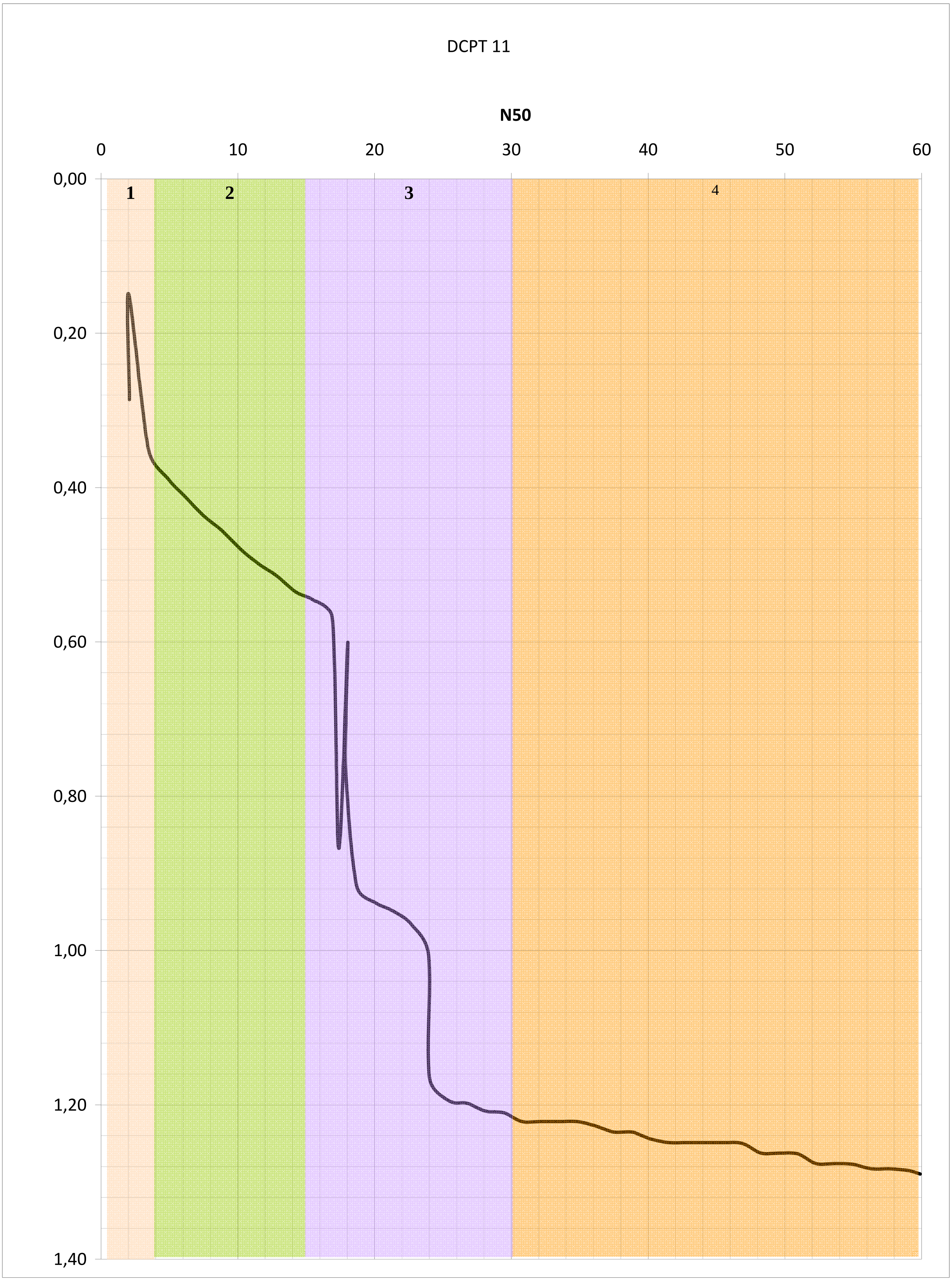

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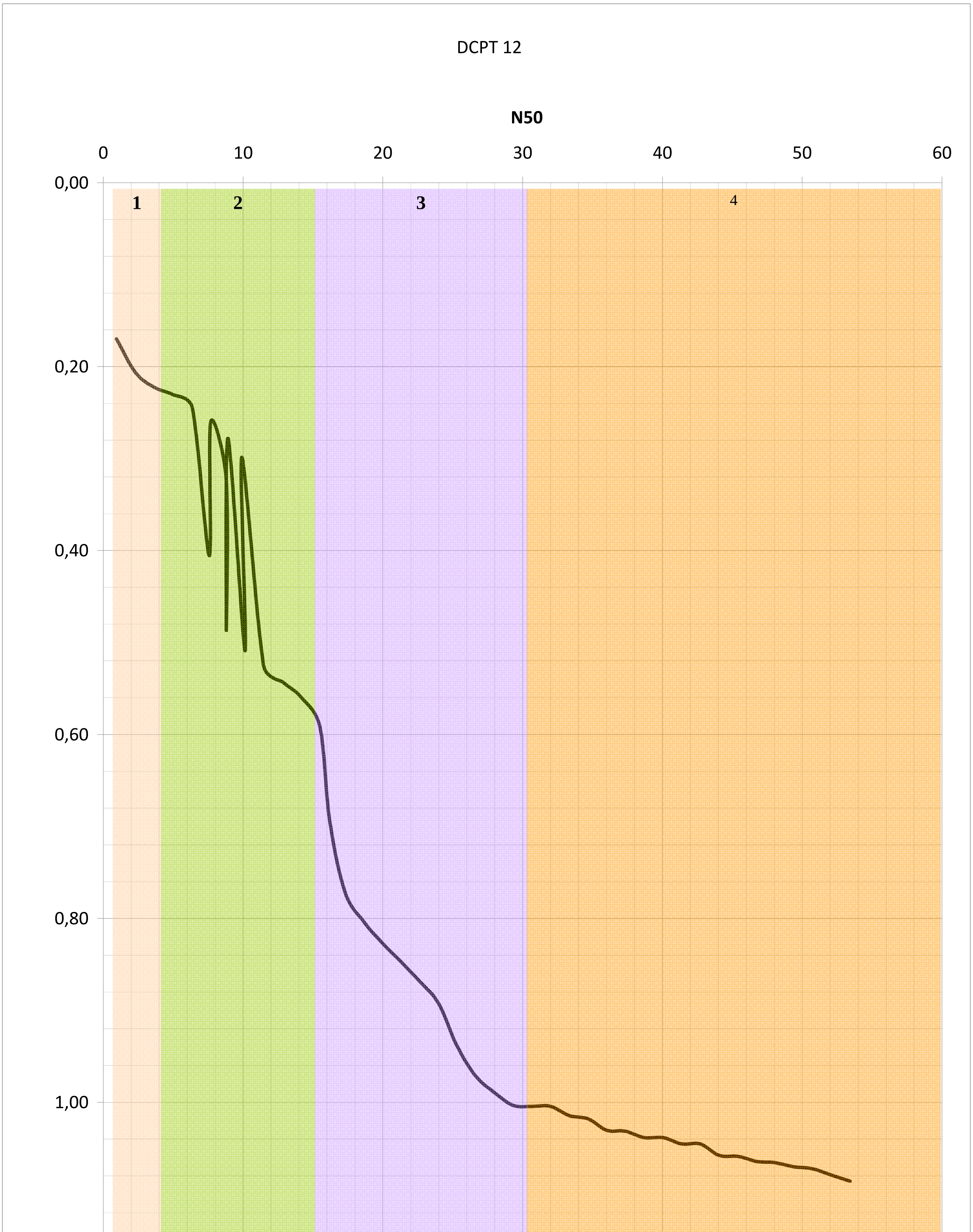

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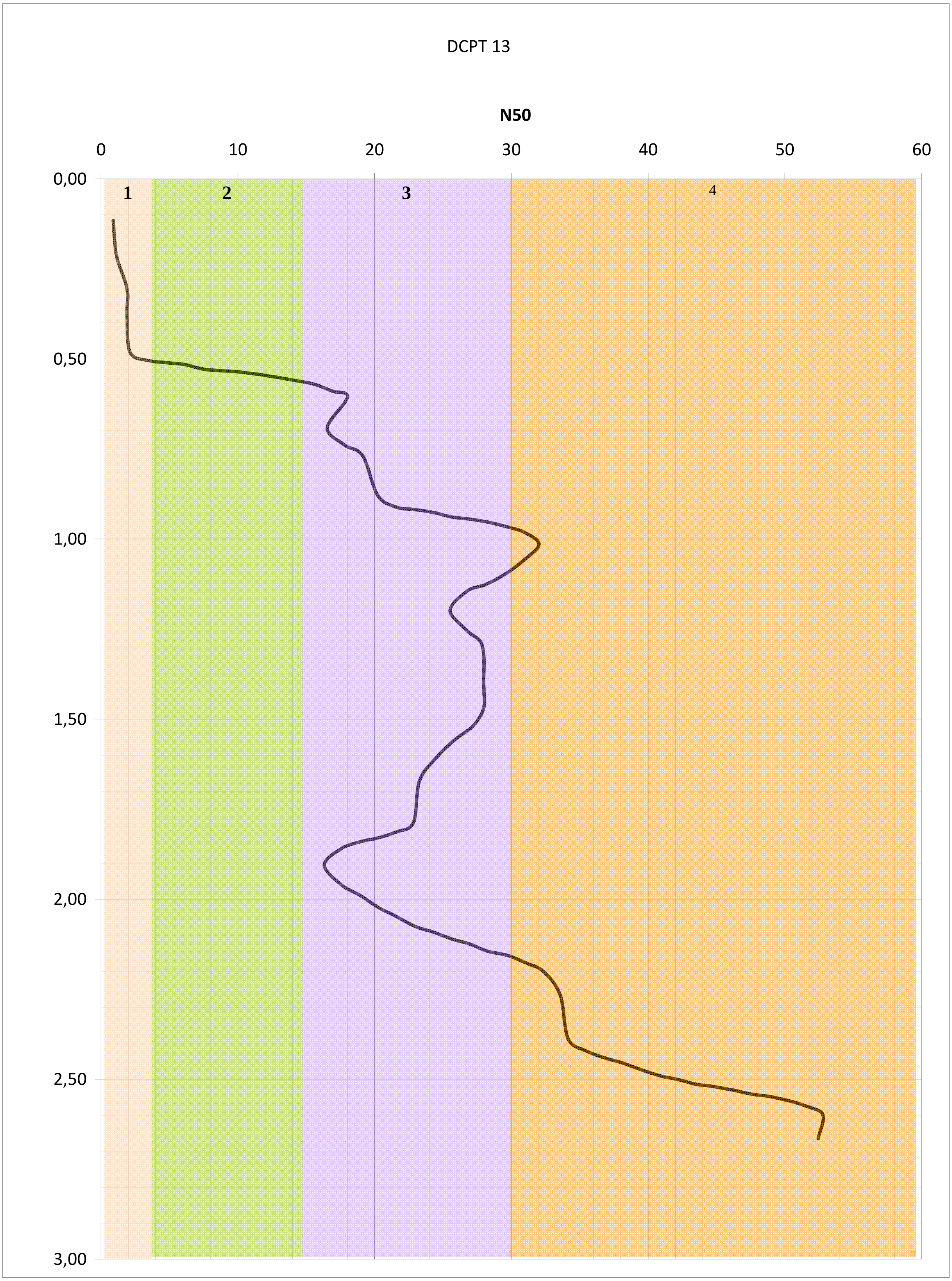
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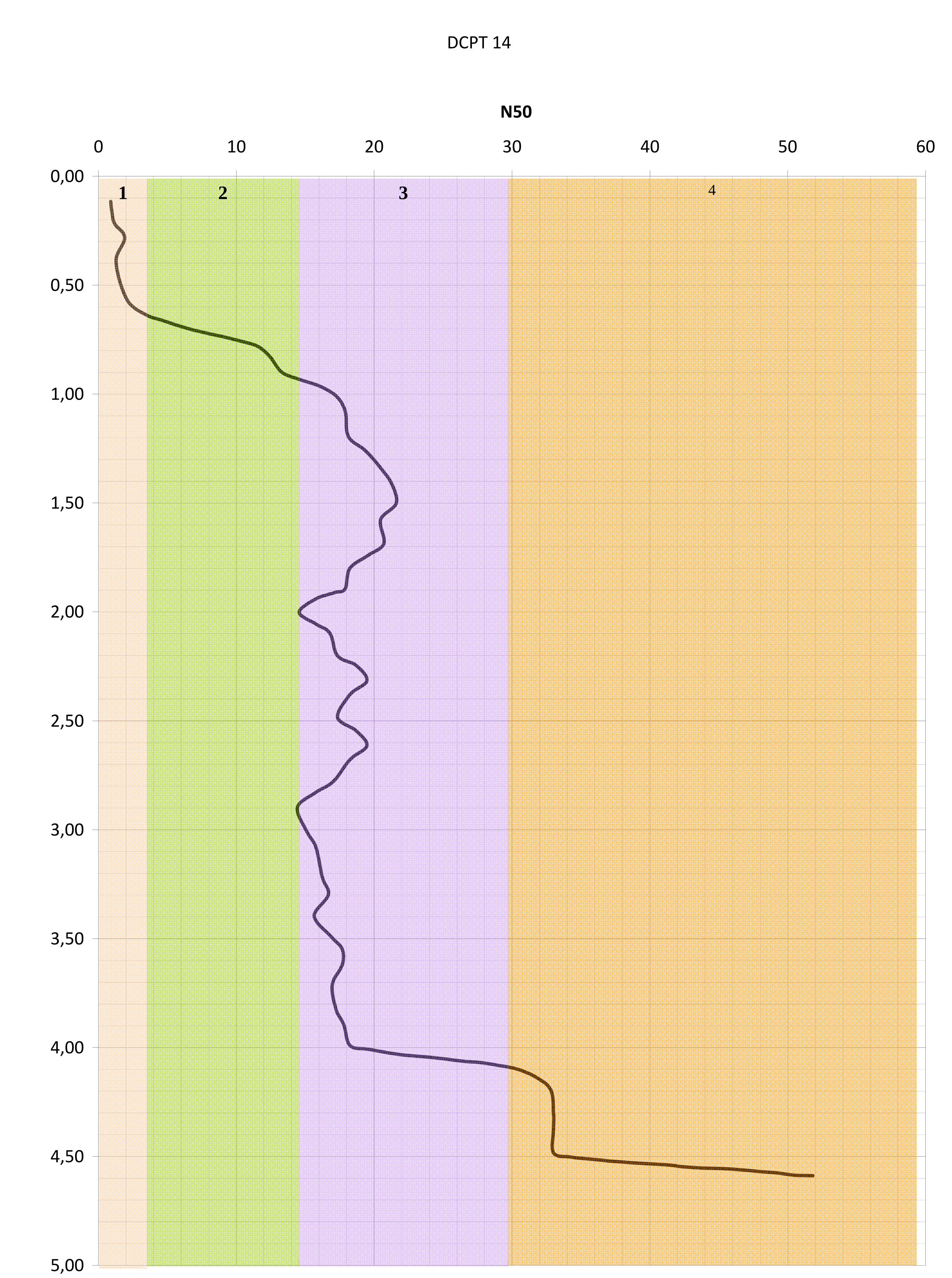

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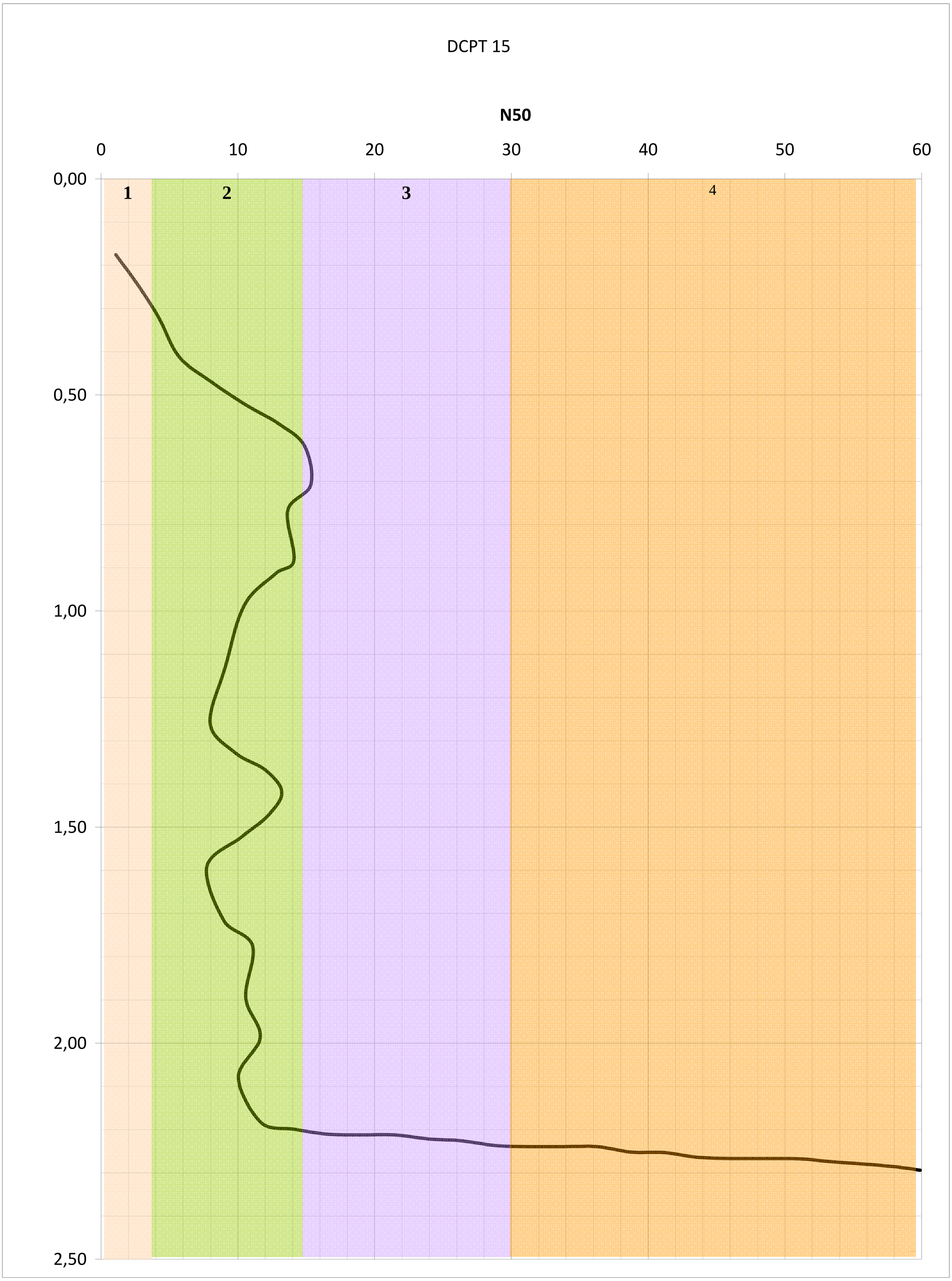
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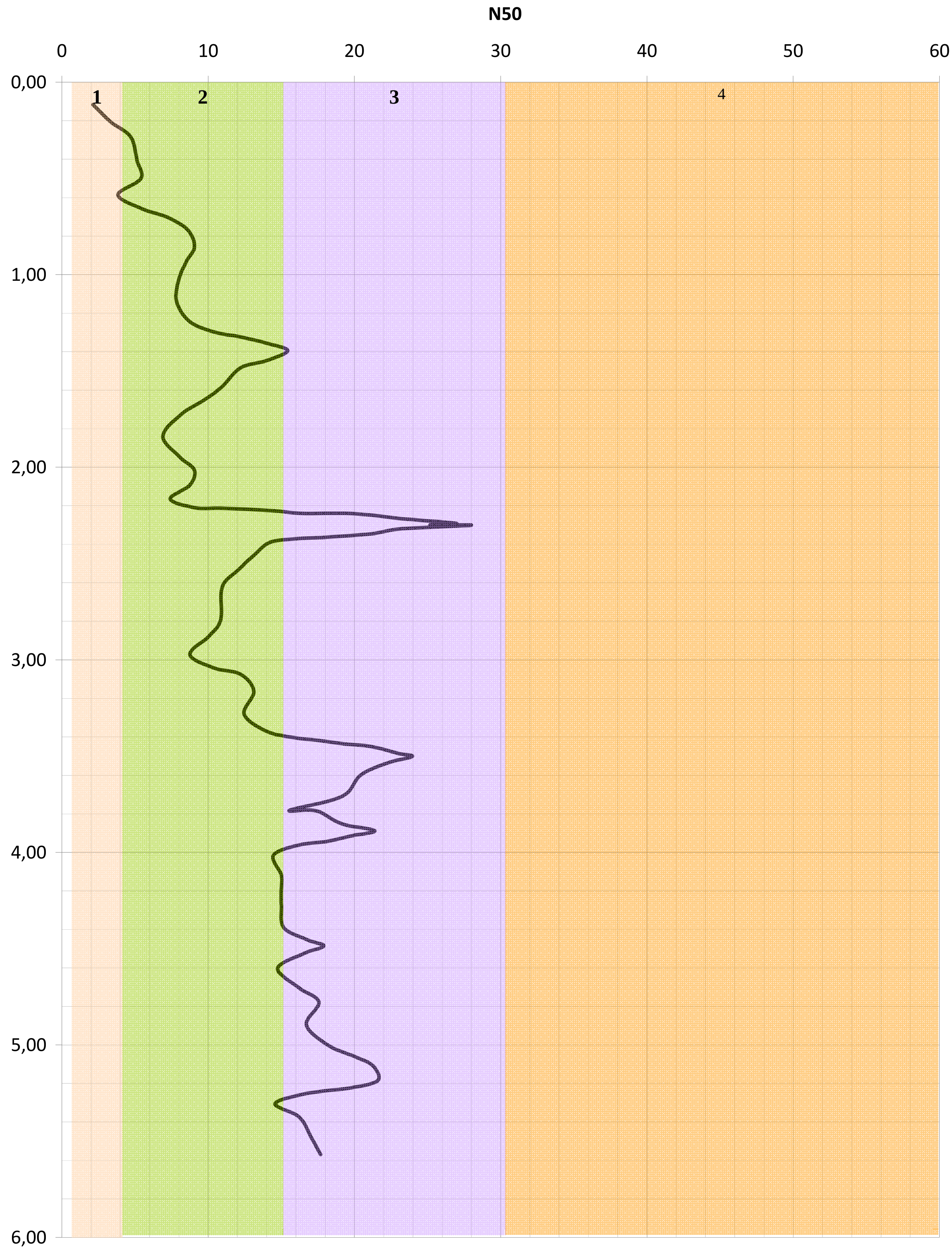
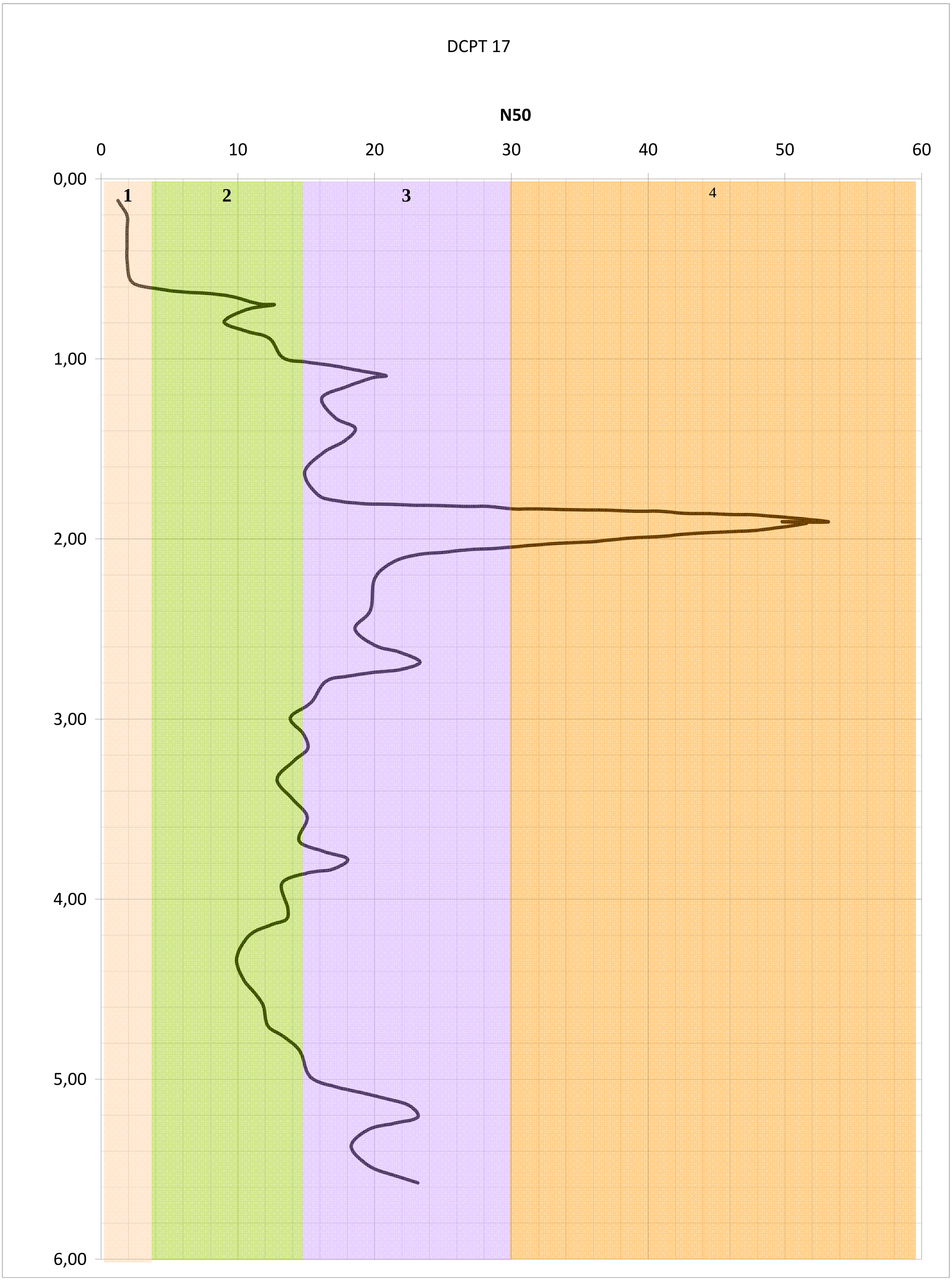
DCPT 16





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4

BORE	TYPE	DEPTH	N50	CLASS
DPT01	N50	0,117381	3,457249	Soft
DPT01	N50	0,185102	4,795539	Soft
DPT01	N50	0,234763	6,133829	Firm
DPT01	N50	0,277652	7,472119	Firm
DPT01	N50	0,309255	8,810409	Firm
DPT01	N50	0,332957	10,148699	Stiff
DPT01	N50	0,356659	11,486989	Stiff
DPT01	N50	0,387133	12,825279	Stiff
DPT01	N50	0,422122	14,163569	Stiff
DPT01	N50	0,464560	15,390335	Stiff
DPT01	N50	0,528217	16,059480	Very stiff
DPT01	N50	0,602709	15,836431	Stiff
DPT01	N50	0,683973	15,836431	Stiff
DPT01	N50	0,796840	16,059480	Very stiff
DPT01	N50	0,893905	16,594796	Very stiff
DPT01	N50	0,982694	15,613383	Stiff
DPT01	N50	1,058691	16,840149	Very stiff
DPT01	N50	1,094808	18,178439	Very stiff
DPT01	N50	1,124153	19,516729	Very stiff
DPT01	N50	1,160271	20,855019	Very stiff
DPT01	N50	1,207675	21,561338	Very stiff
DPT01	N50	1,277370	20,520446	Very stiff
DPT01	N50	1,336343	21,747212	Very stiff
DPT01	N50	1,363431	23,085502	Very stiff
DPT01	N50	1,411287	23,977695	Very stiff
DPT01	N50	1,510158	24,423792	Very stiff
DPT01	N50	1,554176	25,762082	Very stiff
DPT01	N50	1,594808	27,100372	Very stiff
DPT01	N50	1,632054	28,438662	Very stiff
DPT01	N50	1,681151	29,553903	Very stiff
DPT01	N50	1,790713	29,346787	Very stiff
DPT01	N50	1,843115	30,669145	Hard
DPT01	N50	1,871332	32,007435	Hard
DPT01	N50	1,893905	33,345725	Hard
DPT01	N50	1,914221	34,684015	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT01	N50	1,926637	36,022305	Hard
DPT01	N50	1,945824	37,360595	Hard
DPT01	N50	1,963883	38,698885	Hard
DPT01	N50	1,997404	39,814126	Hard
DPT01	N50	2,092551	39,925651	Hard
DPT01	N50	2,173815	39,925651	Hard
DPT01	N50	2,255079	39,925651	Hard
DPT01	N50	2,372138	39,989379	Hard
DPT01	N50	2,411964	41,375465	Hard
DPT01	N50	2,424379	42,713755	Hard
DPT01	N50	2,440181	44,052045	Hard
DPT01	N50	2,474041	45,390335	Hard
DPT01	N50	2,489842	46,505576	Hard
DPT01	N50	2,506611	45,151354	Hard
DPT01	N50	2,545147	43,828996	Hard
DPT01	N50	2,558691	42,490706	Hard
DPT01	N50	2,577878	41,152416	Hard
DPT01	N50	2,608352	39,814126	Hard
DPT01	N50	2,687133	38,565056	Hard
DPT01	N50	2,779910	39,591078	Hard
DPT01	N50	2,867269	39,256506	Hard
DPT01	N50	2,893905	38,029740	Hard
DPT01	N50	2,911964	36,691450	Hard
DPT01	N50	2,918736	35,353160	Hard
DPT01	N50	2,967269	32,676580	Hard
DPT01	N50	2,969150	34,126394	Hard
DPT01	N50	2,975546	31,338290	Hard
DPT01	N50	3,020316	35,353160	Hard
DPT01	N50	3,029345	36,691450	Hard
DPT01	N50	3,033860	38,029740	Hard
DPT01	N50	3,036117	39,368030	Hard
DPT01	N50	3,044018	40,706320	Hard
DPT01	N50	3,051919	42,044610	Hard
DPT01	N50	3,060948	43,382900	Hard
DPT01	N50	3,067720	44,721190	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT01	N50	3,074492	46,059480	Hard
DPT01	N50	3,104966	47,174721	Hard
DPT01	N50	3,189616	47,843866	Hard
DPT01	N50	3,277652	48,736059	Hard
DPT01	N50	3,299097	50,074349	Hard
DPT01	N50	3,314898	51,412639	Hard
DPT01	N50	3,321670	52,750929	Hard
DPT01	N50	3,335214	54,089219	Hard
DPT01	N50	3,345372	55,427509	Hard
DPT01	N50	3,351016	56,765799	Hard
DPT01	N50	3,364560	58,104089	Hard
DPT01	N50	3,373815	59,330855	Hard
DPT02	N50	0,105204	2,798507	Soft
DPT02	N50	0,274604	2,966418	Soft
DPT02	N50	0,315611	4,477612	Soft
DPT02	N50	0,332579	5,485075	Firm
DPT02	N50	0,349548	7,500000	Firm
DPT02	N50	0,359729	8,656716	Firm
DPT02	N50	0,417986	9,962687	Stiff
DPT02	N50	0,522624	11,059701	Stiff
DPT02	N50	0,549774	12,425373	Stiff
DPT02	N50	0,587104	13,880597	Stiff
DPT02	N50	0,627149	15,000000	Stiff
DPT02	N50	0,665158	16,343284	Very stiff
DPT02	N50	0,705882	17,686567	Very stiff
DPT02	N50	0,726244	18,973881	Very stiff
DPT02	N50	0,762896	20,597015	Very stiff
DPT02	N50	0,783937	21,828358	Very stiff
DPT02	N50	0,814480	23,395522	Very stiff
DPT02	N50	0,861991	25,119403	Very stiff
DPT02	N50	0,917986	25,690299	Very stiff
DPT02	N50	0,993778	24,179104	Very stiff
DPT02	N50	1,095023	23,843284	Very stiff
DPT02	N50	1,123303	22,667910	Very stiff
DPT02	N50	1,193156	21,492537	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT02	N50	1,240724	22,791045	Very stiff
DPT02	N50	1,267534	24,011194	Very stiff
DPT02	N50	1,296380	25,186567	Very stiff
DPT02	N50	1,362557	25,858209	Very stiff
DPT02	N50	1,475113	26,044776	Very stiff
DPT02	N50	1,591629	25,858209	Very stiff
DPT02	N50	1,617081	24,794776	Very stiff
DPT02	N50	1,649321	23,432836	Very stiff
DPT02	N50	1,664253	22,343284	Very stiff
DPT02	N50	1,690045	21,044776	Very stiff
DPT02	N50	1,711765	19,522388	Very stiff
DPT02	N50	1,784098	17,494670	Very stiff
DPT02	N50	1,794570	18,671642	Very stiff
DPT02	N50	1,836652	20,597015	Very stiff
DPT02	N50	1,861991	22,611940	Very stiff
DPT02	N50	1,878733	23,731343	Very stiff
DPT02	N50	1,902715	25,634328	Very stiff
DPT02	N50	1,936652	26,977612	Very stiff
DPT02	N50	2,043891	27,313433	Very stiff
DPT02	N50	2,087104	26,082090	Very stiff
DPT02	N50	2,117647	24,447761	Very stiff
DPT02	N50	2,131222	23,171642	Very stiff
DPT02	N50	2,144796	21,828358	Very stiff
DPT02	N50	2,171946	20,014925	Very stiff
DPT02	N50	2,199095	18,582090	Very stiff
DPT02	N50	2,273756	16,119403	Very stiff
DPT02	N50	2,285068	17,276119	Very stiff
DPT02	N50	2,321267	19,029851	Very stiff
DPT02	N50	2,323529	21,380597	Very stiff
DPT02	N50	2,332579	22,723881	Very stiff
DPT02	N50	2,348416	24,067164	Very stiff
DPT02	N50	2,350679	27,425373	Very stiff
DPT02	N50	2,357466	28,768657	Very stiff
DPT02	N50	2,375566	31,007463	Hard
DPT02	N50	2,375566	33,358209	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT02	N50	2,375566	30,134328	Hard
DPT02	N50	2,395928	36,716418	Hard
DPT02	N50	2,397059	35,708955	Hard
DPT02	N50	2,409502	39,402985	Hard
DPT02	N50	2,425339	41,529851	Hard
DPT02	N50	2,427602	42,873134	Hard
DPT02	N50	2,438914	45,223881	Hard
DPT02	N50	2,443439	48,022388	Hard
DPT02	N50	2,443439	44,216418	Hard
DPT02	N50	2,459276	49,365672	Hard
DPT02	N50	2,467873	50,597015	Hard
DPT02	N50	2,487557	53,171642	Hard
DPT02	N50	2,504525	54,067164	Hard
DPT02	N50	2,578337	52,164179	Hard
DPT02	N50	2,587104	50,708955	Hard
DPT02	N50	2,652489	53,283582	Hard
DPT02	N50	2,671946	55,410448	Hard
DPT02	N50	2,687783	56,641791	Hard
DPT03	N50	0,115385	2,903918	Soft
DPT03	N50	0,196833	2,906945	Soft
DPT03	N50	0,278281	2,909973	Soft
DPT03	N50	0,391403	2,988528	Soft
DPT03	N50	0,454751	3,585678	Soft
DPT03	N50	0,509050	4,033794	Soft
DPT03	N50	0,663219	4,007661	Soft
DPT03	N50	0,739819	5,269138	Firm
DPT03	N50	0,779412	6,608900	Firm
DPT03	N50	0,820136	7,948704	Firm
DPT03	N50	0,867647	9,288760	Stiff
DPT03	N50	0,936652	9,179801	Stiff
DPT03	N50	0,989693	8,512628	Firm
DPT03	N50	1,079186	9,631196	Stiff
DPT03	N50	1,153846	9,522448	Stiff
DPT03	N50	1,203620	8,632105	Firm
DPT03	N50	1,299774	7,408914	Firm

BORE	TYPE	DEPTH	N50	CLASS
DPT03	N50	1,410068	8,193683	Firm
DPT03	N50	1,476244	8,865288	Firm
DPT03	N50	1,585973	8,348921	Firm
DPT03	N50	1,687783	9,096200	Stiff
DPT03	N50	1,711538	10,435373	Stiff
DPT03	N50	1,720588	11,774000	Stiff
DPT03	N50	1,733032	13,112752	Stiff
DPT03	N50	1,743213	14,451421	Stiff
DPT03	N50	1,750000	15,789963	Stiff
DPT03	N50	1,765837	17,128842	Very stiff
DPT03	N50	1,778281	18,467594	Very stiff
DPT03	N50	1,786199	19,806178	Very stiff
DPT03	N50	1,806561	21,145225	Very stiff
DPT03	N50	1,816742	22,483894	Very stiff
DPT03	N50	1,835973	23,822899	Very stiff
DPT03	N50	1,850679	25,161735	Very stiff
DPT03	N50	1,888009	26,501413	Very stiff
DPT03	N50	1,943439	26,168901	Very stiff
DPT03	N50	1,966063	25,166025	Very stiff
DPT03	N50	1,989819	23,828618	Very stiff
DPT03	N50	2,004525	22,490875	Very stiff
DPT03	N50	2,021493	21,153215	Very stiff
DPT03	N50	2,024887	19,815052	Very stiff
DPT03	N50	2,038462	18,477266	Very stiff
DPT03	N50	2,052036	17,139481	Very stiff
DPT03	N50	2,093891	14,464457	Stiff
DPT03	N50	2,095023	15,914313	Stiff
DPT03	N50	2,141403	17,142803	Very stiff
DPT03	N50	2,158371	18,481724	Very stiff
DPT03	N50	2,193439	20,490462	Very stiff
DPT03	N50	2,218487	19,169036	Very stiff
DPT03	N50	2,245475	17,815817	Very stiff
DPT03	N50	2,264706	16,478242	Very stiff
DPT03	N50	2,321437	15,086299	Stiff
DPT03	N50	2,448869	15,704419	Stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT03	N50	2,520362	14,926408	Stiff
DPT03	N50	2,546380	13,589085	Stiff
DPT03	N50	2,616893	12,364940	Stiff
DPT03	N50	2,712670	13,260694	Stiff
DPT03	N50	2,779412	13,820796	Stiff
DPT03	N50	2,879525	13,434183	Stiff
DPT03	N50	2,949095	14,719297	Stiff
DPT03	N50	2,986425	15,947451	Stiff
DPT03	N50	3,012670	15,145452	Stiff
DPT03	N50	3,042986	13,830594	Stiff
DPT03	N50	3,096315	12,573947	Stiff
DPT03	N50	3,141403	13,834253	Stiff
DPT03	N50	3,178733	15,173931	Stiff
DPT03	N50	3,207014	16,067175	Very stiff
DPT03	N50	3,305430	15,334774	Stiff
DPT03	N50	3,390271	15,850939	Stiff
DPT03	N50	3,494344	16,300905	Very stiff
DPT03	N50	3,521493	17,640204	Very stiff
DPT03	N50	3,538462	18,979125	Very stiff
DPT03	N50	3,564480	20,318382	Very stiff
DPT03	N50	3,603167	21,546586	Very stiff
DPT03	N50	3,677979	20,322601	Very stiff
DPT03	N50	3,729638	21,662812	Very stiff
DPT03	N50	3,750000	23,001859	Very stiff
DPT03	N50	3,763575	24,340653	Very stiff
DPT03	N50	3,783937	25,679700	Very stiff
DPT03	N50	3,788462	27,018158	Very stiff
DPT03	N50	3,803167	28,356995	Very stiff
DPT03	N50	3,814480	29,695706	Very stiff
DPT03	N50	3,814480	31,033996	Hard
DPT03	N50	3,824661	32,372664	Hard
DPT03	N50	3,833710	33,711290	Hard
DPT03	N50	3,842760	35,049917	Hard
DPT03	N50	3,848416	36,388417	Hard
DPT03	N50	3,854072	37,726917	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT03	N50	3,863122	39,065544	Hard
DPT03	N50	3,872172	40,404170	Hard
DPT03	N50	3,878959	41,742712	Hard
DPT03	N50	3,894796	43,081591	Hard
DPT03	N50	3,954299	44,310569	Hard
DPT03	N50	3,997738	45,538949	Hard
DPT03	N50	4,015837	46,877912	Hard
DPT03	N50	4,031674	48,216791	Hard
DPT03	N50	4,039593	49,555375	Hard
DPT03	N50	4,058824	50,894380	Hard
DPT03	N50	4,067873	52,233006	Hard
DPT03	N50	4,079186	53,571717	Hard
DPT03	N50	4,092760	54,687463	Hard
DPT04	N50	0,115385	1,902985	Very soft
DPT04	N50	0,264706	2,070896	Soft
DPT04	N50	0,324661	3,470149	Soft
DPT04	N50	0,350679	4,813433	Soft
DPT04	N50	0,372172	6,156716	Firm
DPT04	N50	0,415158	7,500000	Firm
DPT04	N50	0,470588	8,843284	Firm
DPT04	N50	0,487557	10,186567	Stiff
DPT04	N50	0,497738	11,529851	Stiff
DPT04	N50	0,502262	12,873134	Stiff
DPT04	N50	0,506787	14,216418	Stiff
DPT04	N50	0,509050	15,559701	Stiff
DPT04	N50	0,512443	16,902985	Very stiff
DPT04	N50	0,515837	18,246269	Very stiff
DPT04	N50	0,515837	19,589552	Very stiff
DPT04	N50	0,524887	20,932836	Very stiff
DPT04	N50	0,529412	22,276119	Very stiff
DPT04	N50	0,529412	23,619403	Very stiff
DPT04	N50	0,535068	24,962687	Very stiff
DPT04	N50	0,536199	26,305970	Very stiff
DPT04	N50	0,536199	27,649254	Very stiff
DPT04	N50	0,541855	28,992537	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT04	N50	0,542986	30,335821	Hard
DPT04	N50	0,546380	31,679104	Hard
DPT04	N50	0,579186	36,604478	Hard
DPT04	N50	0,583710	40,074627	Hard
DPT04	N50	0,584087	35,261194	Hard
DPT04	N50	0,588989	37,947761	Hard
DPT04	N50	0,590498	33,917910	Hard
DPT04	N50	0,590498	39,291045	Hard
DPT04	N50	0,601810	32,574627	Hard
DPT04	N50	0,630090	31,231343	Hard
DPT04	N50	0,632353	29,888060	Very stiff
DPT04	N50	0,632353	28,544776	Very stiff
DPT04	N50	0,638009	25,858209	Very stiff
DPT04	N50	0,638009	27,201493	Very stiff
DPT04	N50	0,643665	24,514925	Very stiff
DPT04	N50	0,651584	21,828358	Very stiff
DPT04	N50	0,651584	23,171642	Very stiff
DPT04	N50	0,657240	20,485075	Very stiff
DPT04	N50	0,658371	19,141791	Very stiff
DPT04	N50	0,658371	17,798507	Very stiff
DPT04	N50	0,671946	15,111940	Stiff
DPT04	N50	0,671946	16,455224	Very stiff
DPT04	N50	0,676471	13,768657	Stiff
DPT04	N50	0,679864	12,425373	Stiff
DPT04	N50	0,703620	11,082090	Stiff
DPT04	N50	0,815328	10,634328	Stiff
DPT04	N50	0,920814	9,925373	Stiff
DPT04	N50	1,073529	10,634328	Stiff
DPT04	N50	1,092760	11,977612	Stiff
DPT04	N50	1,096154	13,320896	Stiff
DPT04	N50	1,099548	14,664179	Stiff
DPT04	N50	1,105204	16,007463	Very stiff
DPT04	N50	1,113122	17,350746	Very stiff
DPT04	N50	1,113122	18,694030	Very stiff
DPT04	N50	1,117647	20,037313	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT04	N50	1,119910	21,380597	Very stiff
DPT04	N50	1,119910	22,723881	Very stiff
DPT04	N50	1,126697	24,067164	Very stiff
DPT04	N50	1,133484	25,410448	Very stiff
DPT04	N50	1,133484	26,753731	Very stiff
DPT04	N50	1,135747	28,097015	Very stiff
DPT04	N50	1,140271	29,440299	Very stiff
DPT04	N50	1,140271	30,783582	Hard
DPT04	N50	1,141403	32,126866	Hard
DPT04	N50	1,153846	33,470149	Hard
DPT04	N50	1,153846	34,813433	Hard
DPT04	N50	1,156109	36,156716	Hard
DPT04	N50	1,191176	44,440299	Hard
DPT04	N50	1,195324	43,097015	Hard
DPT04	N50	1,199095	41,753731	Hard
DPT04	N50	1,204468	40,298507	Hard
DPT04	N50	1,208145	37,723881	Hard
DPT04	N50	1,208145	39,067164	Hard
DPT04	N50	1,227537	36,460554	Hard
DPT04	N50	1,235294	35,037313	Hard
DPT04	N50	1,240950	33,694030	Hard
DPT04	N50	1,248869	31,007463	Hard
DPT04	N50	1,248869	32,350746	Hard
DPT04	N50	1,253394	29,664179	Very stiff
DPT04	N50	1,255656	28,320896	Very stiff
DPT04	N50	1,257919	26,977612	Very stiff
DPT04	N50	1,262443	25,634328	Very stiff
DPT04	N50	1,297888	20,261194	Very stiff
DPT04	N50	1,300151	21,604478	Very stiff
DPT04	N50	1,307692	22,947761	Very stiff
DPT04	N50	1,314480	24,291045	Very stiff
DPT04	N50	1,350679	25,634328	Very stiff
DPT04	N50	1,363122	26,977612	Very stiff
DPT04	N50	1,393100	29,664179	Very stiff
DPT04	N50	1,404223	28,544776	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT04	N50	1,431157	27,281450	Very stiff
DPT04	N50	1,454751	25,858209	Very stiff
DPT04	N50	1,469457	24,514925	Very stiff
DPT04	N50	1,485294	23,171642	Very stiff
DPT04	N50	1,512443	21,828358	Very stiff
DPT04	N50	1,579186	20,597015	Very stiff
DPT04	N50	1,641403	21,828358	Very stiff
DPT04	N50	1,666290	23,171642	Very stiff
DPT04	N50	1,713801	24,291045	Very stiff
DPT04	N50	1,807127	25,186567	Very stiff
DPT04	N50	1,886878	25,858209	Very stiff
DPT04	N50	1,954751	25,634328	Very stiff
DPT04	N50	1,996606	24,514925	Very stiff
DPT04	N50	2,022624	23,171642	Very stiff
DPT04	N50	2,040724	21,828358	Very stiff
DPT04	N50	2,059955	20,485075	Very stiff
DPT04	N50	2,117647	19,085821	Very stiff
DPT04	N50	2,276772	18,283582	Very stiff
DPT04	N50	2,324661	19,589552	Very stiff
DPT04	N50	2,339367	20,932836	Very stiff
DPT04	N50	2,360860	22,276119	Very stiff
DPT04	N50	2,390271	23,619403	Very stiff
DPT04	N50	2,516742	24,179104	Very stiff
DPT04	N50	2,599548	24,962687	Very stiff
DPT04	N50	2,687783	24,962687	Very stiff
DPT04	N50	2,779412	24,291045	Very stiff
DPT04	N50	2,893665	24,850746	Very stiff
DPT04	N50	2,979638	24,850746	Very stiff
DPT04	N50	3,072721	25,170576	Very stiff
DPT04	N50	3,113122	26,529851	Very stiff
DPT04	N50	3,128959	27,873134	Very stiff
DPT04	N50	3,144796	29,216418	Very stiff
DPT04	N50	3,160633	30,559701	Hard
DPT04	N50	3,174208	31,902985	Hard
DPT04	N50	3,201357	32,910448	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT04	N50	3,285068	33,917910	Hard
DPT04	N50	3,298643	35,261194	Hard
DPT04	N50	3,311086	36,604478	Hard
DPT04	N50	3,317873	37,947761	Hard
DPT04	N50	3,322398	39,291045	Hard
DPT04	N50	3,326923	40,634328	Hard
DPT04	N50	3,338235	41,977612	Hard
DPT04	N50	3,341629	43,320896	Hard
DPT04	N50	3,346154	44,664179	Hard
DPT04	N50	3,355204	46,007463	Hard
DPT04	N50	3,359729	47,350746	Hard
DPT04	N50	3,366516	48,694030	Hard
DPT04	N50	3,369910	50,037313	Hard
DPT04	N50	3,380090	51,380597	Hard
DPT04	N50	3,383484	52,723881	Hard
DPT04	N50	3,386878	54,067164	Hard
DPT04	N50	3,390271	54,962687	Hard
DPT05	N50	0,115646	2,014925	Soft
DPT05	N50	0,265306	2,070896	Soft
DPT05	N50	0,311791	3,470149	Soft
DPT05	N50	0,326531	4,813433	Soft
DPT05	N50	0,336735	6,156716	Firm
DPT05	N50	0,353741	7,500000	Firm
DPT05	N50	0,390476	8,910448	Firm
DPT05	N50	0,397581	9,850746	Stiff
DPT05	N50	0,433431	8,027719	Firm
DPT05	N50	0,456916	6,604478	Firm
DPT05	N50	0,481859	5,261194	Firm
DPT05	N50	0,535147	4,253731	Soft
DPT05	N50	0,678005	3,992537	Soft
DPT05	N50	0,733560	5,261194	Firm
DPT05	N50	0,793651	6,828358	Firm
DPT05	N50	0,813411	5,948827	Firm
DPT05	N50	0,902721	4,679104	Soft
DPT05	N50	0,993197	5,820896	Firm

BORE	TYPE	DEPTH	N50	CLASS
DPT05	N50	1,094104	7,052239	Firm
DPT05	N50	1,139456	8,395522	Firm
DPT05	N50	1,187755	9,626866	Stiff
DPT05	N50	1,311791	10,410448	Stiff
DPT05	N50	1,358277	11,753731	Stiff
DPT05	N50	1,400227	13,097015	Stiff
DPT05	N50	1,448980	14,440299	Stiff
DPT05	N50	1,488662	15,783582	Stiff
DPT05	N50	1,517007	17,126866	Very stiff
DPT05	N50	1,545351	18,470149	Very stiff
DPT05	N50	1,569161	19,813433	Very stiff
DPT05	N50	1,598639	21,156716	Very stiff
DPT05	N50	1,625850	22,500000	Very stiff
DPT05	N50	1,659864	23,843284	Very stiff
DPT05	N50	1,696145	24,626866	Very stiff
DPT05	N50	1,773891	24,371002	Very stiff
DPT05	N50	1,824263	25,634328	Very stiff
DPT05	N50	1,842404	26,977612	Very stiff
DPT05	N50	1,857143	28,320896	Very stiff
DPT05	N50	1,876417	29,664179	Very stiff
DPT05	N50	1,896825	31,007463	Hard
DPT05	N50	1,920635	32,350746	Hard
DPT05	N50	1,950113	33,694030	Hard
DPT05	N50	1,998299	34,813433	Hard
DPT05	N50	2,098639	34,291045	Hard
DPT05	N50	2,195011	35,037313	Hard
DPT05	N50	2,215420	36,380597	Hard
DPT05	N50	2,225624	37,723881	Hard
DPT05	N50	2,241497	39,067164	Hard
DPT05	N50	2,246032	40,410448	Hard
DPT05	N50	2,261905	41,753731	Hard
DPT05	N50	2,272109	43,097015	Hard
DPT05	N50	2,280045	44,440299	Hard
DPT05	N50	2,293651	45,783582	Hard
DPT05	N50	2,304989	47,126866	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT05	N50	2,316327	48,470149	Hard
DPT05	N50	2,332200	49,813433	Hard
DPT05	N50	2,340136	51,156716	Hard
DPT05	N50	2,356009	52,500000	Hard
DPT05	N50	2,367347	53,843284	Hard
DPT05	N50	2,375283	55,186567	Hard
DPT05	N50	2,393424	56,529851	Hard
DPT06	N50	0,101810	1,455224	Very soft
DPT06	N50	0,128959	2,798507	Soft
DPT06	N50	0,161765	4,141791	Soft
DPT06	N50	0,230769	5,037313	Firm
DPT06	N50	0,370588	5,014925	Firm
DPT06	N50	0,451357	6,156716	Firm
DPT06	N50	0,588559	7,228145	Firm
DPT06	N50	0,647059	8,619403	Firm
DPT06	N50	0,689593	9,850746	Stiff
DPT06	N50	0,790724	11,082090	Stiff
DPT06	N50	0,843891	12,425373	Stiff
DPT06	N50	0,884615	13,768657	Stiff
DPT06	N50	0,936652	15,111940	Stiff
DPT06	N50	0,977376	16,455224	Very stiff
DPT06	N50	1,003394	17,798507	Very stiff
DPT06	N50	1,019231	19,141791	Very stiff
DPT06	N50	1,031674	20,485075	Very stiff
DPT06	N50	1,046380	21,828358	Very stiff
DPT06	N50	1,063348	23,171642	Very stiff
DPT06	N50	1,082579	24,514925	Very stiff
DPT06	N50	1,134842	25,746269	Very stiff
DPT06	N50	1,191176	26,977612	Very stiff
DPT06	N50	1,200226	28,320896	Very stiff
DPT06	N50	1,213801	29,664179	Very stiff
DPT06	N50	1,221719	31,007463	Hard
DPT06	N50	1,222851	32,350746	Hard
DPT06	N50	1,235294	33,694030	Hard
DPT06	N50	1,245475	35,037313	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT06	N50	1,248869	36,380597	Hard
DPT06	N50	1,254525	37,723881	Hard
DPT06	N50	1,295249	40,858209	Hard
DPT06	N50	1,296757	39,962687	Hard
DPT06	N50	1,311086	38,619403	Hard
DPT06	N50	1,343891	37,276119	Hard
DPT06	N50	1,395551	34,589552	Hard
DPT06	N50	1,401892	35,983718	Hard
DPT06	N50	1,446833	37,276119	Hard
DPT06	N50	1,464932	38,619403	Hard
DPT06	N50	1,504299	39,962687	Hard
DPT06	N50	1,588235	40,298507	Hard
DPT06	N50	1,596154	39,514925	Hard
DPT06	N50	1,616516	38,171642	Hard
DPT06	N50	1,625566	36,828358	Hard
DPT06	N50	1,640271	35,485075	Hard
DPT06	N50	1,654977	34,141791	Hard
DPT06	N50	1,662896	32,798507	Hard
DPT06	N50	1,682127	31,455224	Hard
DPT06	N50	1,729072	30,335821	Hard
DPT06	N50	1,870588	30,074627	Hard
DPT06	N50	1,908371	29,216418	Very stiff
DPT06	N50	1,930995	27,873134	Very stiff
DPT06	N50	1,955882	26,529851	Very stiff
DPT06	N50	2,009050	25,138593	Very stiff
DPT06	N50	2,138009	25,410448	Very stiff
DPT06	N50	2,205882	25,970149	Very stiff
DPT06	N50	2,311086	26,082090	Very stiff
DPT06	N50	2,386878	26,977612	Very stiff
DPT06	N50	2,425339	28,320896	Very stiff
DPT06	N50	2,450226	29,664179	Very stiff
DPT06	N50	2,473982	31,007463	Hard
DPT06	N50	2,495475	32,350746	Hard
DPT06	N50	2,515837	33,694030	Hard
DPT06	N50	2,531674	35,037313	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT06	N50	2,576923	36,447761	Hard
DPT06	N50	2,583258	37,611940	Hard
DPT06	N50	2,623303	35,485075	Hard
DPT06	N50	2,645928	34,141791	Hard
DPT06	N50	2,689291	31,455224	Hard
DPT06	N50	2,691554	32,910448	Hard
DPT06	N50	2,738688	34,141791	Hard
DPT06	N50	2,756787	35,485075	Hard
DPT06	N50	2,777149	36,828358	Hard
DPT06	N50	2,808258	37,947761	Hard
DPT06	N50	2,869910	36,604478	Hard
DPT06	N50	2,915158	35,261194	Hard
DPT06	N50	2,957014	33,917910	Hard
DPT06	N50	3,007919	32,574627	Hard
DPT06	N50	3,075792	31,231343	Hard
DPT06	N50	3,181900	30,000000	Very stiff
DPT06	N50	3,228507	28,768657	Very stiff
DPT06	N50	3,318326	27,514925	Very stiff
DPT06	N50	3,416290	28,768657	Very stiff
DPT06	N50	3,447964	30,111940	Hard
DPT06	N50	3,479638	31,455224	Hard
DPT06	N50	3,520362	32,798507	Hard
DPT06	N50	3,567873	34,141791	Hard
DPT06	N50	3,601810	35,485075	Hard
DPT06	N50	3,624434	36,828358	Hard
DPT06	N50	3,647511	38,104478	Hard
DPT06	N50	3,688537	39,514925	Hard
DPT06	N50	3,726244	37,947761	Hard
DPT06	N50	3,752262	36,604478	Hard
DPT06	N50	3,768100	35,261194	Hard
DPT06	N50	3,797511	33,917910	Hard
DPT06	N50	3,916290	32,985075	Hard
DPT06	N50	4,052036	33,134328	Hard
DPT06	N50	4,187783	33,198294	Hard
DPT06	N50	4,245475	34,589552	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT06	N50	4,287896	35,708955	Hard
DPT06	N50	4,415158	36,380597	Hard
DPT06	N50	4,475566	37,611940	Hard
DPT07	N50	0,151018	0,783582	Very soft
DPT07	N50	0,223982	1,679104	Very soft
DPT07	N50	0,263575	3,022388	Soft
DPT07	N50	0,299774	4,365672	Soft
DPT07	N50	0,322398	5,708955	Firm
DPT07	N50	0,347285	7,052239	Firm
DPT07	N50	0,378733	8,395522	Firm
DPT07	N50	0,414027	9,402985	Stiff
DPT07	N50	0,497172	9,179104	Stiff
DPT07	N50	0,597285	10,074627	Stiff
DPT07	N50	0,661765	11,305970	Stiff
DPT07	N50	0,712670	12,649254	Stiff
DPT07	N50	0,755656	13,992537	Stiff
DPT07	N50	0,802036	15,335821	Stiff
DPT07	N50	0,866063	16,567164	Very stiff
DPT07	N50	0,926471	16,455224	Very stiff
DPT07	N50	0,988688	15,597015	Stiff
DPT07	N50	1,081448	16,679104	Very stiff
DPT07	N50	1,114253	18,022388	Very stiff
DPT07	N50	1,142534	19,365672	Very stiff
DPT07	N50	1,165158	20,708955	Very stiff
DPT07	N50	1,192308	22,052239	Very stiff
DPT07	N50	1,217195	23,395522	Very stiff
DPT07	N50	1,238688	24,738806	Very stiff
DPT07	N50	1,265837	26,082090	Very stiff
DPT07	N50	1,309955	27,089552	Very stiff
DPT07	N50	1,402715	26,865672	Very stiff
DPT07	N50	1,479638	26,082090	Very stiff
DPT07	N50	1,540724	24,962687	Very stiff
DPT07	N50	1,604072	23,619403	Very stiff
DPT07	N50	1,673077	22,276119	Very stiff
DPT07	N50	1,779638	21,044776	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT07	N50	1,824661	19,813433	Very stiff
DPT07	N50	1,892157	18,582090	Very stiff
DPT07	N50	1,959276	19,813433	Very stiff
DPT07	N50	1,995475	21,156716	Very stiff
DPT07	N50	2,030543	22,500000	Very stiff
DPT07	N50	2,078620	23,619403	Very stiff
DPT07	N50	2,127828	23,395522	Very stiff
DPT07	N50	2,142534	22,500000	Very stiff
DPT07	N50	2,184389	21,156716	Very stiff
DPT07	N50	2,288462	20,261194	Very stiff
DPT07	N50	2,371041	21,380597	Very stiff
DPT07	N50	2,406109	22,723881	Very stiff
DPT07	N50	2,432127	24,067164	Very stiff
DPT07	N50	2,471342	25,858209	Very stiff
DPT07	N50	2,495475	24,514925	Very stiff
DPT07	N50	2,516968	23,171642	Very stiff
DPT07	N50	2,520362	21,828358	Very stiff
DPT07	N50	2,528281	20,485075	Very stiff
DPT07	N50	2,538462	19,141791	Very stiff
DPT07	N50	2,544118	17,798507	Very stiff
DPT07	N50	2,550905	16,455224	Very stiff
DPT07	N50	2,590121	12,425373	Stiff
DPT07	N50	2,592760	13,768657	Stiff
DPT07	N50	2,599548	15,162822	Stiff
DPT07	N50	2,639140	16,455224	Very stiff
DPT07	N50	2,645928	17,798507	Very stiff
DPT07	N50	2,654977	19,141791	Very stiff
DPT07	N50	2,661765	20,485075	Very stiff
DPT07	N50	2,668552	21,828358	Very stiff
DPT07	N50	2,683258	23,171642	Very stiff
DPT07	N50	2,714932	24,179104	Very stiff
DPT07	N50	2,786199	24,067164	Very stiff
DPT07	N50	2,809955	23,171642	Very stiff
DPT07	N50	2,839367	21,828358	Very stiff
DPT07	N50	2,900452	20,597015	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT07	N50	2,944570	21,828358	Very stiff
DPT07	N50	2,973982	23,171642	Very stiff
DPT07	N50	3,010181	24,514925	Very stiff
DPT07	N50	3,059389	25,746269	Very stiff
DPT07	N50	3,111991	25,186567	Very stiff
DPT07	N50	3,141403	23,843284	Very stiff
DPT07	N50	3,207149	22,589552	Very stiff
DPT07	N50	3,265837	23,843284	Very stiff
DPT07	N50	3,295249	25,186567	Very stiff
DPT07	N50	3,319005	26,529851	Very stiff
DPT07	N50	3,338235	27,873134	Very stiff
DPT07	N50	3,354072	29,216418	Very stiff
DPT07	N50	3,389593	30,537313	Hard
DPT07	N50	3,492760	30,391791	Hard
DPT07	N50	3,573394	31,567164	Hard
DPT07	N50	3,631222	32,238806	Hard
DPT07	N50	3,703620	31,679104	Hard
DPT07	N50	3,785671	30,447761	Hard
DPT07	N50	3,845023	31,679104	Hard
DPT07	N50	3,874434	33,022388	Hard
DPT07	N50	3,899321	34,365672	Hard
DPT07	N50	3,920814	35,708955	Hard
DPT07	N50	3,937783	37,052239	Hard
DPT07	N50	3,957014	38,395522	Hard
DPT07	N50	4,014221	39,530917	Hard
DPT07	N50	4,093609	38,507463	Hard
DPT07	N50	4,179638	39,626866	Hard
DPT07	N50	4,235294	39,402985	Hard
DPT07	N50	4,298039	38,507463	Hard
DPT07	N50	4,383258	39,626866	Hard
DPT07	N50	4,505656	40,410448	Hard
DPT07	N50	4,567873	41,753731	Hard
DPT07	N50	4,601810	41,194030	Hard
DPT07	N50	4,602941	40,410448	Hard
DPT07	N50	4,608597	39,067164	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT07	N50	4,619910	37,723881	Hard
DPT07	N50	4,622172	36,380597	Hard
DPT07	N50	4,628959	35,037313	Hard
DPT07	N50	4,631222	33,694030	Hard
DPT07	N50	4,642534	32,350746	Hard
DPT07	N50	4,644796	31,007463	Hard
DPT07	N50	4,649321	29,597015	Very stiff
DPT07	N50	4,686652	24,291045	Very stiff
DPT07	N50	4,687500	28,432836	Very stiff
DPT07	N50	4,690045	26,977612	Very stiff
DPT07	N50	4,693439	25,634328	Very stiff
DPT07	N50	4,725113	29,664179	Very stiff
DPT07	N50	4,730769	31,007463	Hard
DPT07	N50	4,731900	32,350746	Hard
DPT07	N50	4,744344	33,694030	Hard
DPT07	N50	4,744344	35,037313	Hard
DPT07	N50	4,750000	36,380597	Hard
DPT07	N50	4,751131	37,723881	Hard
DPT07	N50	4,760181	39,067164	Hard
DPT07	N50	4,762443	40,410448	Hard
DPT07	N50	4,766968	41,753731	Hard
DPT07	N50	4,771493	43,097015	Hard
DPT07	N50	4,771493	44,440299	Hard
DPT07	N50	4,778281	45,783582	Hard
DPT07	N50	4,778281	47,126866	Hard
DPT07	N50	4,787330	48,470149	Hard
DPT07	N50	4,791855	49,701493	Hard
DPT08	N50	0,115385	0,895522	Very soft
DPT08	N50	0,196833	0,895522	Very soft
DPT08	N50	0,278281	0,895522	Very soft
DPT08	N50	0,379864	1,007463	Very soft
DPT08	N50	0,411765	2,350746	Soft
DPT08	N50	0,426471	3,694030	Soft
DPT08	N50	0,443439	5,037313	Firm
DPT08	N50	0,451357	6,380597	Firm

BORE	TYPE	DEPTH	N50	CLASS
DPT08	N50	0,472851	7,723881	Firm
DPT08	N50	0,493213	9,067164	Stiff
DPT08	N50	0,561086	10,410448	Stiff
DPT08	N50	0,605204	11,753731	Stiff
DPT08	N50	0,626697	13,097015	Stiff
DPT08	N50	0,644796	14,440299	Stiff
DPT08	N50	0,667421	15,783582	Stiff
DPT08	N50	0,694570	17,126866	Very stiff
DPT08	N50	0,749321	18,358209	Very stiff
DPT08	N50	0,886231	19,317697	Very stiff
DPT08	N50	0,938914	20,708955	Very stiff
DPT08	N50	0,962670	22,052239	Very stiff
DPT08	N50	0,980769	23,395522	Very stiff
DPT08	N50	0,998869	24,738806	Very stiff
DPT08	N50	1,007919	26,082090	Very stiff
DPT08	N50	1,023756	27,425373	Very stiff
DPT08	N50	1,035068	28,768657	Very stiff
DPT08	N50	1,041855	30,111940	Hard
DPT08	N50	1,054299	31,455224	Hard
DPT08	N50	1,063348	32,798507	Hard
DPT08	N50	1,069005	34,141791	Hard
DPT08	N50	1,080317	35,485075	Hard
DPT08	N50	1,090498	36,828358	Hard
DPT08	N50	1,099548	38,171642	Hard
DPT08	N50	1,099548	39,514925	Hard
DPT08	N50	1,110860	40,858209	Hard
DPT08	N50	1,121041	42,201493	Hard
DPT08	N50	1,126697	43,544776	Hard
DPT08	N50	1,126697	44,888060	Hard
DPT08	N50	1,136878	46,231343	Hard
DPT08	N50	1,143665	47,574627	Hard
DPT08	N50	1,153846	48,917910	Hard
DPT08	N50	1,159502	50,261194	Hard
DPT08	N50	1,161765	51,604478	Hard
DPT08	N50	1,167421	52,947761	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT08	N50	1,179864	54,291045	Hard
DPT08	N50	1,183258	55,634328	Hard
DPT08	N50	1,189480	56,753731	Hard
DPT10	N50	0,162896	0,895522	Very soft
DPT10	N50	0,246606	1,902985	Very soft
DPT10	N50	0,300905	3,246269	Soft
DPT10	N50	0,342760	4,589552	Soft
DPT10	N50	0,385520	5,820896	Firm
DPT10	N50	0,478507	6,828358	Firm
DPT10	N50	0,553167	7,947761	Firm
DPT10	N50	0,597285	9,291045	Stiff
DPT10	N50	0,626697	10,634328	Stiff
DPT10	N50	0,651584	11,977612	Stiff
DPT10	N50	0,668552	13,320896	Stiff
DPT10	N50	0,686652	14,664179	Stiff
DPT10	N50	0,700226	16,007463	Very stiff
DPT10	N50	0,710407	17,350746	Very stiff
DPT10	N50	0,722851	18,694030	Very stiff
DPT10	N50	0,729638	20,037313	Very stiff
DPT10	N50	0,740950	21,380597	Very stiff
DPT10	N50	0,750000	22,723881	Very stiff
DPT10	N50	0,756787	24,067164	Very stiff
DPT10	N50	0,764706	25,410448	Very stiff
DPT10	N50	0,774887	26,753731	Very stiff
DPT10	N50	0,787330	28,097015	Very stiff
DPT10	N50	0,787330	29,440299	Very stiff
DPT10	N50	0,797511	30,783582	Hard
DPT10	N50	0,806561	32,126866	Hard
DPT10	N50	0,814480	33,470149	Hard
DPT10	N50	0,821267	34,813433	Hard
DPT10	N50	0,824661	36,156716	Hard
DPT10	N50	0,828054	37,500000	Hard
DPT10	N50	0,840498	38,843284	Hard
DPT10	N50	0,845023	40,186567	Hard
DPT10	N50	0,848416	41,529851	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT10	N50	0,855204	42,873134	Hard
DPT10	N50	0,860860	44,216418	Hard
DPT10	N50	0,868778	45,559701	Hard
DPT10	N50	0,882353	48,246269	Hard
DPT10	N50	0,882353	46,902985	Hard
DPT10	N50	0,892534	49,589552	Hard
DPT10	N50	0,904977	50,932836	Hard
DPT10	N50	0,915158	52,276119	Hard
DPT10	N50	0,923077	53,619403	Hard
DPT10	N50	0,940045	54,962687	Hard
DPT10	N50	0,949095	56,305970	Hard
DPT10	N50	0,966063	57,649254	Hard
DPT10	N50	0,975113	58,992537	Hard
DPT10	N50	0,990950	59,888060	Hard
DPT11	N50	0,286037	2,078891	Soft
DPT11	N50	0,149321	2,014925	Soft
DPT11	N50	0,350679	3,470149	Soft
DPT11	N50	0,386878	4,813433	Soft
DPT11	N50	0,411765	6,156716	Firm
DPT11	N50	0,436652	7,500000	Firm
DPT11	N50	0,455882	8,843284	Firm
DPT11	N50	0,479638	10,186567	Stiff
DPT11	N50	0,498869	11,529851	Stiff
DPT11	N50	0,514706	12,873134	Stiff
DPT11	N50	0,535068	14,216418	Stiff
DPT11	N50	0,546380	15,559701	Stiff
DPT11	N50	0,569005	16,902985	Very stiff
DPT11	N50	0,867773	17,388060	Very stiff
DPT11	N50	0,605769	18,022388	Very stiff
DPT11	N50	0,699095	17,910448	Very stiff
DPT11	N50	0,773756	17,910448	Very stiff
DPT11	N50	0,916290	18,694030	Very stiff
DPT11	N50	0,937783	20,037313	Very stiff
DPT11	N50	0,949095	21,380597	Very stiff
DPT11	N50	0,967195	22,723881	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT11	N50	1,006154	23,955224	Very stiff
DPT11	N50	1,164027	24,011194	Very stiff
DPT11	N50	1,194570	25,410448	Very stiff
DPT11	N50	1,197964	26,753731	Very stiff
DPT11	N50	1,208145	28,097015	Very stiff
DPT11	N50	1,210407	29,440299	Very stiff
DPT11	N50	1,221719	30,783582	Hard
DPT11	N50	1,221719	32,126866	Hard
DPT11	N50	1,221719	33,470149	Hard
DPT11	N50	1,221719	34,813433	Hard
DPT11	N50	1,227376	36,156716	Hard
DPT11	N50	1,235294	37,500000	Hard
DPT11	N50	1,235294	38,843284	Hard
DPT11	N50	1,244344	40,186567	Hard
DPT11	N50	1,248869	41,529851	Hard
DPT11	N50	1,248869	42,873134	Hard
DPT11	N50	1,248869	44,216418	Hard
DPT11	N50	1,248869	45,559701	Hard
DPT11	N50	1,250000	46,902985	Hard
DPT11	N50	1,262443	48,246269	Hard
DPT11	N50	1,262443	49,589552	Hard
DPT11	N50	1,263575	50,932836	Hard
DPT11	N50	1,276018	52,276119	Hard
DPT11	N50	1,276018	53,619403	Hard
DPT11	N50	1,277149	54,962687	Hard
DPT11	N50	1,282805	56,305970	Hard
DPT11	N50	1,282805	57,649254	Hard
DPT11	N50	1,285068	58,992537	Hard
DPT11	N50	1,289593	59,888060	Hard
DPT12	N50	0,169683	0,947955	Very soft
DPT12	N50	0,207014	2,342007	Soft
DPT12	N50	0,222851	3,680297	Soft
DPT12	N50	0,230769	5,018587	Firm
DPT12	N50	0,244344	6,356877	Firm
DPT12	N50	0,405480	7,583643	Firm

BORE	TYPE	DEPTH	N50	CLASS
DPT12	N50	0,260181	7,695167	Firm
DPT12	N50	0,323906	8,810409	Firm
DPT12	N50	0,486425	8,810409	Firm
DPT12	N50	0,278281	8,921933	Firm
DPT12	N50	0,509050	10,148699	Stiff
DPT12	N50	0,298643	9,925651	Stiff
DPT12	N50	0,526018	11,486989	Stiff
DPT12	N50	0,542986	12,825279	Stiff
DPT12	N50	0,559955	14,163569	Stiff
DPT12	N50	0,591629	15,501859	Stiff
DPT12	N50	0,693665	16,193309	Very stiff
DPT12	N50	0,771493	17,286245	Very stiff
DPT12	N50	0,803167	18,624535	Very stiff
DPT12	N50	0,826923	19,962825	Very stiff
DPT12	N50	0,847285	21,301115	Very stiff
DPT12	N50	0,868778	22,639405	Very stiff
DPT12	N50	0,892534	23,977695	Very stiff
DPT12	N50	0,938914	25,315985	Very stiff
DPT12	N50	0,971719	26,654275	Very stiff
DPT12	N50	0,989819	27,992565	Very stiff
DPT12	N50	1,003394	29,330855	Very stiff
DPT12	N50	1,004525	30,669145	Hard
DPT12	N50	1,004525	32,007435	Hard
DPT12	N50	1,014706	33,345725	Hard
DPT12	N50	1,018100	34,684015	Hard
DPT12	N50	1,030543	36,022305	Hard
DPT12	N50	1,031674	37,360595	Hard
DPT12	N50	1,038462	38,698885	Hard
DPT12	N50	1,038462	40,037175	Hard
DPT12	N50	1,045249	41,375465	Hard
DPT12	N50	1,045249	42,713755	Hard
DPT12	N50	1,057692	44,052045	Hard
DPT12	N50	1,058824	45,390335	Hard
DPT12	N50	1,064480	46,728625	Hard
DPT12	N50	1,065611	48,066914	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT12	N50	1,070136	49,405204	Hard
DPT12	N50	1,072398	50,743494	Hard
DPT12	N50	1,079186	52,081784	Hard
DPT12	N50	1,085973	53,420074	Hard
DPT13	N50	0,115385	0,895522	Very soft
DPT13	N50	0,210407	1,119403	Very soft
DPT13	N50	0,305430	1,902985	Very soft
DPT13	N50	0,376697	1,902985	Very soft
DPT13	N50	0,481900	2,126866	Soft
DPT13	N50	0,504525	3,470149	Soft
DPT13	N50	0,510181	4,813433	Soft
DPT13	N50	0,515837	6,156716	Firm
DPT13	N50	0,528281	7,500000	Firm
DPT13	N50	0,532805	8,843284	Firm
DPT13	N50	0,536199	10,186567	Stiff
DPT13	N50	0,542986	11,529851	Stiff
DPT13	N50	0,550905	12,873134	Stiff
DPT13	N50	0,559955	14,216418	Stiff
DPT13	N50	0,570136	15,559701	Stiff
DPT13	N50	0,588989	16,902985	Very stiff
DPT13	N50	0,605769	18,022388	Very stiff
DPT13	N50	0,691338	16,535181	Very stiff
DPT13	N50	0,738688	17,798507	Very stiff
DPT13	N50	0,769457	19,141791	Very stiff
DPT13	N50	0,878474	20,213220	Very stiff
DPT13	N50	0,911765	21,604478	Very stiff
DPT13	N50	0,918552	22,947761	Very stiff
DPT13	N50	0,926471	24,291045	Very stiff
DPT13	N50	0,938914	25,634328	Very stiff
DPT13	N50	0,944570	26,977612	Very stiff
DPT13	N50	0,953620	28,320896	Very stiff
DPT13	N50	0,966063	29,664179	Very stiff
DPT13	N50	0,981448	30,940299	Hard
DPT13	N50	1,015083	32,014925	Hard
DPT13	N50	1,059793	30,863539	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT13	N50	1,099548	29,440299	Very stiff
DPT13	N50	1,126697	28,097015	Very stiff
DPT13	N50	1,144796	26,753731	Very stiff
DPT13	N50	1,198812	25,522388	Very stiff
DPT13	N50	1,254525	26,753731	Very stiff
DPT13	N50	1,296380	27,873134	Very stiff
DPT13	N50	1,407240	27,985075	Very stiff
DPT13	N50	1,469457	27,985075	Very stiff
DPT13	N50	1,519231	27,201493	Very stiff
DPT13	N50	1,557692	25,858209	Very stiff
DPT13	N50	1,607466	24,514925	Very stiff
DPT13	N50	1,671041	23,283582	Very stiff
DPT13	N50	1,787783	22,835821	Very stiff
DPT13	N50	1,813348	21,604478	Very stiff
DPT13	N50	1,830317	20,261194	Very stiff
DPT13	N50	1,841629	18,917910	Very stiff
DPT13	N50	1,859729	17,574627	Very stiff
DPT13	N50	1,905301	16,311301	Very stiff
DPT13	N50	1,960407	17,574627	Very stiff
DPT13	N50	1,988688	18,917910	Very stiff
DPT13	N50	2,022624	20,261194	Very stiff
DPT13	N50	2,048643	21,604478	Very stiff
DPT13	N50	2,075792	22,947761	Very stiff
DPT13	N50	2,091629	24,291045	Very stiff
DPT13	N50	2,110860	25,634328	Very stiff
DPT13	N50	2,125566	26,977612	Very stiff
DPT13	N50	2,145928	28,320896	Very stiff
DPT13	N50	2,156109	29,664179	Very stiff
DPT13	N50	2,176471	31,007463	Hard
DPT13	N50	2,201357	32,350746	Hard
DPT13	N50	2,266968	33,582090	Hard
DPT13	N50	2,388386	34,141791	Hard
DPT13	N50	2,421946	35,485075	Hard
DPT13	N50	2,441176	36,828358	Hard
DPT13	N50	2,455882	38,171642	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT13	N50	2,473982	39,514925	Hard
DPT13	N50	2,490950	40,858209	Hard
DPT13	N50	2,501131	42,201493	Hard
DPT13	N50	2,514706	43,544776	Hard
DPT13	N50	2,521493	44,888060	Hard
DPT13	N50	2,530543	46,231343	Hard
DPT13	N50	2,541855	47,574627	Hard
DPT13	N50	2,548643	48,917910	Hard
DPT13	N50	2,559955	50,261194	Hard
DPT13	N50	2,575792	51,604478	Hard
DPT13	N50	2,599548	52,779851	Hard
DPT13	N50	2,665385	52,432836	Hard
DPT14	N50	0,115385	0,895522	Very soft
DPT14	N50	0,210407	1,119403	Very soft
DPT14	N50	0,281674	1,902985	Very soft
DPT14	N50	0,393665	1,279318	Very soft
DPT14	N50	0,567166	2,070896	Soft
DPT14	N50	0,636878	3,470149	Soft
DPT14	N50	0,665158	4,813433	Soft
DPT14	N50	0,693439	6,156716	Firm
DPT14	N50	0,714932	7,500000	Firm
DPT14	N50	0,734163	8,843284	Firm
DPT14	N50	0,754525	10,186567	Stiff
DPT14	N50	0,780543	11,529851	Stiff
DPT14	N50	0,828054	12,425373	Stiff
DPT14	N50	0,900452	13,320896	Stiff
DPT14	N50	0,934389	14,664179	Stiff
DPT14	N50	0,962670	16,007463	Very stiff
DPT14	N50	1,008597	17,238806	Very stiff
DPT14	N50	1,079186	17,910448	Very stiff
DPT14	N50	1,194570	18,134328	Very stiff
DPT14	N50	1,260181	19,365672	Very stiff
DPT14	N50	1,340498	20,485075	Very stiff
DPT14	N50	1,411765	21,268657	Very stiff
DPT14	N50	1,501357	21,604478	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT14	N50	1,576600	20,469083	Very stiff
DPT14	N50	1,686652	20,708955	Very stiff
DPT14	N50	1,738688	19,589552	Very stiff
DPT14	N50	1,799612	18,230277	Very stiff
DPT14	N50	1,893665	17,910448	Very stiff
DPT14	N50	1,911765	17,126866	Very stiff
DPT14	N50	1,940045	15,783582	Stiff
DPT14	N50	2,002011	14,552239	Stiff
DPT14	N50	2,055430	15,783582	Stiff
DPT14	N50	2,097285	16,791045	Very stiff
DPT14	N50	2,202489	17,350746	Very stiff
DPT14	N50	2,245475	18,694030	Very stiff
DPT14	N50	2,315837	19,477612	Very stiff
DPT14	N50	2,378959	18,246269	Very stiff
DPT14	N50	2,484333	17,350746	Very stiff
DPT14	N50	2,545249	18,694030	Very stiff
DPT14	N50	2,614480	19,477612	Very stiff
DPT14	N50	2,678733	18,246269	Very stiff
DPT14	N50	2,780090	17,014925	Very stiff
DPT14	N50	2,828054	15,783582	Stiff
DPT14	N50	2,897342	14,440299	Stiff
DPT14	N50	3,008484	15,111940	Stiff
DPT14	N50	3,081448	15,783582	Stiff
DPT14	N50	3,217195	16,231343	Very stiff
DPT14	N50	3,298643	16,679104	Very stiff
DPT14	N50	3,396380	15,649254	Stiff
DPT14	N50	3,492081	16,902985	Very stiff
DPT14	N50	3,549774	17,686567	Very stiff
DPT14	N50	3,619910	17,686567	Very stiff
DPT14	N50	3,712670	16,958955	Very stiff
DPT14	N50	3,825792	17,238806	Very stiff
DPT14	N50	3,895249	17,798507	Very stiff
DPT14	N50	3,990950	18,246269	Very stiff
DPT14	N50	4,007919	19,589552	Very stiff
DPT14	N50	4,023756	20,932836	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT14	N50	4,035068	22,276119	Very stiff
DPT14	N50	4,041855	23,619403	Very stiff
DPT14	N50	4,050905	24,962687	Very stiff
DPT14	N50	4,062217	26,305970	Very stiff
DPT14	N50	4,069005	27,649254	Very stiff
DPT14	N50	4,081448	28,992537	Very stiff
DPT14	N50	4,098416	30,335821	Hard
DPT14	N50	4,133484	31,679104	Hard
DPT14	N50	4,192873	32,798507	Hard
DPT14	N50	4,303167	33,022388	Hard
DPT14	N50	4,374434	33,022388	Hard
DPT14	N50	4,484163	33,022388	Hard
DPT14	N50	4,503394	34,365672	Hard
DPT14	N50	4,512443	35,708955	Hard
DPT14	N50	4,521493	37,052239	Hard
DPT14	N50	4,527149	38,395522	Hard
DPT14	N50	4,532805	39,738806	Hard
DPT14	N50	4,537330	41,082090	Hard
DPT14	N50	4,547511	42,425373	Hard
DPT14	N50	4,553167	43,768657	Hard
DPT14	N50	4,555430	45,111940	Hard
DPT14	N50	4,561086	46,455224	Hard
DPT14	N50	4,569005	47,798507	Hard
DPT14	N50	4,574661	49,141791	Hard
DPT14	N50	4,585973	50,485075	Hard
DPT14	N50	4,588235	51,828358	Hard
DPT15	N50	0,175339	1,082090	Very soft
DPT15	N50	0,250452	2,798507	Soft
DPT15	N50	0,323529	4,253731	Soft
DPT15	N50	0,411991	5,708955	Firm
DPT15	N50	0,469560	8,059701	Firm
DPT15	N50	0,522007	10,522388	Stiff
DPT15	N50	0,566434	12,985075	Stiff
DPT15	N50	0,618778	14,888060	Stiff
DPT15	N50	0,707919	15,335821	Stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT15	N50	0,767471	13,656716	Stiff
DPT15	N50	0,882353	14,104478	Stiff
DPT15	N50	0,913821	12,761194	Stiff
DPT15	N50	0,986335	10,477612	Stiff
DPT15	N50	1,131787	9,067164	Stiff
DPT15	N50	1,260747	7,975746	Firm
DPT15	N50	1,329083	9,850746	Stiff
DPT15	N50	1,367647	12,005597	Stiff
DPT15	N50	1,418552	13,208955	Stiff
DPT15	N50	1,470911	12,281450	Stiff
DPT15	N50	1,522213	10,298507	Stiff
DPT15	N50	1,591144	7,739872	Firm
DPT15	N50	1,715343	8,955224	Firm
DPT15	N50	1,775170	11,082090	Stiff
DPT15	N50	1,895249	10,589552	Stiff
DPT15	N50	1,986425	11,641791	Stiff
DPT15	N50	2,078733	10,044776	Stiff
DPT15	N50	2,183484	11,686567	Stiff
DPT15	N50	2,199095	14,104478	Stiff
DPT15	N50	2,210819	16,567164	Very stiff
DPT15	N50	2,212670	19,029851	Very stiff
DPT15	N50	2,212670	21,492537	Very stiff
DPT15	N50	2,221925	23,955224	Very stiff
DPT15	N50	2,226244	26,417910	Very stiff
DPT15	N50	2,237351	28,880597	Very stiff
DPT15	N50	2,239819	31,343284	Hard
DPT15	N50	2,239819	33,805970	Hard
DPT15	N50	2,239819	36,268657	Hard
DPT15	N50	2,252160	38,731343	Hard
DPT15	N50	2,253394	41,194030	Hard
DPT15	N50	2,264500	43,656716	Hard
DPT15	N50	2,266968	46,119403	Hard
DPT15	N50	2,266968	48,582090	Hard
DPT15	N50	2,267585	51,044776	Hard
DPT15	N50	2,274990	53,507463	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT15	N50	2,280543	55,970149	Hard
DPT15	N50	2,287330	58,432836	Hard
DPT15	N50	2,294118	59,888060	Hard
DPT16	N50	0,117081	2,126866	Soft
DPT16	N50	0,208468	3,358209	Soft
DPT16	N50	0,285068	4,701493	Soft
DPT16	N50	0,407240	5,149254	Firm
DPT16	N50	0,500566	5,401119	Firm
DPT16	N50	0,585030	3,843284	Soft
DPT16	N50	0,657523	5,485075	Firm
DPT16	N50	0,703337	7,276119	Firm
DPT16	N50	0,768665	8,619403	Firm
DPT16	N50	0,855204	9,067164	Stiff
DPT16	N50	0,932127	8,507463	Firm
DPT16	N50	1,027149	7,985075	Firm
DPT16	N50	1,140271	7,835821	Firm
DPT16	N50	1,243051	8,731343	Firm
DPT16	N50	1,298077	10,410448	Stiff
DPT16	N50	1,323529	12,201493	Stiff
DPT16	N50	1,356618	13,992537	Stiff
DPT16	N50	1,394118	15,447761	Stiff
DPT16	N50	1,446550	13,992537	Stiff
DPT16	N50	1,484729	12,201493	Stiff
DPT16	N50	1,581448	10,970149	Stiff
DPT16	N50	1,644473	9,850746	Stiff
DPT16	N50	1,723982	8,171642	Firm
DPT16	N50	1,839367	6,902985	Firm
DPT16	N50	1,946994	8,059701	Firm
DPT16	N50	2,015837	9,067164	Stiff
DPT16	N50	2,093213	8,731343	Firm
DPT16	N50	2,164932	7,410448	Firm
DPT16	N50	2,210124	9,067164	Stiff
DPT16	N50	2,212670	10,858209	Stiff
DPT16	N50	2,217760	12,649254	Stiff
DPT16	N50	2,226244	14,440299	Stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT16	N50	2,238971	16,231343	Very stiff
DPT16	N50	2,239819	18,022388	Very stiff
DPT16	N50	2,240667	19,813433	Very stiff
DPT16	N50	2,252545	21,604478	Very stiff
DPT16	N50	2,266968	23,171642	Very stiff
DPT16	N50	2,291855	26,977612	Very stiff
DPT16	N50	2,300057	25,186567	Very stiff
DPT16	N50	2,300905	27,985075	Very stiff
DPT16	N50	2,320419	23,171642	Very stiff
DPT16	N50	2,344174	21,380597	Very stiff
DPT16	N50	2,356052	19,589552	Very stiff
DPT16	N50	2,365385	17,798507	Very stiff
DPT16	N50	2,372172	16,007463	Very stiff
DPT16	N50	2,390837	14,216418	Stiff
DPT16	N50	2,460407	13,097015	Stiff
DPT16	N50	2,530705	12,089552	Stiff
DPT16	N50	2,621606	10,970149	Stiff
DPT16	N50	2,792986	10,858209	Stiff
DPT16	N50	2,876471	10,074627	Stiff
DPT16	N50	2,973373	8,748565	Firm
DPT16	N50	3,043269	10,410448	Stiff
DPT16	N50	3,074661	12,201493	Stiff
DPT16	N50	3,162896	13,134328	Stiff
DPT16	N50	3,282805	12,462687	Stiff
DPT16	N50	3,371606	13,992537	Stiff
DPT16	N50	3,403846	15,783582	Stiff
DPT16	N50	3,419118	17,574627	Very stiff
DPT16	N50	3,437783	19,365672	Very stiff
DPT16	N50	3,451357	21,156716	Very stiff
DPT16	N50	3,486425	23,014925	Very stiff
DPT16	N50	3,502262	23,955224	Very stiff
DPT16	N50	3,535351	22,276119	Very stiff
DPT16	N50	3,597285	20,447761	Very stiff
DPT16	N50	3,710124	19,141791	Very stiff
DPT16	N50	3,782240	15,559701	Stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT16	N50	3,785068	17,402985	Very stiff
DPT16	N50	3,851810	19,141791	Very stiff
DPT16	N50	3,888386	21,380597	Very stiff
DPT16	N50	3,914350	19,797441	Very stiff
DPT16	N50	3,945136	18,022388	Very stiff
DPT16	N50	3,962104	16,231343	Very stiff
DPT16	N50	4,015014	14,470828	Stiff
DPT16	N50	4,119910	15,000000	Stiff
DPT16	N50	4,201357	15,000000	Stiff
DPT16	N50	4,276018	15,000000	Stiff
DPT16	N50	4,391403	15,167910	Stiff
DPT16	N50	4,455505	16,828358	Very stiff
DPT16	N50	4,486425	17,910448	Very stiff
DPT16	N50	4,525641	16,517413	Very stiff
DPT16	N50	4,603130	14,738806	Stiff
DPT16	N50	4,705317	16,231343	Very stiff
DPT16	N50	4,778281	17,574627	Very stiff
DPT16	N50	4,897146	16,722158	Very stiff
DPT16	N50	5,003959	18,246269	Very stiff
DPT16	N50	5,060803	20,037313	Very stiff
DPT16	N50	5,108597	21,268657	Very stiff
DPT16	N50	5,186199	21,604478	Very stiff
DPT16	N50	5,222851	19,813433	Very stiff
DPT16	N50	5,238122	18,022388	Very stiff
DPT16	N50	5,261029	16,231343	Very stiff
DPT16	N50	5,306787	14,574627	Stiff
DPT16	N50	5,375566	16,231343	Very stiff
DPT16	N50	5,483314	17,070896	Very stiff
DPT16	N50	5,570136	17,686567	Very stiff
DPT17	N50	0,120475	1,231343	Very soft
DPT17	N50	0,203620	1,902985	Very soft
DPT17	N50	0,285068	1,902985	Very soft
DPT17	N50	0,366516	1,902985	Very soft
DPT17	N50	0,447964	1,902985	Very soft
DPT17	N50	0,573529	2,261194	Soft

BORE	TYPE	DEPTH	N50	CLASS
DPT17	N50	0,610860	4,141791	Soft
DPT17	N50	0,627828	5,932836	Firm
DPT17	N50	0,635464	7,723881	Firm
DPT17	N50	0,652432	9,514925	Stiff
DPT17	N50	0,694005	11,529851	Stiff
DPT17	N50	0,699661	12,649254	Stiff
DPT17	N50	0,726244	10,646766	Stiff
DPT17	N50	0,793912	8,995929	Firm
DPT17	N50	0,845871	10,634328	Stiff
DPT17	N50	0,886231	12,313433	Stiff
DPT17	N50	0,994344	13,320896	Stiff
DPT17	N50	1,018948	15,111940	Stiff
DPT17	N50	1,036765	16,902985	Very stiff
DPT17	N50	1,061369	18,694030	Very stiff
DPT17	N50	1,092760	20,820896	Very stiff
DPT17	N50	1,104719	19,861407	Very stiff
DPT17	N50	1,152149	18,022388	Very stiff
DPT17	N50	1,216660	16,139756	Very stiff
DPT17	N50	1,328620	17,126866	Very stiff
DPT17	N50	1,383258	18,582090	Very stiff
DPT17	N50	1,455882	17,798507	Very stiff
DPT17	N50	1,521210	16,231343	Very stiff
DPT17	N50	1,631222	14,888060	Stiff
DPT17	N50	1,756949	15,895522	Stiff
DPT17	N50	1,791855	17,574627	Very stiff
DPT17	N50	1,805430	19,365672	Very stiff
DPT17	N50	1,807975	21,156716	Very stiff
DPT17	N50	1,812217	22,947761	Very stiff
DPT17	N50	1,814762	24,738806	Very stiff
DPT17	N50	1,819005	26,529851	Very stiff
DPT17	N50	1,819853	28,320896	Very stiff
DPT17	N50	1,832579	30,111940	Hard
DPT17	N50	1,832579	31,902985	Hard
DPT17	N50	1,836821	33,694030	Hard
DPT17	N50	1,839367	35,485075	Hard

BORE	TYPE	DEPTH	N50	CLASS
DPT17	N50	1,841063	37,276119	Hard
DPT17	N50	1,846154	39,067164	Hard
DPT17	N50	1,846154	40,858209	Hard
DPT17	N50	1,858032	42,649254	Hard
DPT17	N50	1,859729	44,440299	Hard
DPT17	N50	1,864819	46,231343	Hard
DPT17	N50	1,866516	48,022388	Hard
DPT17	N50	1,904223	53,171642	Hard
DPT17	N50	1,904695	49,813433	Hard
DPT17	N50	1,912048	51,604478	Hard
DPT17	N50	1,948812	48,246269	Hard
DPT17	N50	1,958145	46,455224	Hard
DPT17	N50	1,963235	44,664179	Hard
DPT17	N50	1,971719	42,873134	Hard
DPT17	N50	1,984446	41,082090	Hard
DPT17	N50	1,991233	39,291045	Hard
DPT17	N50	2,003111	37,500000	Hard
DPT17	N50	2,016686	35,708955	Hard
DPT17	N50	2,022624	33,917910	Hard
DPT17	N50	2,031957	32,126866	Hard
DPT17	N50	2,043835	30,335821	Hard
DPT17	N50	2,054016	28,544776	Very stiff
DPT17	N50	2,060803	26,753731	Very stiff
DPT17	N50	2,074378	24,962687	Very stiff
DPT17	N50	2,087104	23,171642	Very stiff
DPT17	N50	2,126131	21,380597	Very stiff
DPT17	N50	2,219186	20,014925	Very stiff
DPT17	N50	2,395928	19,701493	Very stiff
DPT17	N50	2,499095	18,559701	Very stiff
DPT17	N50	2,591912	20,037313	Very stiff
DPT17	N50	2,628394	21,828358	Very stiff
DPT17	N50	2,684551	23,315565	Very stiff
DPT17	N50	2,725962	21,828358	Very stiff
DPT17	N50	2,740385	20,037313	Very stiff
DPT17	N50	2,759898	18,246269	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT17	N50	2,789593	16,455224	Very stiff
DPT17	N50	2,909502	15,335821	Stiff
DPT17	N50	2,992647	13,843284	Stiff
DPT17	N50	3,081448	14,776119	Stiff
DPT17	N50	3,162896	15,111940	Stiff
DPT17	N50	3,232708	14,104478	Stiff
DPT17	N50	3,335973	12,873134	Stiff
DPT17	N50	3,444570	13,992537	Stiff
DPT17	N50	3,545249	15,074627	Stiff
DPT17	N50	3,676265	14,470828	Stiff
DPT17	N50	3,734729	16,231343	Very stiff
DPT17	N50	3,777715	18,022388	Very stiff
DPT17	N50	3,834842	16,902985	Very stiff
DPT17	N50	3,855204	15,111940	Stiff
DPT17	N50	3,911538	13,231343	Stiff
DPT17	N50	4,050679	13,656716	Stiff
DPT17	N50	4,113122	13,544776	Stiff
DPT17	N50	4,143665	12,425373	Stiff
DPT17	N50	4,200226	10,858209	Stiff
DPT17	N50	4,325792	9,925373	Stiff
DPT17	N50	4,445701	10,410448	Stiff
DPT17	N50	4,528846	11,305970	Stiff
DPT17	N50	4,595023	11,865672	Stiff
DPT17	N50	4,705317	12,201493	Stiff
DPT17	N50	4,768584	13,432836	Stiff
DPT17	N50	4,847059	14,552239	Stiff
DPT17	N50	4,987934	15,298507	Stiff
DPT17	N50	5,042138	17,126866	Very stiff
DPT17	N50	5,073529	18,917910	Very stiff
DPT17	N50	5,106618	20,708955	Very stiff
DPT17	N50	5,146493	22,500000	Very stiff
DPT17	N50	5,211700	23,155650	Very stiff
DPT17	N50	5,246606	21,380597	Very stiff
DPT17	N50	5,278846	19,589552	Very stiff
DPT17	N50	5,373626	18,294243	Very stiff

BORE	TYPE	DEPTH	N50	CLASS
DPT17	N50	5,481618	19,589552	Very stiff
DPT17	N50	5,533371	21,380597	Very stiff
DPT17	N50	5,575792	23,171642	Very stiff
DPT09	N50	0,095023	1,455224	Very soft
DPT09	N50	0,115385	2,798507	Soft
DPT09	N50	0,134615	4,141791	Soft
DPT09	N50	0,152715	5,485075	Firm
DPT09	N50	0,196833	6,716418	Firm
DPT09	N50	0,251131	6,492537	Firm
DPT09	N50	0,265837	5,708955	Firm
DPT09	N50	0,304299	4,365672	Soft
DPT09	N50	0,329186	3,022388	Soft
DPT09	N50	0,354072	1,679104	Very soft
DPT09	N50	0,378959	0,335821	Very soft
DPT09	N50	0,378959		Refusal

SPT or N value	Cohesion, C or Su	Consistency
< 2	< 500 psf	Very soft
2 – 4	500 – 1000 psf	Soft
5 – 8	1000 – 2000 psf	Firm
9 – 15	2000 – 4000 psf	Stiff
16-30	4000 – 8000 psf	Very stiff
>30	> 8000 psf	Hard

Appendix

4

Characterization dumped hazardous waste

	Substances	Amount on the list	Tones	Remarks	Type	POP	Rodenticide	Pesticide	Insecticide	Herbicide	Fungicide	Bactericide	seed disinfectant	Defolian	Acaricideagainst ticks	fumigand	Acute toxic	Toxic	moderate toxicity	low toxic	Volatile	Solubility in water	Appearance	Colour	Smell	Package	Half-life period
1	DDT	192.5 tons	192,50		Organochlorine, C14H9Cl5,	x		x		x								x			low volatility, vapor pressure at 20C: 1.5x10-7 mm Hg	practically insoluble	crystalline	from white to light brown	with a specific fruity smell	paper bag -20 kg	Extremely resistant to environmental factors
2	Entobacterin	33,121 kg	33,12		Biological preparation, Entobacterin-3 contains 30 billion bacterial spores/ kg of *Bacillus cereus var. Galleriae*. Usually applied together with DDT				x														Powder/ the liquid form is a dark brown liquid creamy texture	gray / dark brown			
3	Fenthiuram	6,765 kg	6,77	compound of TMTD 40% и HCH 20% and trichlorophenol copper 10% and kaolin 10 %	Mixture containing organochlorine				x										x				Powder	reddish brown	pungent odor of phenol	multi-ply paper bags with polyethylene liner 20-25 kg	
4	Dalapon	17 tons	17,00		2,2 dichloropropanoic acid (C3H4Cl2O2), liquid. Sodium salt is crystalline solid. Corrosive to iron					x										x		45gram/L at 25C	crystalline powder	white with a yellow tinge		30-40kg drums	decomposes at 174-176C. Aquous solutions hydrolyze above 70C
5	Hexachlorocyclohexane	48,396 kg	48,40	all isomers are reasonably anticipated to be a human carcinogen	Organochlorine, C6H6Cl6	x			x										x		vapor pressure at 20C: 9.4x10-6 mm Hg. (y-HCH)	practically insoluble (7.3mg/L at 25C)	crystalline	yellowish-gray or light gray	smell of mold	multi-ply paper bags - 20-25 kg	At a temperature of 50 ° in 8 days 75% evaporates. It refers to a very persistent preparations: in the soil after a year 76% of the original amount is found.
6	Simazine	18,117 kg	18,12		Organochlorine, C7H12ClN5					x										x	low volatility	practically insoluble	crystalline/ dry powder	white/ gray white		paper bag 20 kg	Can preserve toxicity in the soil up to 2 years
7	Cosan	2,693 kg	2,64	Thiovit	80% sulfur. Trade name Cosan has also been used for phenyl mercury acetate						x				x				x	x		x	powder	yellow		bag 20 kg	
8	Granosan	8,402 kg	8,40		2% ethylmercury						x	x	x				x					x	crystalline	white, dark pink/ purple	specific	steel drums with polyethylene liner - 10 kg	
9	TUR	1,280 kg	1,28							x																	
10	Thiovit	1,810 kg	1,81	Cosan	80% sulfur						x				x				x	x		x	powder	yellow		bag 20 kg	
11	Cytox	0,096 tons	0,10	Methyl cistox, methyl demeton	Organophosphorous, C6H15O3PS2. Demeton (s methyl)				X						x		X	x				practically insoluble	Oily liquid, flammable	colurless	bad, faint odour	30% concentrate in steel capsules - 2 litres	
12	Liquid soap	0,289 tons	0,29																								
13	Hexachlorobenzene	1,265 tons	1,27	resonably anticipated to be a human carcinogen							x		x							x	vapor pressure at 20C: 1.09x10-5 mm Hg. Sublimable.	insoluble	crystalline, needles	gray / white to cream-colored	bad	30% dry powder -multi-ply paper bags with polyethylene liner - 20 kg; 30 kg	resistant to light, acids and alkalis
14	Dichol	0,168 tons	0,17	mixture of ethylene glycol and propylene glycol																			powder	white to light gray		bituminized paper bag with polyethylene liner - 20kg	
15	Pentachlorophenol	8,715 tons	8,72				x			x				x			x				x	slightly soluble in water (80mg/L), soluble in oils	20 % oil solution	white	smell of phenol, very pungent odor only when hot	iron drums of 30-40 kg	
16	Lissapol	1,878 tons	1,88	Polyoxyethylene (10) nonylphenol, NP10	C15H24O. (C2H4O)n an alkylphenol ethoxylate, used as wetting agent, detergent														X			easily dissolves	colorless liquid				
17	Diamine phosphate	5 tons	5,00		Ethylene diamine acid -o-phosphate EDAP ??																						
18	Chlorophos	1,695 kg	1,70	organochlorophosphorus	C4H8Cl3O4P				x										x			12,30%	7 % granular formulation or 80% dry powder	white-crystal powder	bad	multi-ply paper bags with polyethylene liner- 20-25 kg	when heated to 70 degrees, in an acidic environment (pH 6) - three hours, neutral - 0.7hours, alkaline (pH 6) - 0.6 hours
19	Sevin	1,846 lg	1,85	1-naphthyl methylcarbamate, Carbaryl	C12H11NO2	x			x										x			slightly soluble, soluble in organic solvents	crystal powder/dust/ granules	white	no smell	cardboard boxes with polyethylene liner - 15 kg, 25 kg, 50 kg	
20	Cossan	1,498 kg	1,50		80% sulfur. Trade name Cosan has also been used for phenyl mercury acetate						x				x				x	x		x	powder	yellow		bag 20kg	
21	Cyneb	16,374 kg	16,37	Zinc ethylenebis (dithiocarbamate), Zineb	C4H6N2S4Zn						x									x		insoluble in water and organic solvents, moderately soluble in pyridine	80% dry powder	White slightly yellowish / white light gray	bad	paper bag 30 kg	In the environment is destroyed within a month. Toxic products of its transformation stored for 1,5 - 2 months
22	Colloid sulfur	17,950 kg	17,95		Sulfur				x	x	x				x					x			70 % dry powder, 80% dry powder	yellow		metal or wooden barrels or paper bags 20-25 kg	
23	Metaldehyde	0,1 ton	0,10		Polymer of acetaldehyde (C2H4O)n				x											x		practically insoluble	crystal	colorless		50% dry powder or 5% granules, cardboard drums -20 -25 kg	
24	Calcium arsenate	42,640 kg	42,64		Ca3(AsO4)2				x	x	x			x			x					slightly soluble in water (0.13gr/L), soluble in hydrochloric and nitric acids	powder, density 3.62gr/cm3	from white to light gray	odorless	38-40 % dry powder - steel drums - 25 кг	
25	Tobacco packs			5494 packs	Nicotine											x					sublimes at 112C						
26	BIP Biological insecticide preparation	5,160 kg	5,16																								
27	TMTD Tetramethylthiuramdisulphide	7,205 kg	7,21	Known also as Aatiram, Thiram	Carbamate, C6H12N2S4								x						x			insoluble	crystal	from white to cream-colored		50-80 %dry powder, also in a mixture with insecticides, multy-ply bituminized paper bag placed in plywood drums - 20-25 kg, 30 kg	In water in a neutral medium -46.7 days, in acidic (pH 3.5) -9.4 hours. In a neutral medium still on the 200th day retained 5.2% TMTD. Resistant to high temperatures. In alkaline medium (pH 7) after 2-4 hours of boiling saved 60-30% TMTD introduced.
28	Paris Green	0,239 tons	0,24	copper(II) acetoarsenite, Cu(CH3COO)2·3Cu(AsO2)2 (Mixed copper acetate arsenite (II))			x		x	x							x					practically insoluble	fine crystalline powder	green		In metal containers	
29	Copper vitriol				CuSO4.5h2o						x											highly soluble, 316gr/L at 0C for the pentahydrate	coarsely crystalline powder containing 93-98.2% of the active substance	blue		multi-ply paper bags with polyethylene liner- 20-25 kg	
30	Dendrobacilin	9,815 kg	9,82		Biological preparation																						
31	Rezetopth	17,1 ton	17,10	Rezitoks/Koral/, muskatoks,. Bayer	Is this? Coumaphos: "0,0-diethyl 0-3-chloro-4- methyl-7-coumarinyl thiophosphate"				x						x			x					crystal	белый/ желтоватого цвета		25 %, 30% и 50 % dry powder, 16 % emulsion concentrate, 0.5% и 5 % dust	
32	DNOC Dinitroortocresol	0,890 ton	0,89					x	x	x	x						x				moderately volatile with steam	slightly soluble in water, better in alcohol. Sodium salt is freely soluble in water	crystal	from yellow to orange	no smell	40% soluble powder- iron drums with polyethylene liner or 30-40 kgcardboard drums with polyethylene liner - 10 kg	
33	Sodium trichloroacetate	4,98 tons	4,98							x										x		highly soluble in water	crystal, hygroscopic	yellow or white		87 % powder - drums 30 -40kg	Remains active in the soil for 4-10 months
34	Pesticides containing arsenic, sulfur, phosphor, cyanide and mercury	30 tons	30,00																								
		Total	**504,93**																								

Appendix 5

Stakeholders involvement

Встреча заинтересованных сторон
22 марта 2013

Оценка и технико-экономическое обоснование захоронения в Нубарашене, Армения




Tauw OSCE MILIEUKONTAKT INTERNATIONAL

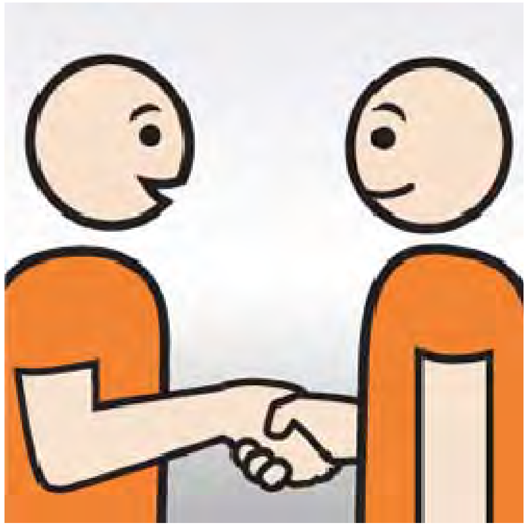
ARMENIAN WOMEN FOR HEALTH AND HEALTHY ENVIRONMENT
non-profit, non-governmental organization

Program

Программа	Председатель	Время
Приветствие	Edward – OSCE	11.00 – 11.15
Представление участников	Wouter – MKI	11.15 – 11.45
Ход выполнения проекта	Boudewijn – Tauw	11.45 – 12.00
Введение: быстрое сканирование - анализ заинтересованных сторон	Wouter – MKI	12.00 – 12.15
Предварительные результаты быстрого сканирования	Gohar – AWHHE	12.15 – 12.30
Анализ участниками результатов быстрого сканирования	Wouter – MKI	12.30 – 12.45
Перерыв		12.45 – 13.30
Работа в группах: редактирование окончательных результатов быстрого сканирования	Gohar – AWHHE	13.30 – 14.00
Планирование участия заинтересованных сторон	Wouter – MKI	14.00 – 14.45
Подведение итогов - обратная связь с участниками	Edward – OSCE	14.45 – 15.00

Приветствие

- Приветствие: ОБСЕ (Эдвард)
- Представление участников (Wouter – фасилитатор)



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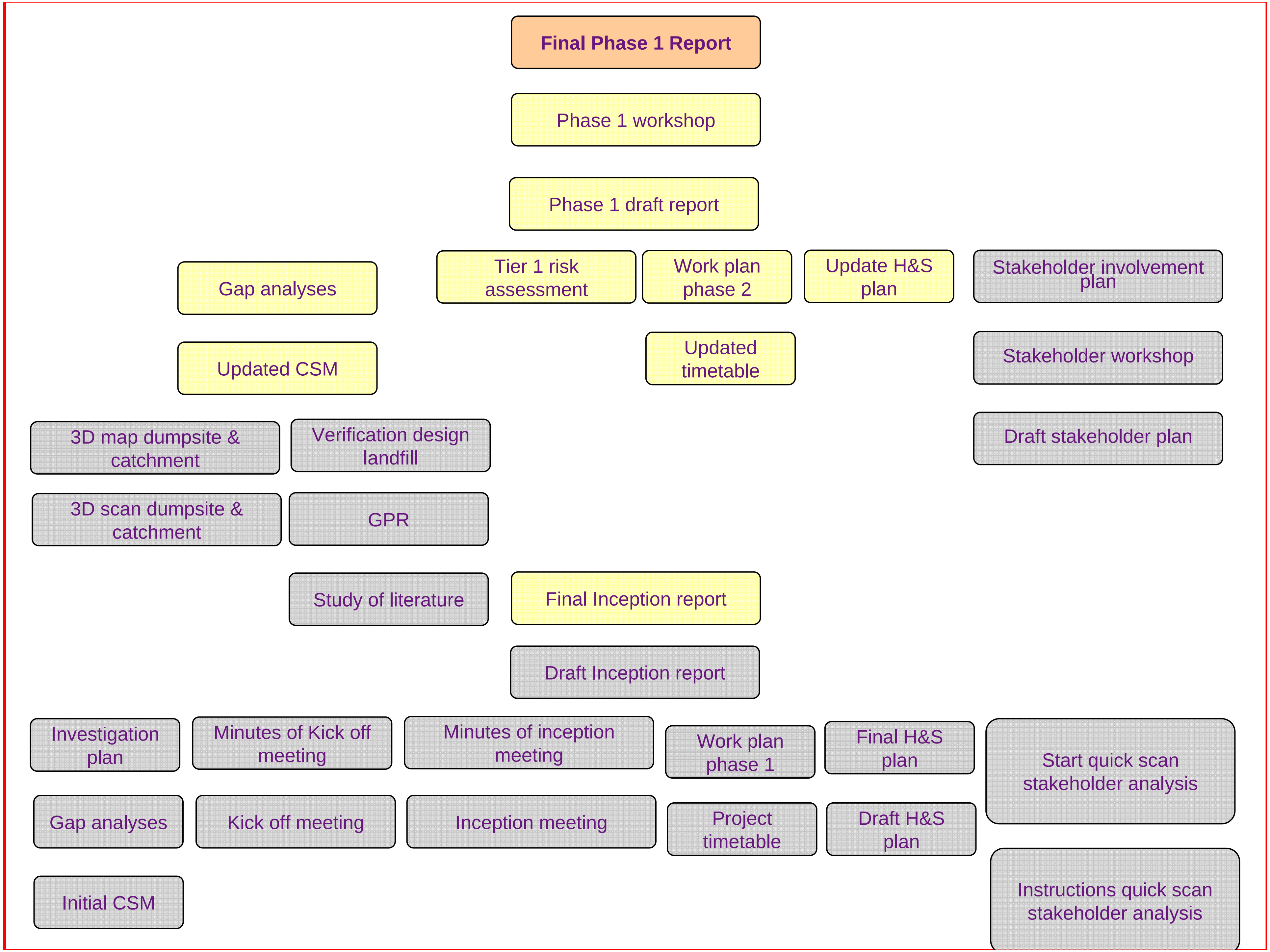
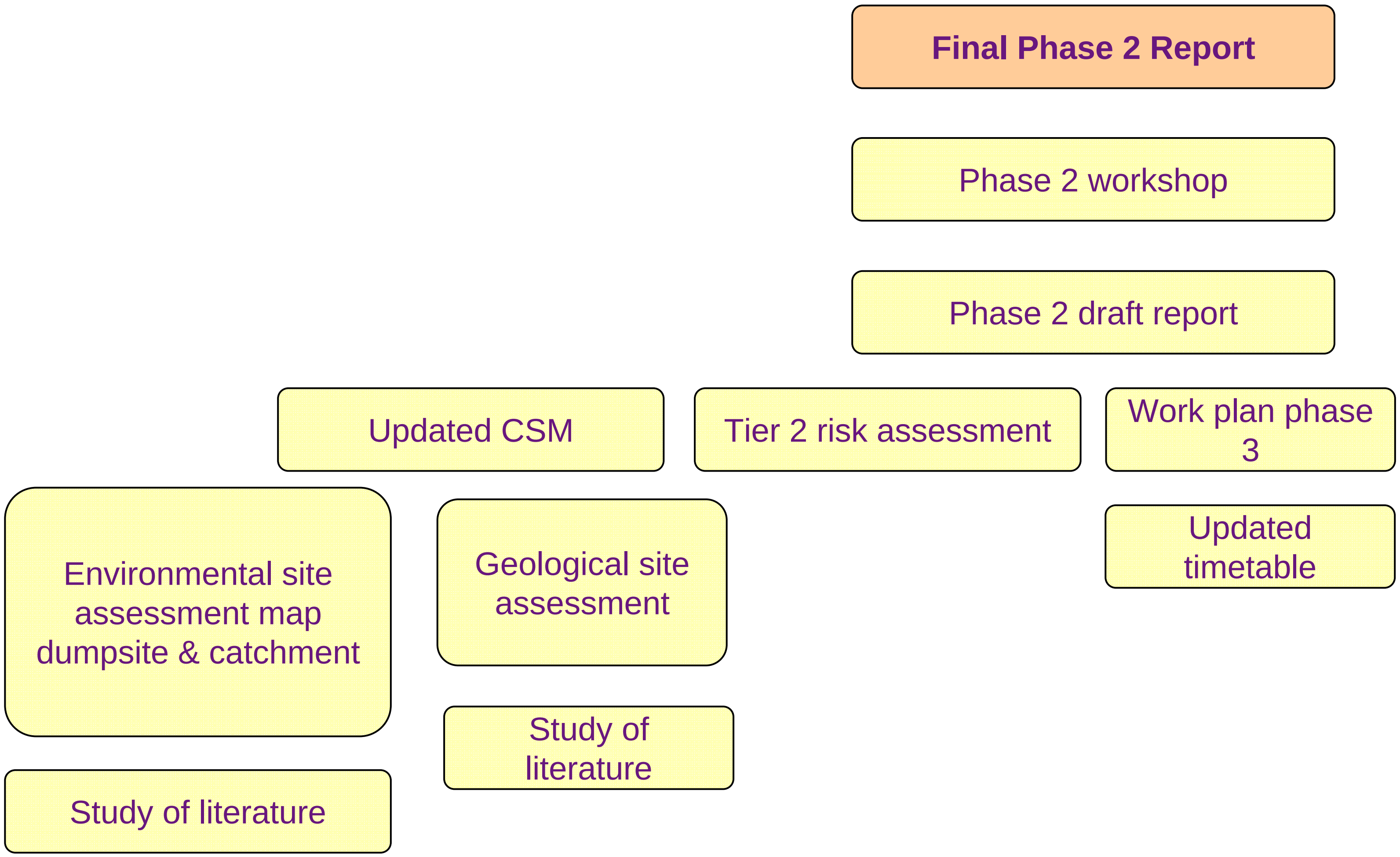
Update project progress

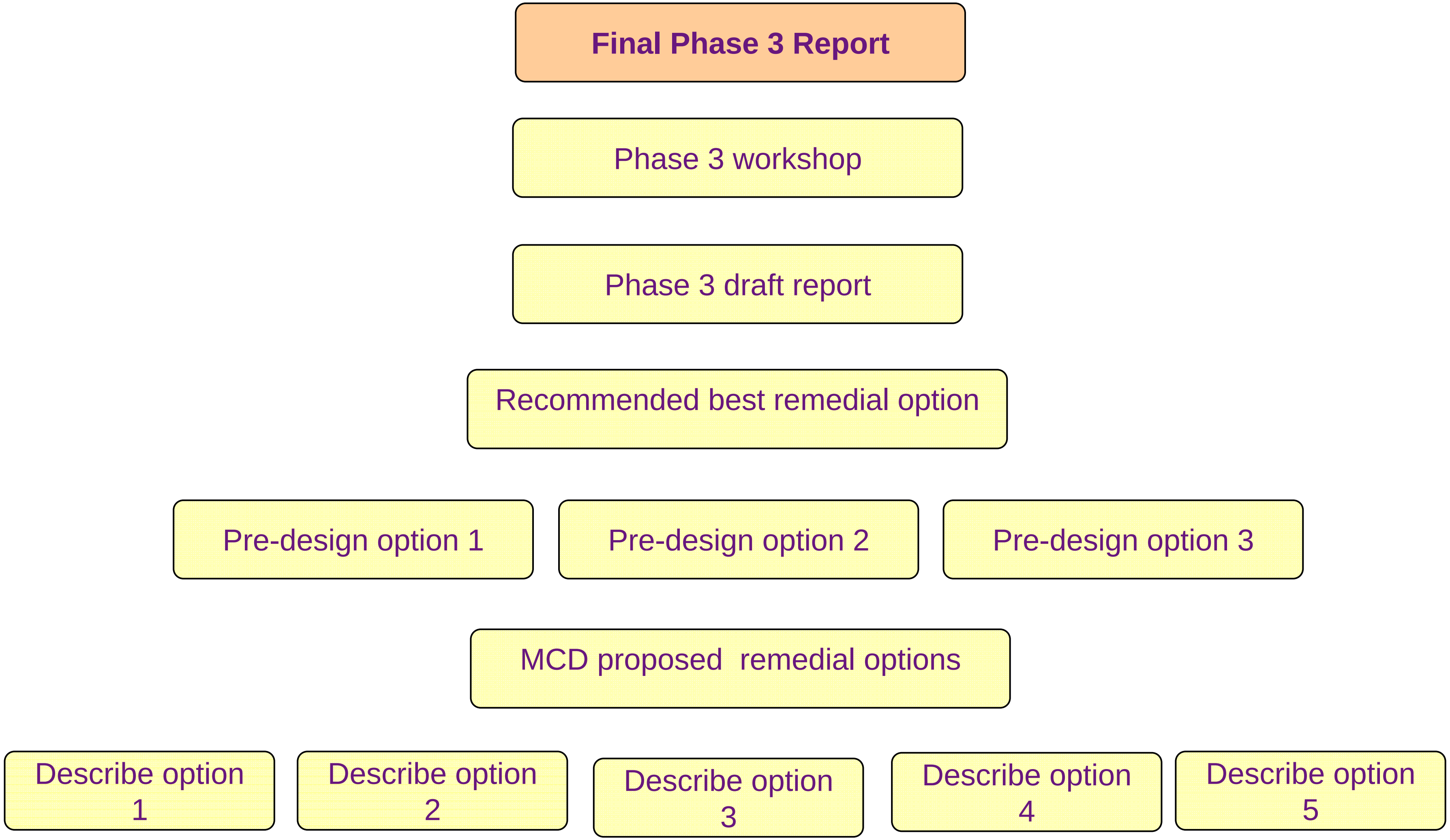
Phase 3
Long term technical solution

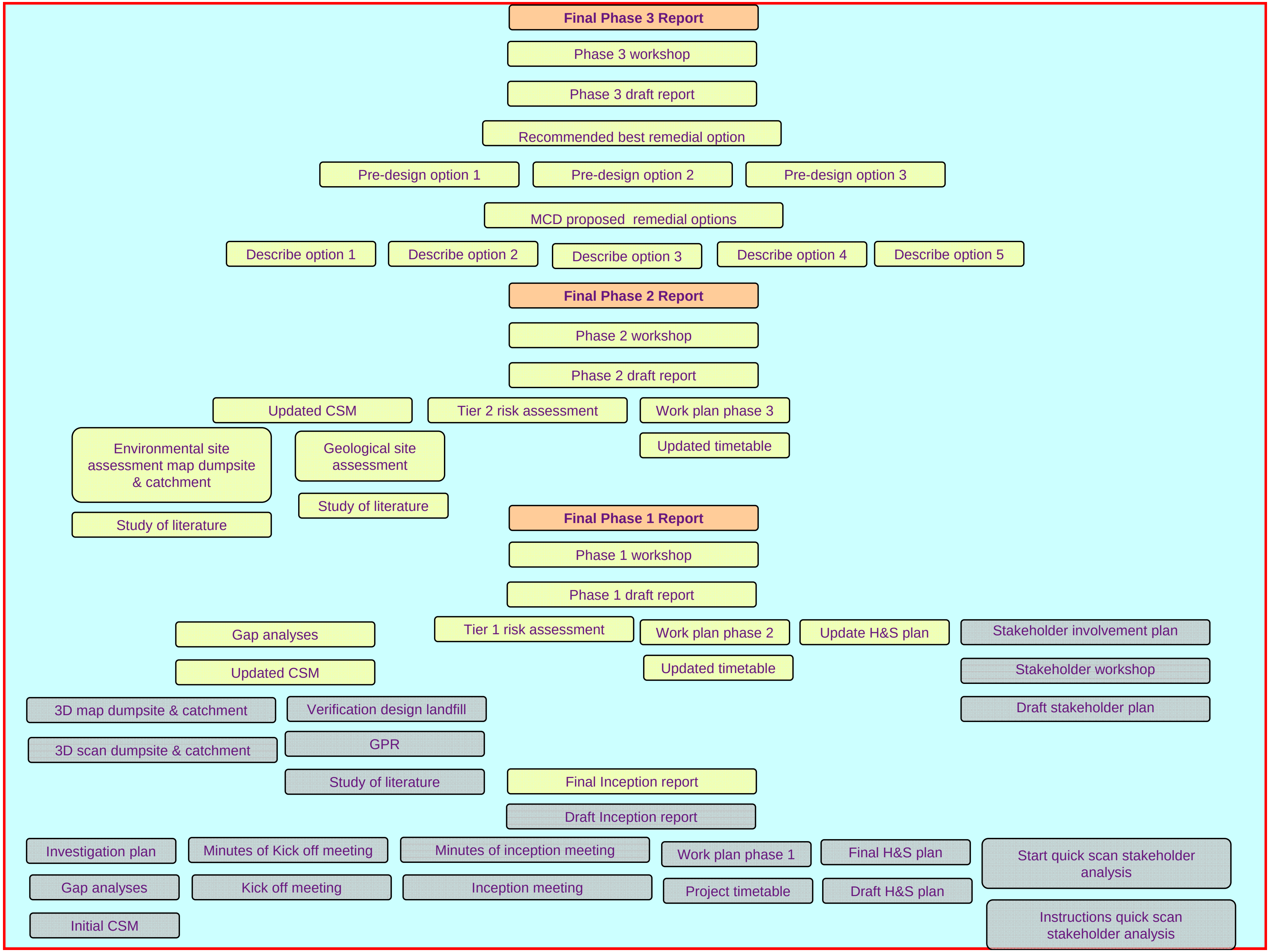
Phase 2
Investigation and risk assessment for feasibility for long term solution

Phase 1
Investigation burial site extent


Final Phase 1 Report
Phase 1 workshop
Phase 1 draft report
Gap analyses
Tier 1 risk assessment
Work plan phase 2
Update H&S plan
Stakeholder involvement plan
Updated CSM
Updated timetable
Stakeholder workshop
3D map dumpsite & catchment
Verification design landfill
Draft stakeholder plan
3D scan dumpsite & catchment
GPR
Study of literature
Final Inception report
Draft Inception report
Investigation plan
Minutes of Kick off meeting
Minutes of inception meeting
Work plan phase 1
Final H&S plan
Start quick scan stakeholder analysis
Gap analyses
Kick off meeting
Inception meeting
Project timetable
Draft H&S plan
Initial CSM
Instructions quick scan stakeholder analysis


Final Phase 2 Report
Phase 2 workshop
Phase 2 draft report
Updated CSM
Tier 2 risk assessment
Work plan phase 3
Updated timetable
Environmental site assessment map dumpsite & catchment
Geological site assessment
Study of literature
Study of literature


Final Phase 3 Report
Phase 3 workshop
Phase 3 draft report
Recommended best remedial option
Pre-design option 1
Pre-design option 2
Pre-design option 3
MCD proposed remedial options
Describe option 1
Describe option 2
Describe option 3
Describe option 4
Describe option 5


Final Phase 3 Report
Phase 3 workshop
Phase 3 draft report
Recommended best remedial option
Pre-design option 1
Pre-design option 2
Pre-design option 3
MCD proposed remedial options
Describe option 1
Describe option 2
Describe option 3
Describe option 4
Describe option 5
Final Phase 2 Report
Phase 2 workshop
Phase 2 draft report
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Tier 2 risk assessment
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Updated timetable
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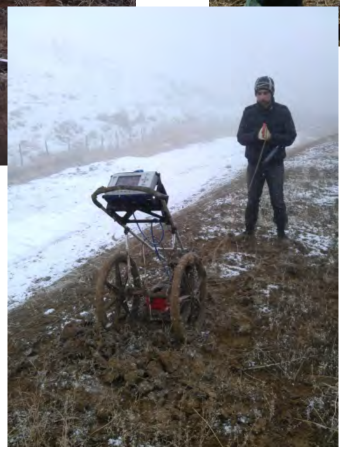
Initial CSM

Update project progress



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Update project progress

- Initial CSM is updated
- Available data are reviewed
- Data TEGSIS set up
- 3 D scan is nearly finished
- GPR is not giving the desired results
- Looking for alternatives to assess the extend
  - Geo electrical survey
  - Coring

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2004
Image © 2013 DigitalGlobe
Google ear

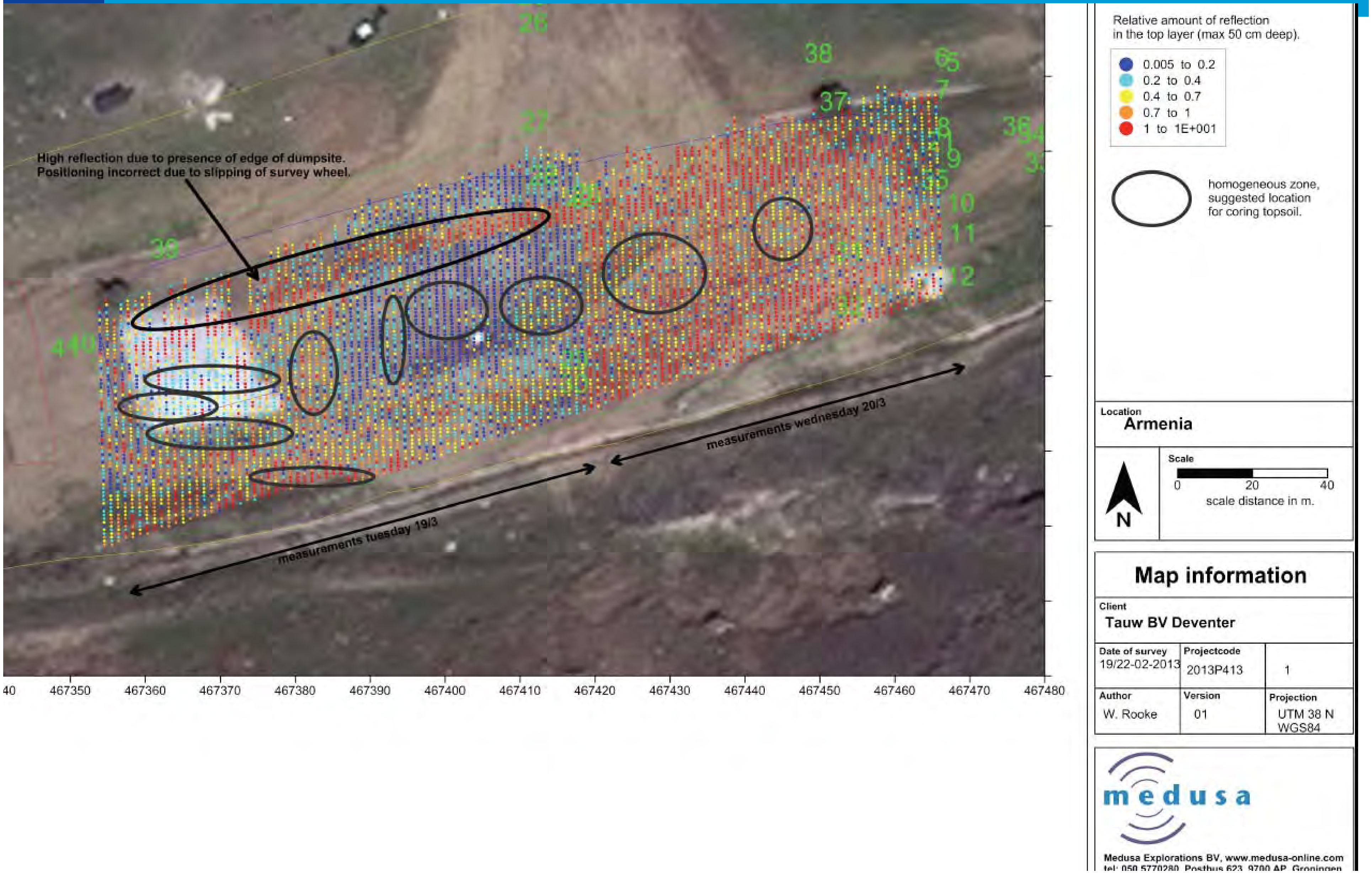

2009
2012
Image © 2013 DigitalGlobe

2009

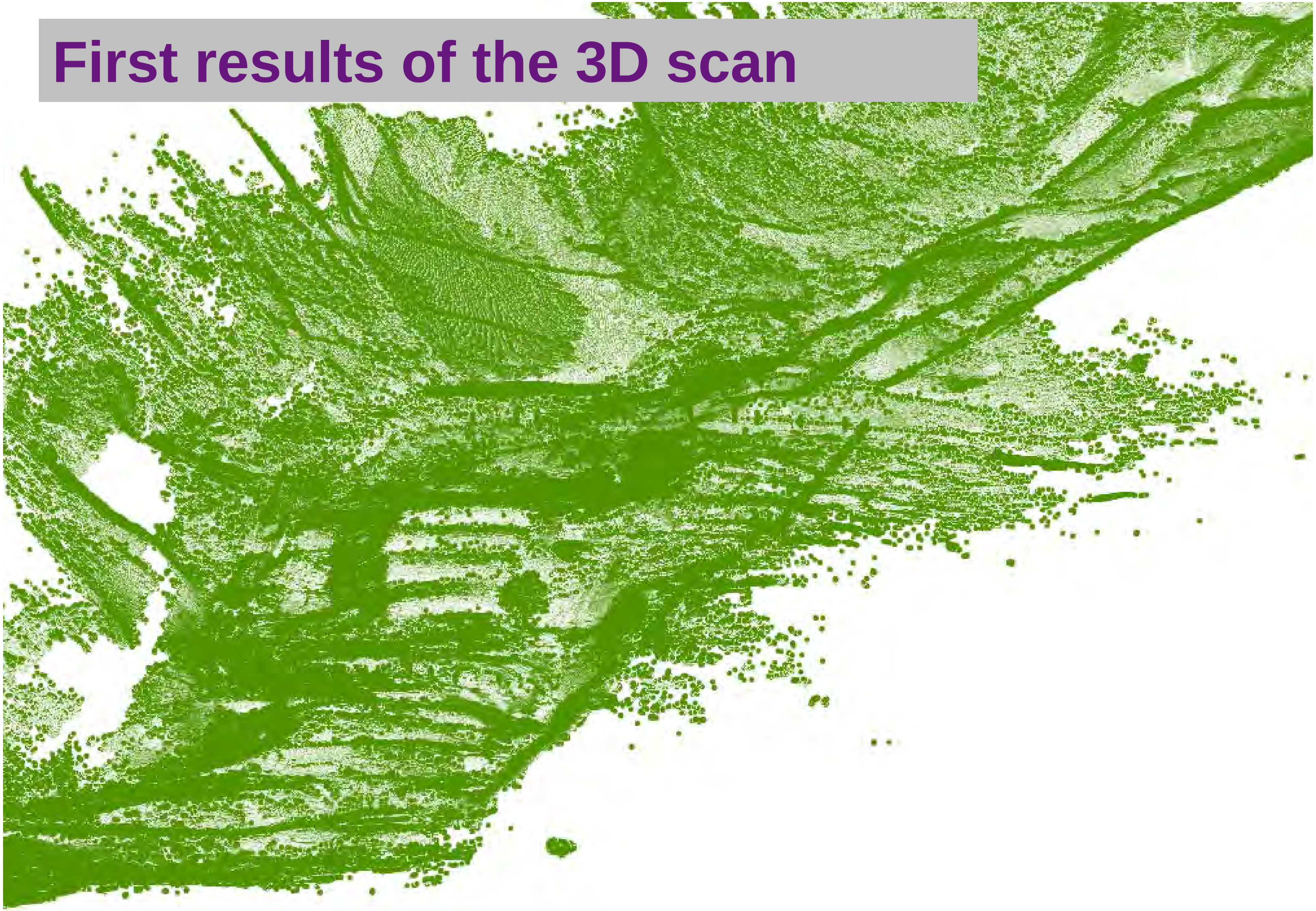

2010


2011
Image © 2013 GeoEye
Datum van beeldmateriaal: 3-8-2011 40°08'36.54" N 44°36'56.47" O verh 1343 m

Results GPR


High reflection due to presence of edge of dumpsite.
Positioning incorrect due to slipping of survey wheel.
measurements wednesday 20/3
measurements tuesday 19/3
40
467350
467360
467370
467380
467390
467400
467410
467420
467430
467440
467450
467460
467470
467480
Relative amount of reflection
in the top layer (max 50 cm deep).
0.005 to 0.2
0.2 to 0.4
0.4 to 0.7
0.7 to 1
1 to 1E+001
homogeneous zone, suggested location for coring topsoil.
Location
Armenia
N
Scale
0
20
40
scale distance in m.
Map information
Client
Tauw BV Deventer
Date of survey
19/22-02-2013
Projectcode
2013P413
1
Author
W. Rooke
Version
01
Projection
UTM 38 N
WGS84
medusa
Medusa Explorations BV, www.medusa-online.com

First results of the 3D scan



Процесс вовлечения заинтересованных сторон

Проект плана вовлечения заинтересованных сторон

Планирование вовлечения заинтересованных сторон

Отчет по оценке быстрого сканирования

Оценка быстрого сканирования

Быстрое сканирование

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Кратко о Milieukontakt

- Основан: 1988
- Основан экологическими НПО
  - Friends of the Earth International (FoEI)
  - Milieudefensie
  - Foundation Natuur en Milieu
  - World Information Service on Energy (WISE)
- Первая страна: Польша
- Milieukontakt активно работает примерно в 25 странах, в основном в
  - Центральной и Восточной Европе
  - На Балканах
  - На Кавказе
  - В Центральной Азии
- Годовой оборот на 2012 г.: EURO 800.000. EUR

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Три столпа

1. Создание потенциала
2. Вовлечение граждан
3. Решение конкретных экологических проблем

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Главные темы и вопросы

- *“Зеленая повестка дня”* - стратегии устойчивого развития на местах (подход “снизу вверх”)
- Устаревшие пестициды
- Интегрированное управление водными ресурсами
- Участие общественности в добывающей промышленности
- ИКТ и гражданское общество
- Сети и работа с ними

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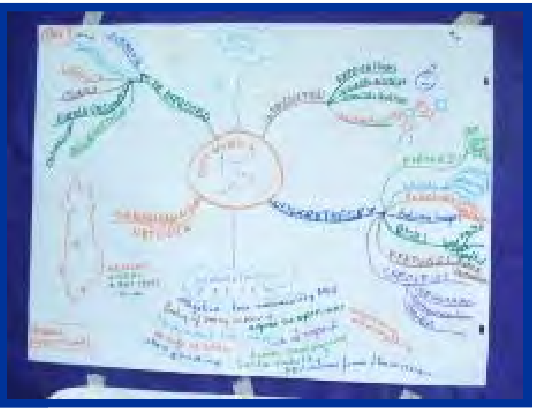
Milieukontakt International Команда Тренеров

- Milieukontakt International Команда Тренеров: MI-КТ
- Подход к обучению с прямым участием основан на
  - Цикл Обучении Взрослых американского теоретика образования Дэвида Колба (David Kolb)
  - Институте культуры (Institute of Cultural Affairs)
  - Опыте Milieukontakt International



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Международная сеть

- Широкая сеть в Восточной Европе, на Балканах, в бывшем СССР и в Центральной Азии

- В сеть Milieukontakt International Network входят 10 организаций в 10 странах (Албании, Грузии, Косово, Киргизстане, Македонии, Молдове, Монтенегро, Нидерландах, Сербии, Украине)

- Хорошее сотрудничество с техническими инженерными компаниями и международными организациями, например с Tauw и Witteveen+Bos

- В центре внимания: устаревшие пестициды, “Зеленая повестка дня”, Интегрированное управление водными ресурсами

Роль НПО в обществе

- Охрана природы: началось в начале 20-го века
- Массовые демонстрации против неправильной политики властей
- (Религия) Работа по обеспечению социального благосостояния, чтобы помочь обездоленным группам
- Рабочие профсоюзы для защиты прав трудящихся и социальной справедливости
- Спортивные и культурные организации для образования и развития
- НПО помогают там, где правительству не удается

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Роль НПО в обществе

• Природоохранные организации владеют и управляют 5-10% территории Голландии

• 23 % населения Голландии является частным спонсором прирооохранных / экологических НПО

• В результате протестов политикам приходится изменить решения

• Ядерная политика Нидерладнов изменилась в результате массовых протестов и в связи с Чернобылем

• 44% взрослых голландцев вовлечены в волонтерскую работу

• Большинство мужчин в спортивных организациях, большинство женщин в социальной сфере

• Членство в НПО уменьшается

• Индивидуализм и экономический кризис играют свою роль




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Роль НПО в обществе

- Большинство НПО знают, как следует говорить с людьми
- Вовлекая заинтересованные стороны, правительство может избежать проблемы, протесты, восстания
- У голландских политиков все больше проблем с налаживанием контактов с людьми
- Международные финансовые организации требуют хорошо отработанные схемы вовлечения занинтересованных сторон
- Пропаганда демократии играет роль
- Но более важно избегать финансирование вызывающих разногласия проектов

- *www.**ifc**.org/**performancestandards***




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Understanding IFC's Environmental and Social Due Diligence Process

International Finance Corporation
World Bank Group

IFC and client agree to work together

Review and Agree on Next Steps

The client receives copies of:
• IFC's Performance Standards,
• Relevant World Bank Group Environmental, Health and Safety (EHS) Guidelines, and
• Other supporting documents.

The IFC Environmental and Social (E&S) team:
• Asks the client to provide key information regarding assets and management of E&S risks and impacts.
• Assesses the project against the

Publicly disclose the project and consult with local community

IFC discloses its ESRS along with relevant sponsor E&S documentation on the IFC website. The client discloses project E&S assessment information locally. Projects will engage and consult with Affected Communities to ensure their awareness of the project, and provide for an ongoing constructive relationship.

For projects with potential significant adverse impacts on Affected Communities and projects involving Indigenous Peoples, IFC will make a determination of the level of

Finalize the investment agreement

Once the World Bank Group Board of Directors approves the project:
• The investment agreement is mutually agreed and finalized.
• The final agreement reflects the terms of the ESAP plus any other E&S commitments.
• Funds are disbursed once the client meets disbursement conditions.

Вовлечение заинтересованных сторон в Армении

- Нет необходимости копировать западную модель социальных движений
- Вовлечение заинтересованных сторон важно
- Необходимо работать эффективно и избегать разногласия
- Инструменты вовлечения заинтересованных сторон, разработанные Консорциумом Tauw по СОЗ
- Адаптация к потребностям и условиям Армении
- Необходимо ваше активное участие

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Вовлечение заинтересованных сторон в цикле проекта по СОЗ

- СОЗ образуют глобальную угрозу;
- Люди, живущие рядом с горячими точками, наиболее уязвимы;
- Повышение осведомленности снижает риски;
- Участие заинтересованных сторон помогает избежать ошибок, несчастных случаев, протестов;
- Повышение информированности и защита групп риска является обязательством по Стокгольмской конвенции

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Кто у нас заинтересованные стороны?

Участие заинтересованных сторон на национальном, региональном и местном уровне

- Покитики, власти в регионах и на местах
- Министерства окружающей среды, сельского хозяйства, здравоохранения, финансов, чрезвычайных ситуаций, ...
- Их отделы на региональном и местном уровне
- Частные владельцы земли
- Представители деловых кругов
- НПО и фермерские организации
- Группы риска

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Инструменты вовлечения заинтересованных сторон

- Анализ заинтересованных сторон по Quick scan/ быстрое сканирование
- План по вовлечению заинтересованных сторон
- Анализ заинтересованных сторон в конкретном месте
- План действий для участия местных заинтересованных сторон
- Мониторинг участия заинтересованных сторон

Предварительные результаты быстрого сканирования

Gohar: Предварительные результаты на основе заполненных форм

- Количесто полученных форм: министерства; НПО
- и т. д.

[Preliminary results on the basis of the form
Number of submitted forms: ministries, NGOs
etc.]

Редактирование окончательных результатов быстрого сканирования

- Wouter: работа в группах.
- Во время работы в группах будет произведена оценка результатов Quick Scan / быстрого сканирования

Перерыв

Встреча заинтересованных сторон
22 марта 2013

Оценка и технико-экономическое обоснование захоронения в Нубарашене, Армения

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Работа в группах: редактирование окончательных результатов Quick Scan

Планирование вовлечения заинтересованных сторон

- Wouter (председатель): интерактивная сессия по планированию вовлечения заинтересованных сторон

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Подведение итогов - обратная связь с участниками

- Edward: подведение итогов, обратная связь с участниками

Stakeholder Workshop
22 March 2013

Assessment and Feasibility Study Burial Dumpsite in Nubarashen, Armenia

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Draft results Quick Scan

- 26 organizations identified, Quick Scan sent out to all with the request to fill in
- 14 organizations responded

Including:

- 6 state bodies (ministries, state committees, etc.)
- 2 international organizations
- 2 national research centers
- 1 private company
- 3 NGOs

Draft results Quick Scan

Quick Scan analyses of project stakeholders helped to establish a better understanding of:

- The level of information among stakeholders
- The different roles that the different stakeholders play to solve the social, environmental and public health problems around the dumpsite and eliminate existing risks
- The position of the different groups that face direct risks

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Draft results Quick Scan

Groups at Risk where identified:

- Workers maintaining the site;
- Inspecting officer (from governmental and from NGO background);
- police officers;
- population living downstream the site;
- herdsmen;
- children playing in the neighbourhood;
- women collecting herbs in the neighbourhood;
- women using surface water for irrigation;
- tourists

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Draft results Quick Scan

Good prerequisites to keep the issue of Nubarashen high on the political agenda in Armenia:

- Strong and committed key ministries,
- Adequate legislation
- High awareness of the issue among many of the key stakeholders
- etc.

Draft results Quick Scan

Some areas of concern:

- Is the Armenian legislation in line with the international best practice of POPs legislation?
- Is there sufficient funding?
- Is there sufficient expertise?
- How to further improve coordination?
- How to further increase awareness at all levels?
- How to help the affected population to be better protected?

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Nubarashen Stakeholder Analysis
Organizations

Name of the organizations that have a relation to POPs pesticides	Does this organization have the formal objective to solve the environmental and public health problems around POPs pesticides?		Is this organization active to reach this goal?			Does this organization have the technical capabilities to reach this goal?				Does this organization have the managerial capabilities to reach this goal?				Does this organization have the financial capabilities to reach this goal?				Does this organization coordinate its efforts with other relevant stakeholders				Is this organization well informed about POPs pesticides?/		
Name	Yes	no	Very Active	Active	Not really	Strong	Moderate	Limited	Weak	Strong	Moderate	Limited	Weak	Strong	Moderate	Limited	Weak	Strong	Partial	Limited	Weak	Very well informed	Well informed	Not really informed
Ministry of Nature Protection	X		X				X			X					X			X				X		
Ministry of Agriculture		X			X				X				X				X			X			X	
Ministry of Health	X				X		X			X				X										
Ministry of Emergency Situations	X		X			X				X						X			X			X		
Ministry of Economy		X			X				X				X											
Ministry of Foreign Affairs		X			X				X				X											
Ministry of Territorial Administration																								
Ministry of Defence	X		X						X			X					X	X					X	
State Police Department		X	X					X			X						X	X						X
National Security Service																								
State Revenues Committee of the Government of Armenia																								
Yerevan Municipality	X			X							X					X			X				X	
Local Authorities																								

Nubarashen Stakeholder Analysis
Organizations

Name of the organizations that have a relation to POPs pesticides	Does this organization have the formal objective to solve the environmental and public health problems around POPs pesticides?		Is this organization active to reach this goal?			Does this organization have the technical capabilities to reach this goal?				Does this organization have the managerial capabilities to reach this goal?				Does this organization have the financial capabilities to reach this goal?				Does this organization coordinate its efforts with other relevant stakeholders				Is this organization well informed about POPs pesticides?/		
Name	Yes	no	Very Active	Active	Not really	Strong	Moderate	Limited	Weak	Strong	Moderate	Limited	Weak	Strong	Moderate	Limited	Weak	Strong	Partial	Limited	Weak	Very well informed	Well informed	Not really informed
UNDP	x		x			x				x				x				x				x		
UNIDO																								
OSCE	X			X				X			X				X			X					X	
AWHHE NGO	x		x				x				x						x	x				x		
Scientific Research Institute on General Hygiene and Occupational Diseases																								
"Waste research center" SNCO, Ministry of Nature Protection	V աջակցություն/ support			V			V						V				V ՈՉ/ no		V			V		
Informative NGO EcoLur NGO	x			x					x		x						x		x				x	
Center for Ecological-Noosphere Studies of RA National Academy of Sciences	?			?		?				?					?			?				?		
Engineer-Geologist Ltd.		x		x			x			x						x		x				x		
Khazer NGO	x			x				?				?					?		x				x	
Ecoglobe NGO	x		x			x				x					x			x				x		
Association for Human Sustainable Development NGO																								
Ecological Survival NGO																								

Nubarashen Stakeholder Analysis
Organizations

Name of the organizations that have a relation to POPs pesticides	Does this organization have the power of effective decision making?												Does the organization have an interest to solve the problems around POPs pesticides?			ADDITIONAL COMMENTS IF NEEDED	Questions
	In policy development?			In legislation and decision making?			In law enforcement?			In funding implementation?							
Name	Very Powerful	Powerful	Not really Powerful	Very Powerful	Powerful	Not really Powerful	Very Powerful	Powerful	Not really Powerful	Very Powerful	Powerful	Not really Powerful	YES	Not really	NO		
Ministry of Nature Protection	X			X			X			X			X			Co-Chair of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
Ministry of Agriculture			X		X			X			X		X			Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
Ministry of Health																Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
Ministry of Emergency Situations							X			X			X			Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
Ministry of Economy																Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
Ministry of Foreign Affairs																Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	անդամ
Ministry of Territorial Administration																Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	անդամ
Ministry of Defence			X		X		X			X			X			Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	անդամ
State Police Department			X		X		X					X	X			Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
National Security Service																Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
State Revenues Committee of the Government of Armenia																Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
Yerevan Municipality			X			X			X			X	X			Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
Local Authorities																	

Nubarashen Stakeholder Analysis
Organizations

Name of the organizations that have a relation to POPs pesticides	Does this organization have the power of effective decision making? In policy development?			In legislation and decision making?			In law enforcement?			In funding implementation?			Does the organization have an interest to solve the problems around POPs pesticides?			ADDITIONAL COMMENTS IF NEEDED	Questions
Name	Very Powerful	Powerful	Not really Powerful	Very Powerful	Powerful	Not really Powerful	Very Powerful	Powerful	Not really Powerful	Very Powerful	Powerful	Not really Powerful	YES	Not really	NO		
UNDP	X			X			X			X			X			Co-Chair of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
UNIDO																	
OSCE		X			X				X		X					Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
AWHHE NGO		X			X				X		X		X			Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites, representative of the NGO sector	
Scientific Research Institute on General Hygiene and Occupational Diseases																Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	անդամ
"Waste research center" SNCO, Ministry of Nature Protection		V աջակցություն/ support	no/ ոչ			V			V	?	?	?	V				
Informative NGO EcoLur NGO		X			X			X				X	X				
Center for Ecological-Noosphere Studies of RA National Academy of Sciences			?		?				?			?	?			Member of the Steering Committee on project on Elimination of Obsolete Pesticide Stocks and Rehabilitation of POPs Contaminated Sites	
Engineer-Geologist Ltd.			X			X			X			X	X				
Khazer NGO		?				?		?			?		X				
Ecoglobe NGO		X			X			X			X		X				
Association for Human Sustainable Development NGO																	
Ecological Survival NGO																	

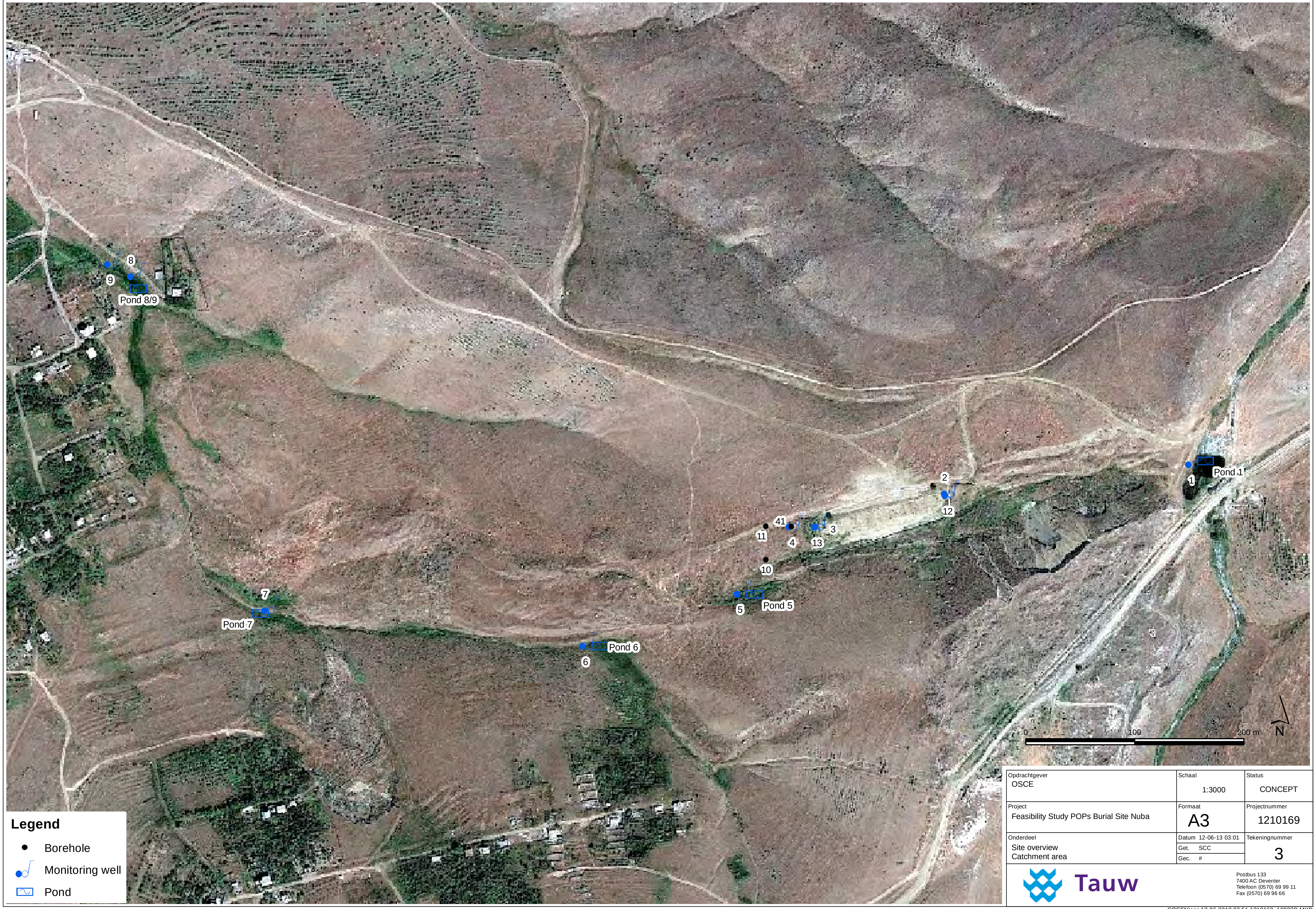
Armenia Nubarashen Stakeholder Analysis
Groups at Risk

Name groups with the highest risk to be affected by negative impacts	Are these groups informed about POPs pesticides?			Has this group the power to protect itself from the negative impacts of POPs pesticides?			Does the group have an interest to solve the problems around POPs pesticides?			ADDITIONAL COMMENTS, IF NEEDED	Questions Հարցեր
name	Very well informed	Well informed	Not really informed	Very Powerful	Powerful	Not really Powerful	Yes	Not really	No		
Workers maintaining the site			X			X		X			
Inspection staff (NGO representative and government officers)	X				X		X				
Police guards			X			X	X				
Population living downstream the dumpsite			X			X	X				
Project team	X			X			X				
Herdsmen			X			X	X				
children playing in the neighbourhood			X			X	X				
women collecting herbs in the neighbourhood			X			X	X				
women using surface water for irrigation			X			X	X				
tourists			X			X		X			

Appendix

6

Bore logs



Opdrachtgever	Schaal	Status
OSCE	1:3000	CONCEPT
Project	Formaat	Projectnummer
Feasibility Study POPs Burial Site Nuba	A3	1210169
Onderdeel	Datum 12-06-13 03:01	Tekeningnummer
Site overview Catchment area	Get. SCC Gec. #	3

Tauw

Postbus 133
7400 AC Deventer
Telefoon (0570) 69 99 11
Fax (0570) 69 96 66

Legend

- Monitoring well
- Pond
- Borehole
- Topsoil sample from areas with plant cover
- Topsoil sample from areas with bare soil

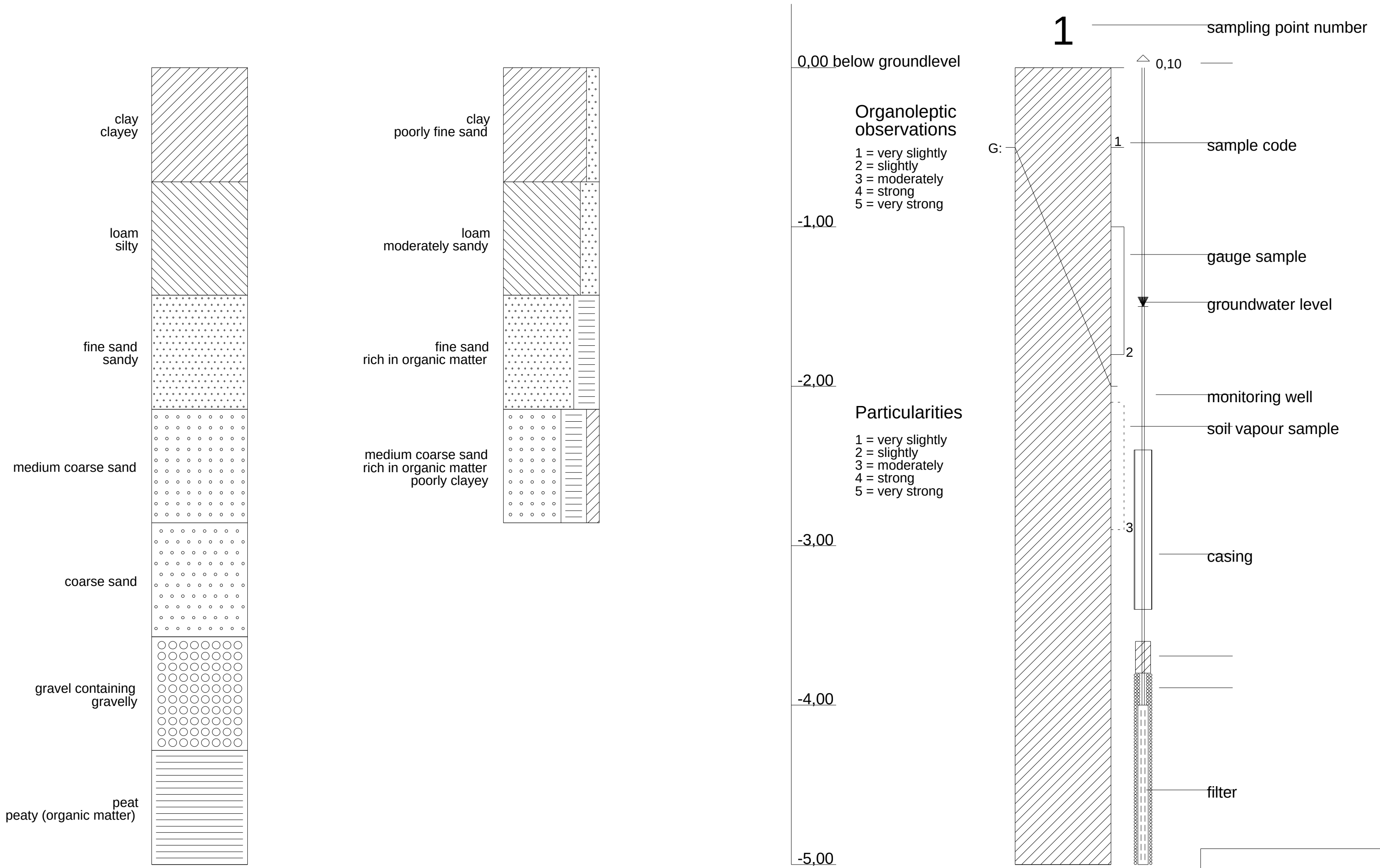
Opdrachtgever	Schaal	Status
OSCE	1:750	CONCEPT
Project: Feasibility Study POPs Burial Site Nuba	Formaat: A3	Projectnummer: 1210169
Onderdeel: Dumpsite detail	Datum 12-06-13 03:29 Get. SCC Gec. #	Tekeningnummer: 4

Tauw

Postbus 133
7400 AC Deventer
Telefoon (0570) 69 99 11
Fax (0570) 69 96 66

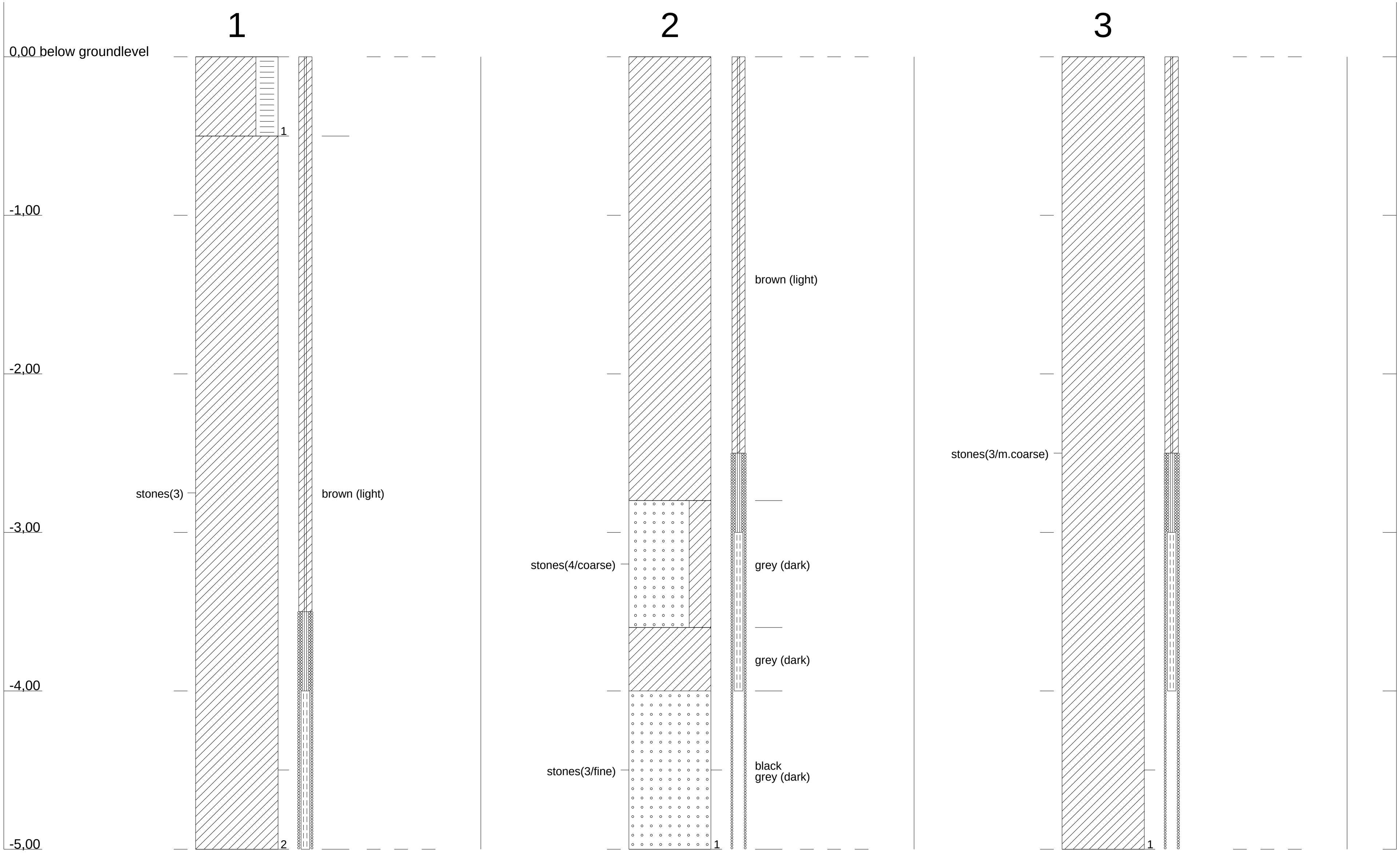
GREEN\scc 12-06-2013 04:00 1210169_10004D.MXD

Legend boreholes



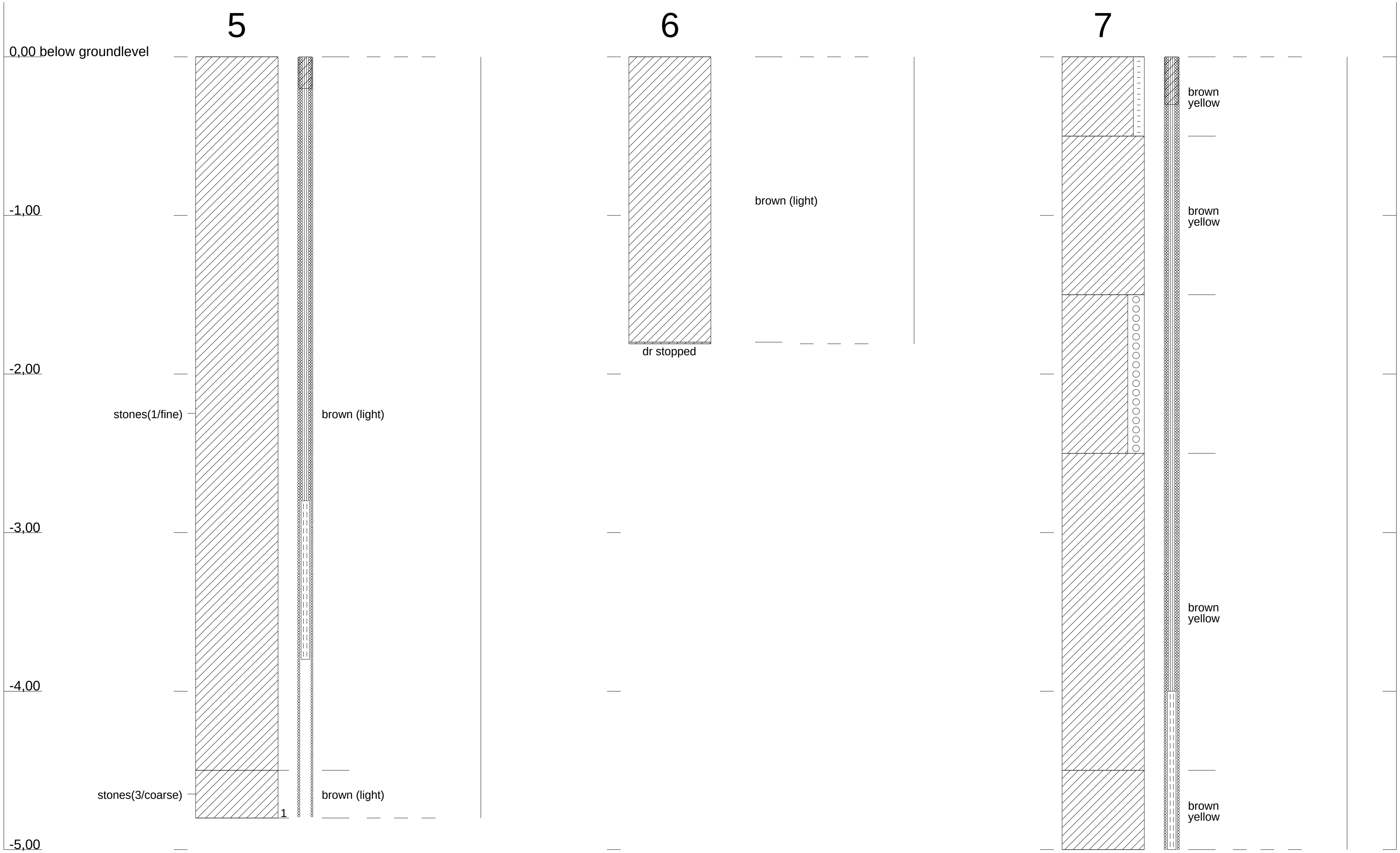
Tauw

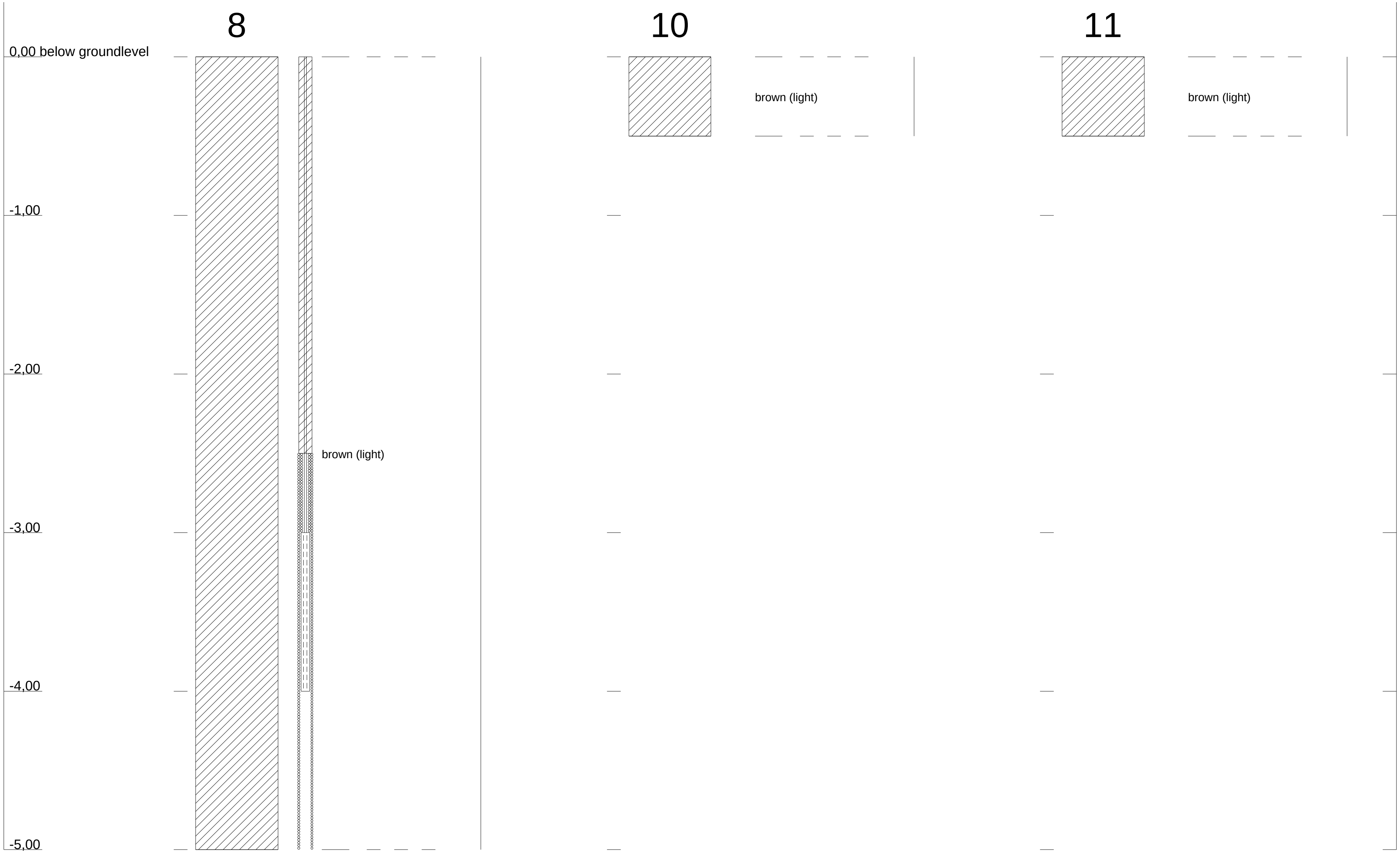
shading in accordance with Dutch NEN 5104



Profiles according to NEN 5104

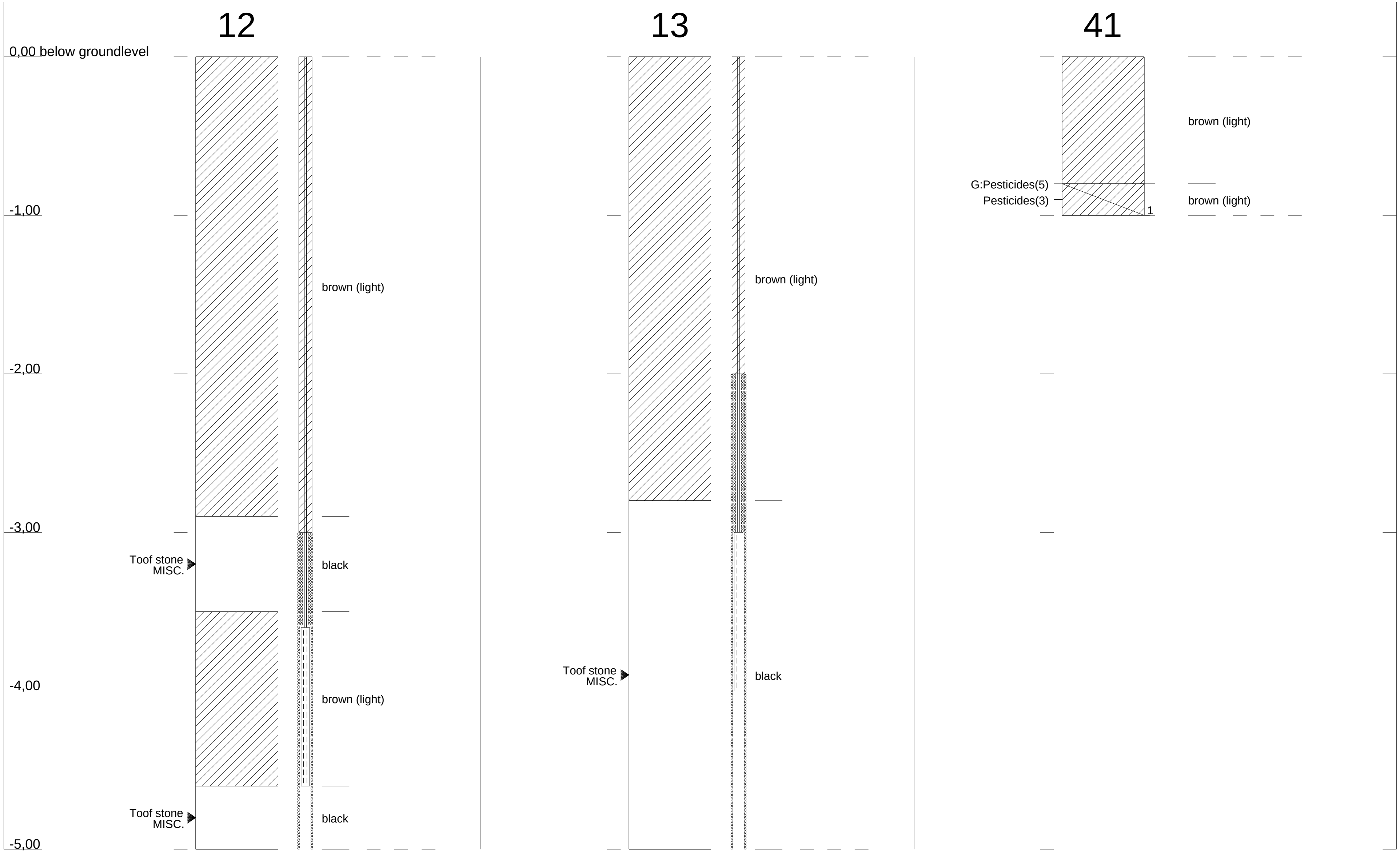
1210169 : Feasibility Study POP's Burial Site Nuba


5
6
7
0,00 below groundlevel
-1,00
-2,00
-3,00
-4,00
-5,00
stones(1/fine)
brown (light)
stones(3/coarse)
brown (light)
1
brown (light)
dr stopped
brown
yellow
brown
yellow
brown
yellow
brown
yellow



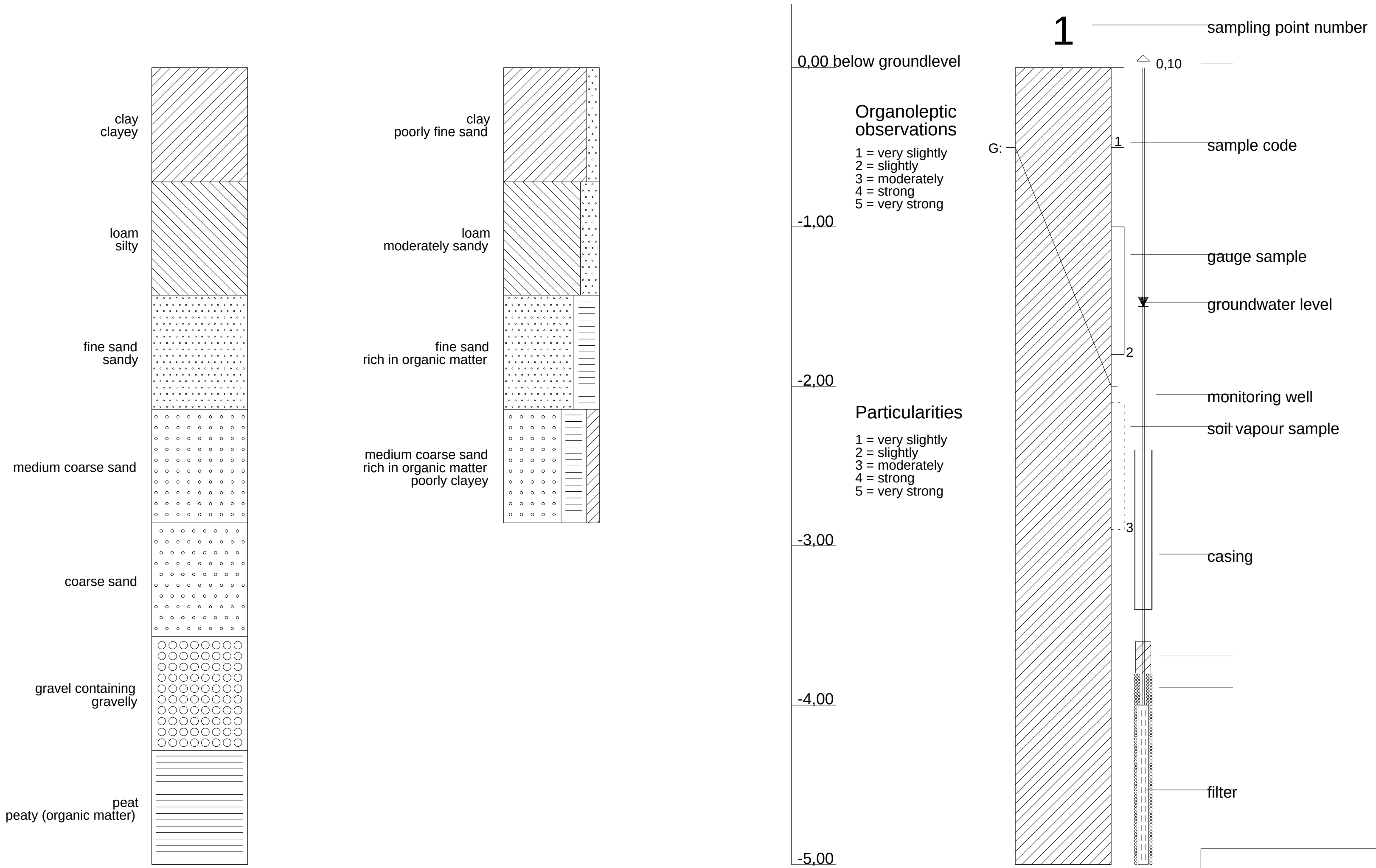
Profiles according to NEN 5104

Tauw



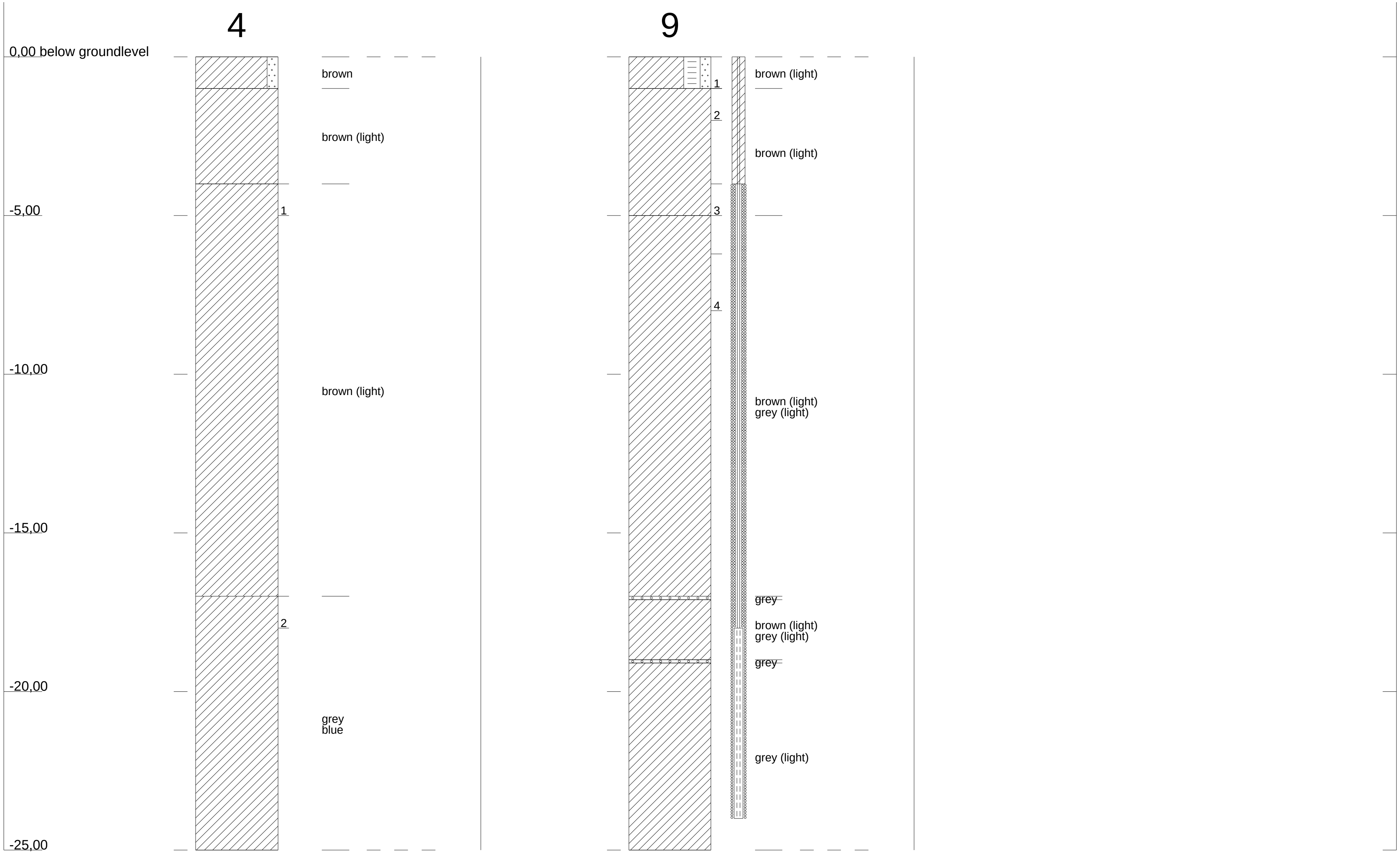
12
13
41
0,00 below groundlevel
-1,00
-2,00
-3,00
-4,00
-5,00
brown (light)
Toof stone
MISC.
black
brown (light)
Toof stone
MISC.
black
brown (light)
Toof stone
MISC.
black
brown (light)
G:Pesticides(5)
Pesticides(3)
1
brown (light)

Legend boreholes



Tauw

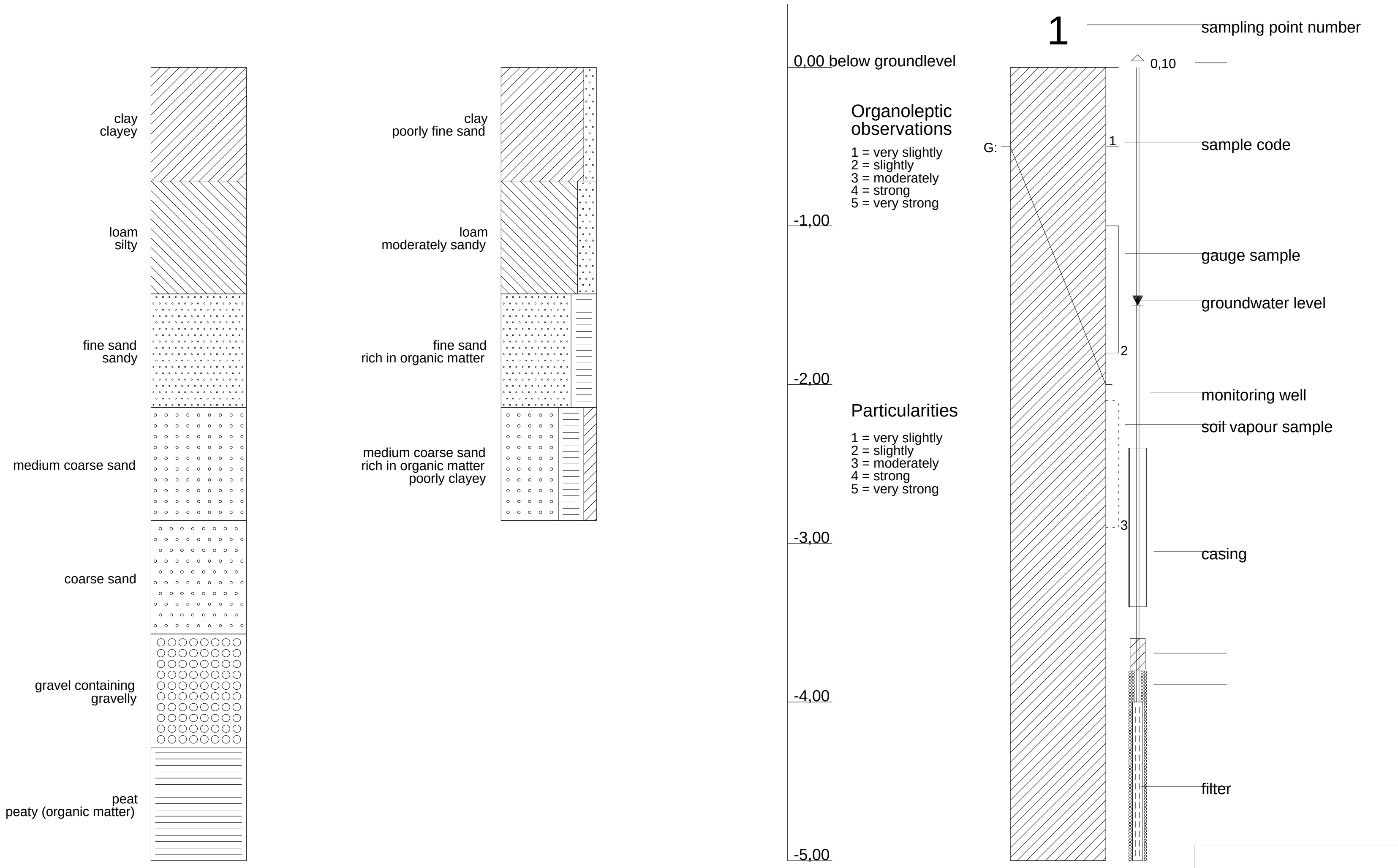
shading in accordance with Dutch NEN 5104



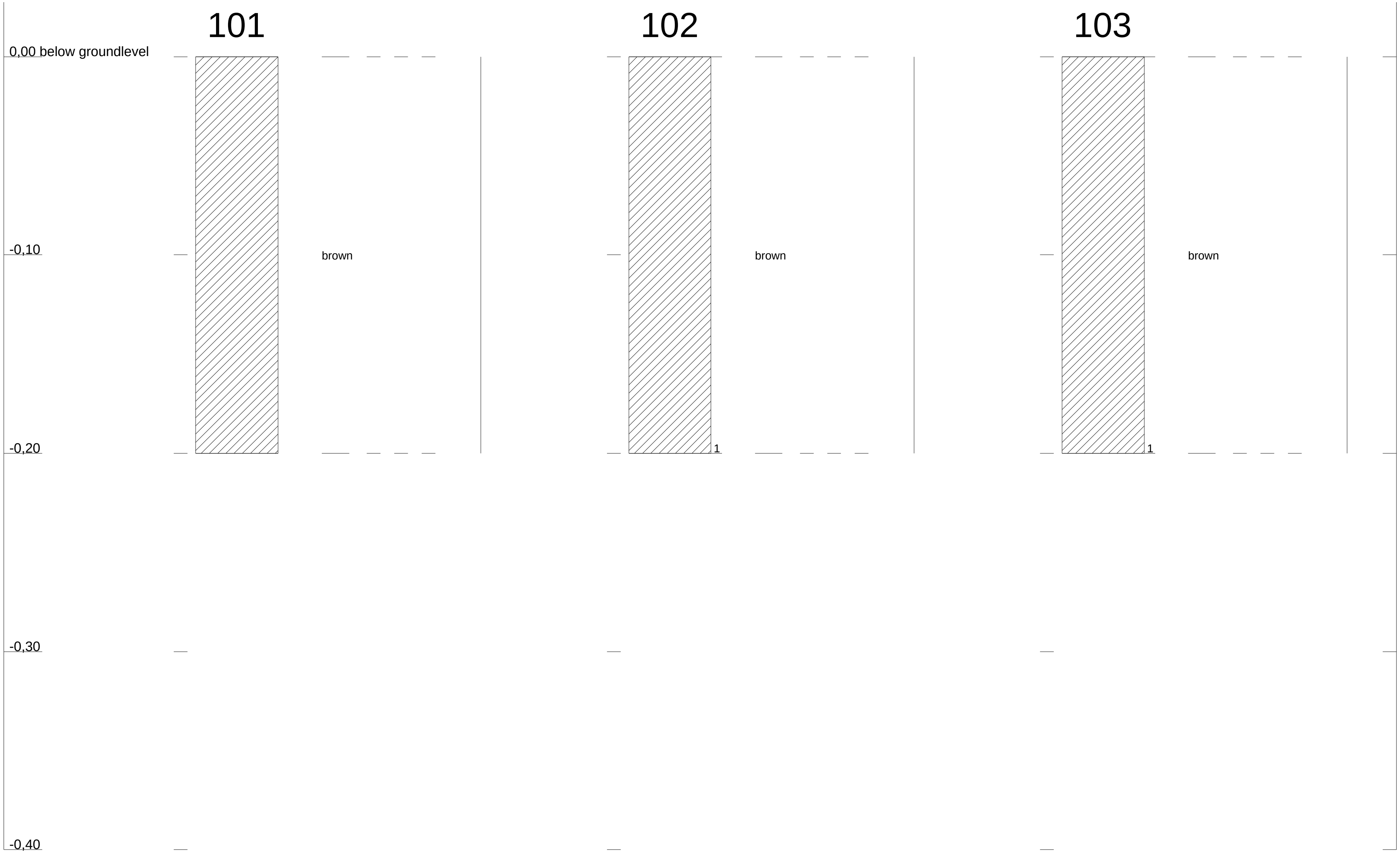
Profiles according to NEN 5104

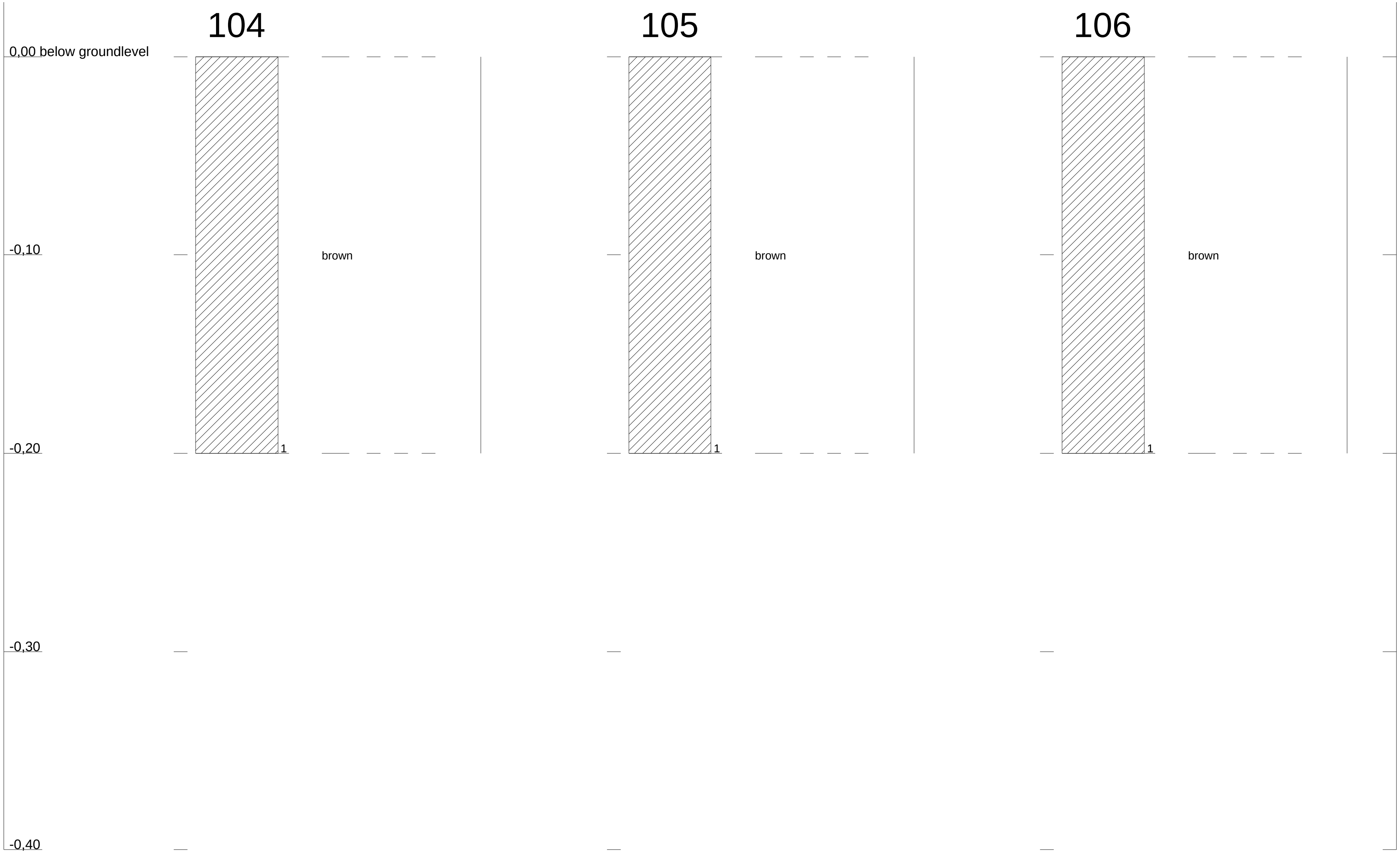
1210169 : Feasibility Study POP's Burial Site Nuba

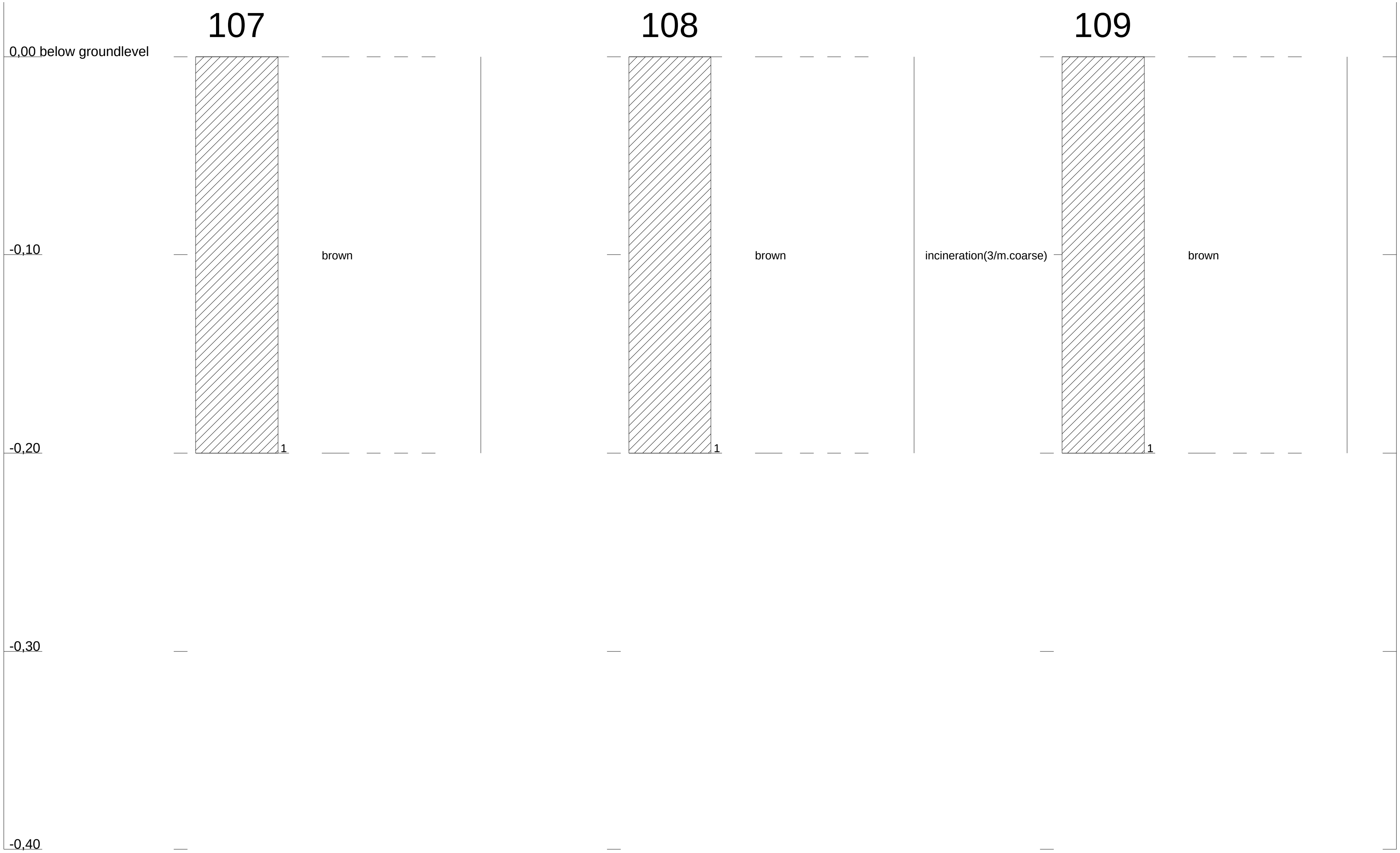
Legend boreholes

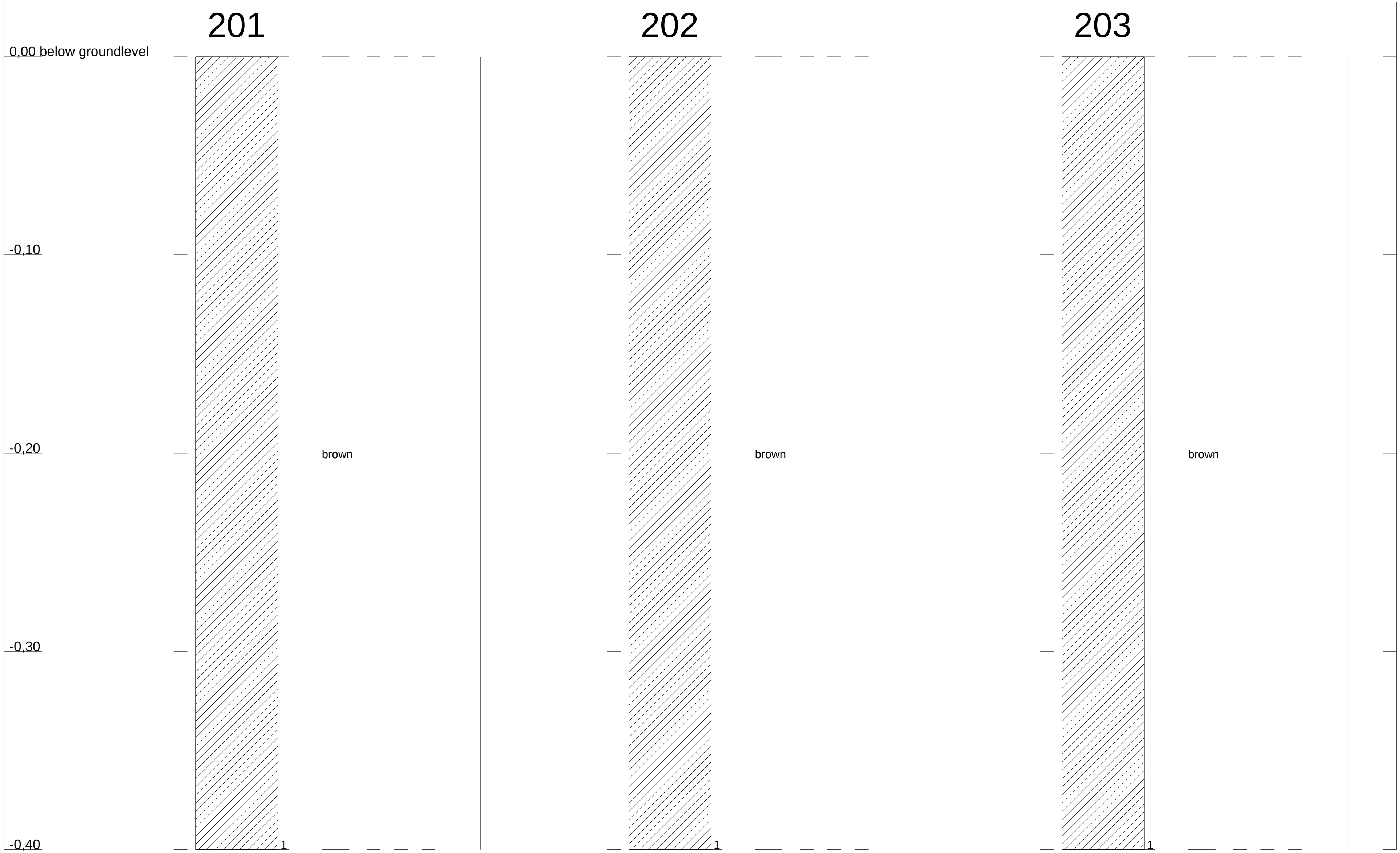


shading in accordance with Dutch NEN 5104


101
102
103
0,00 below groundlevel
-0,10
-0,20
-0,30
-0,40
brown
brown
brown
1
1


104
105
106
0,00 below groundlevel
-0,10
brown
brown
brown
-0,20
1
1
1
-0,30
-0,40


107
108
109
0,00 below groundlevel
-0,10
-0,20
-0,30
-0,40
brown
1
brown
1
incineration(3/m.coarse)
brown
1


201
202
203
0,00 below groundlevel
-0,10
-0,20
-0,30
-0,40
brown
brown
brown
1
1
1

Tauw

Appendix

7

Analytical certificates and STI limit values

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TAUW DEVENTER
Matthijs Bouwknegt
POSTBUS 133
7400 AC DEVENTER

Date	28.05.2013
Customer no.	35003840
Order nr.	372753
Page 1 of 11	

REPORT

Order **372753 Soil / Eluate**

Client	35003840 TAUW DEVENTER
Reference	1210169 Nubarashen, Armenia
Sample acceptance	15.05.13
Sample taker	Client

Dear sir, madam,

Please find enclosed the results of the laboratory tests you requested. Unless stated otherwise at applied methods, the analyses are accredited according to EN-ISO/IEC 17025 and were carried out using the methods listed in the most recent version of the annex of the accreditation certificate number L005 issued by the Dutch Accreditation Council (RvA).

Should you require details regarding the uncertainty of measurement of a method, we will be happy to supply these on request.

Allow us to draw your attention to the fact that the report enclosed may only be reproduced in its entirety.

Should you require any further information, please do not hesitate to contact the after-sales department.

We trust that the enclosed information will meet with your requirements.

Yours sincerely,

AL-West B.V. Dhr. Peter Wijers, Tel. +31/570788111
Customer Service

TESTING
RvA L 005

AL-West B.V.

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***Order* 372753 Soil / Eluate**

Sample no.	*Date of sampling*	*Sample code*
213072	09.05.2013	101 (0-0.2)
213073	09.05.2013	102 (0-0.2)
213074	09.05.2013	103 (0-0.2)
213075	09.05.2013	104 (0-0.2)
213076	09.05.2013	105 (0-0.2)

	Unit	**213072** 101 (0-0.2)	**213073** 102 (0-0.2)	**213074** 103 (0-0.2)	**213075** 104 (0-0.2)	**213076** 105 (0-0.2)
Sample Pre-treatment						
Homogenization by Samplemate		++	++	++	++	++
dry matter	%	**76,1**	**78,3**	**74,8**	**75,6**	**75,7**
Physical - chemical analysis						
CaCO3	% DM	--	--	--	--	--
Loss on ignition (organic matter)	% DM	--	--	--	--	--
Fractions (sedigraph)						
Fraction < 2 µm	% DM	--	--	--	--	--
fraction < 16 µm	% DM	--	--	--	--	--
fraction < 63 µm	% DM	--	--	--	--	--
fraction (Sedigraaf) < 125 µm	% DM	--	--	--	--	--
fraction < 180 µm	% DM	--	--	--	--	--
fraction (Sedigraaf) < 250 µm	% DM	--	--	--	--	--
fraction (sedigraaf) <355 µm	% DM	--	--	--	--	--
fraction (Sedigraaf) < 500 µm	% DM	--	--	--	--	--
fraction (Sedigraaf) < 1 mm	% DM	--	--	--	--	--
fraction (Sedigraaf) < 2 mm	% DM	--	--	--	--	--
Pretreatment of metal analyses						
Digestion with aqua regia		++	++	++	++	++
Metals						
Arsenic (As)	mg/kg DM	**7,1**	**5,2**	**8,0**	**7,5**	**12**
Cadmium (Cd)	mg/kg DM	**0,11**	**0,12**	**0,42**	**0,13**	**0,23**
Chromium (Cr)	mg/kg DM	**27**	**29**	**28**	**27**	**27**
Copper (Cu)	mg/kg DM	**55**	**49**	**110**	**53**	**160**
Lead (Pb)	mg/kg DM	**20**	**16**	**20**	**20**	**19**
Mercury (Hg)	mg/kg DM	**<0,05**	**0,16**	**1,8**	**<0,05**	**22**
Nickel (Ni)	mg/kg DM	**27**	**29**	**28**	**31**	**28**
Zinc (Zn)	mg/kg DM	**84**	**64**	**410**	**69**	**310**
Pesticiden (OCB"s)						
DDT-Sum	mg/kg DM	**8,6**	**8,0**	**960** x)	**2,3** x)	**1500**
Sum Drins (STI-Table)	mg/kg DM	**n.d.**	**n.d.**	**n.d.**	**n.d.**	**n.d.**
Sum HCH (STI-Table)	mg/kg DM	**n.d.**	**n.d.**	**20** x)	**n.d.**	**39** x)
Sum Heptachlor and -epoxide	mg/kg DM	**n.d.**	**n.d.**	**n.d.**	**n.d.**	**n.d.**
Sum alpha-Endosulfane and -sulfate	mg/kg DM	**n.d.**	**n.d.**	**n.d.**	**n.d.**	**n.d.**
o,p-DDE	mg/kg DM	**0,24**	**0,32**	**<5,0** m)	**<0,050** m)	**8,3**
p,p-DDE	mg/kg DM	**2,2**	**1,2**	**<5,0** m)	**0,29**	**10**
o,p-DDD	mg/kg DM	**0,11**	**0,097**	**11**	**<0,050** m)	**16**

TESTING RvA L 005

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Sample no.	*Date of sampling*	*Sample code*
213077	09.05.2013	106 (0-0.2)
213078	09.05.2013	107 (0-0.2)
213079	09.05.2013	108 (0-0.2)
213080	09.05.2013	109 (0-0.2)
213081	09.05.2013	201 (0-0.5)

	Unit	213077 106 (0-0.2)	213078 107 (0-0.2)	213079 108 (0-0.2)	213080 109 (0-0.2)	213081 201 (0-0.5)
Sample Pre-treatment						
Homogenization by Samplemate		++	++	++	++	++
dry matter	%	81,9	78,0	80,8	72,9	74,2
Physical - chemical analysis						
CaCO3	% DM	--	--	--	6,8	--
Loss on ignition (organic matter)	% DM	--	--	--	7,3	--
Fractions (sedigraph)						
Fraction < 2 µm	% DM	--	--	--	30	--
fraction < 16 µm	% DM	--	--	--	58	--
fraction < 63 µm	% DM	--	--	--	70	--
fraction (Sedigraaf) < 125 µm	% DM	--	--	--	76	--
fraction < 180 µm	% DM	--	--	--	78	--
fraction (Sedigraaf) < 250 µm	% DM	--	--	--	79	--
fraction (sedigraaf) <355 µm	% DM	--	--	--	81	--
fraction (Sedigraaf) < 500 µm	% DM	--	--	--	82	--
fraction (Sedigraaf) < 1 mm	% DM	--	--	--	84	--
fraction (Sedigraaf) < 2 mm	% DM	--	--	--	85	--
Pretreatment of metal analyses						
Digestion with aqua regia		++	++	++	++	++
Metals						
Arsenic (As)	mg/kg DM	6,6	11	7,3	6,6	5,8
Cadmium (Cd)	mg/kg DM	<0,10	<0,10	<0,10	0,12	<0,10
Chromium (Cr)	mg/kg DM	35	28	37	31	21
Copper (Cu)	mg/kg DM	50	120	62	56	51
Lead (Pb)	mg/kg DM	14	15	16	17	18
Mercury (Hg)	mg/kg DM	0,08	3,5	0,31	0,15	<0,05
Nickel (Ni)	mg/kg DM	38	29	40	32	24
Zinc (Zn)	mg/kg DM	58	140	69	68	66
Pesticiden (OCB"s)						
DDT-Sum	mg/kg DM	8,3	120 x)	31 x)	30 x)	0,74 x)
Sum Drins (STI-Table)	mg/kg DM	n.d.	n.d.	n.d.	n.d.	n.d.
Sum HCH (STI-Table)	mg/kg DM	0,087 x)	300	n.d.	n.d.	n.d.
Sum Heptachlor and -epoxide	mg/kg DM	n.d.	n.d.	n.d.	n.d.	n.d.
Sum alpha-Endosulfane and -sulfate	mg/kg DM	n.d.	n.d.	n.d.	n.d.	n.d.
o,p-DDE	mg/kg DM	0,16	<5,0 m)	<10 m)	<10 m)	<0,050 m)
p,p-DDE	mg/kg DM	0,55	<5,0 m)	<10 m)	<10 m)	<0,050 m)
o,p-DDD	mg/kg DM	0,11	<5,0 m)	<10 m)	<10 m)	<0,050 m)

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Sample no.	*Date of sampling*	*Sample code*
213082	09.05.2013	202 (0-0.4)
213083	09.05.2013	203 (0-0.4)
213084	09.05.2013	204 (0-0.4)
213085	09.05.2013	2 (0-0.5)
213086	09.05.2013	Pond 5 (0-0.2)

	Unit	213082 202 (0-0.4)	213083 203 (0-0.4)	213084 204 (0-0.4)	213085 2 (0-0.5)	213086 Pond 5 (0-0.2)
Sample Pre-treatment						
Homogenization by Samplemate		++	++	++	++	++
dry matter	%	74,6	75,0	76,9	77,3	74,2
Physical - chemical analysis						
CaCO3	% DM	--	--	--	9,9	10
Loss on ignition (organic matter)	% DM	--	--	--	6,7	7,5
Fractions (sedigraph)						
Fraction < 2 µm	% DM	--	--	--	37	33
fraction < 16 µm	% DM	--	--	--	63	59
fraction < 63 µm	% DM	--	--	--	69	71
fraction (Sedigraaf) < 125 µm	% DM	--	--	--	74	76
fraction < 180 µm	% DM	--	--	--	75	77
fraction (Sedigraaf) < 250 µm	% DM	--	--	--	76	77
fraction (sedigraaf) <355 µm	% DM	--	--	--	76	78
fraction (Sedigraaf) < 500 µm	% DM	--	--	--	77	79
fraction (Sedigraaf) < 1 mm	% DM	--	--	--	81	80
fraction (Sedigraaf) < 2 mm	% DM	--	--	--	84	82
Pretreatment of metal analyses						
Digestion with aqua regia		++	++	++	++	++
Metals						
Arsenic (As)	mg/kg DM	5,4	5,8	6,8	6,7	6,2
Cadmium (Cd)	mg/kg DM	0,10	<0,10	0,12	0,12	0,10
Chromium (Cr)	mg/kg DM	25	25	20	20	43
Copper (Cu)	mg/kg DM	57	50	47	55	62
Lead (Pb)	mg/kg DM	20	19	17	18	17
Mercury (Hg)	mg/kg DM	<0,05	<0,05	0,05	0,09	<0,05
Nickel (Ni)	mg/kg DM	29	27	24	24	47
Zinc (Zn)	mg/kg DM	74	70	61	67	65
Pesticiden (OCB"s)						
DDT-Sum	mg/kg DM	1,6 [x)]	0,57 [x)]	5,5 [x)]	8,5	0,42
Sum Drins (STI-Table)	mg/kg DM	n.d.	n.d.	n.d.	n.d.	n.d.
Sum HCH (STI-Table)	mg/kg DM	n.d.	n.d.	n.d.	n.d.	0,002 [x)]
Sum Heptachlor and -epoxide	mg/kg DM	n.d.	n.d.	n.d.	n.d.	n.d.
Sum alpha-Endosulfane and - sulfate	mg/kg DM	n.d.	n.d.	n.d.	n.d.	0,002 [x)]
o,p-DDE	mg/kg DM	<0,10 [m)]	<0,050 [m)]	<0,050 [m)]	0,12	0,0047
p,p-DDE	mg/kg DM	<0,10 [m)]	<0,050 [m)]	0,31	1,2	0,051
o,p-DDD	mg/kg DM	<0,10 [m)]	<0,050 [m)]	0,070	0,096	0,015

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Order 372753 Soil / Eluate

Sample no.	Date of sampling	Sample code
213087	09.05.2013	5 (1-1.5)
213088	09.05.2013	5 (4-4.5)
213089	09.05.2013	Pond 6 (0-0.5)
213090	09.05.2013	Pond 7 (0-0.2)
213091	09.05.2013	Pond 8/9 (0-0.2)

	Unit	213087 5 (1-1.5)	213088 5 (4-4.5)	213089 Pond 6 (0-0.5)	213090 Pond 7 (0-0.2)	213091 Pond 8/9 (0-0.2)
Sample Pre-treatment						
Homogenization by Samplemate		++	++	++	++	++
dry matter	%	81,4	80,8	68,5	68,8	74,6
Physical - chemical analysis						
CaCO3	% DM	10	--	--	--	9,2
Loss on ignition (organic matter)	% DM	6,3	--	--	--	5,9
Fractions (sedigraph)						
Fraction < 2 µm	% DM	25	--	--	--	19
fraction < 16 µm	% DM	52	--	--	--	37
fraction < 63 µm	% DM	61	--	--	--	64
fraction (Sedigraaf) < 125 µm	% DM	71	--	--	--	78
fraction < 180 µm	% DM	73	--	--	--	79
fraction (Sedigraaf) < 250 µm	% DM	75	--	--	--	80
fraction (sedigraaf) <355 µm	% DM	76	--	--	--	81
fraction (Sedigraaf) < 500 µm	% DM	78	--	--	--	82
fraction (Sedigraaf) < 1 mm	% DM	80	--	--	--	83
fraction (Sedigraaf) < 2 mm	% DM	83	--	--	--	84
Pretreatment of metal analyses						
Digestion with aqua regia		++	++	++	++	++
Metals						
Arsenic (As)	mg/kg DM	7,3	7,6	7,7	6,8	8,6
Cadmium (Cd)	mg/kg DM	<0,10	<0,10	<0,10	<0,10	<0,10
Chromium (Cr)	mg/kg DM	39	45	31	51	37
Copper (Cu)	mg/kg DM	56	61	65	52	56
Lead (Pb)	mg/kg DM	15	18	21	18	18
Mercury (Hg)	mg/kg DM	<0,05	<0,05	<0,05	<0,05	<0,05
Nickel (Ni)	mg/kg DM	43	46	42	48	45
Zinc (Zn)	mg/kg DM	59	67	75	62	63
Pesticiden (OCB"s)						
DDT-Sum	mg/kg DM	0,49 [x)]	0,20	0,48 [x)]	0,012 [x)]	1,4 [x)]
Sum Drins (STI-Table)	mg/kg DM	n.d.	n.d.	n.d.	n.d.	n.d.
Sum HCH (STI-Table)	mg/kg DM	n.d.	0,003 [x)]	n.d.	n.d.	n.d.
Sum Heptachlor and -epoxide	mg/kg DM	n.d.	n.d.	n.d.	n.d.	n.d.
Sum alpha-Endosulfane and -sulfate	mg/kg DM	n.d.	0,007 [x)]	n.d.	n.d.	n.d.
o,p-DDE	mg/kg DM	<0,050 [m)]	0,0015	<0,050 [m)]	<0,0010	<0,050 [m)]
p,p-DDE	mg/kg DM	<0,050 [m)]	0,0038	<0,050 [m)]	0,0019	<0,050 [m)]
o,p-DDD	mg/kg DM	<0,050 [m)]	0,0026	<0,050 [m)]	<0,0010	<0,050 [m)]

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***Order* 372753 Soil / Eluate**

Sample no.	*Date of sampling*	*Sample code*
213092	09.05.2013	9 (4-5)

	Unit	213092 9 (4-5)
Sample Pre-treatment		
Homogenization by Samplemate		**++**
dry matter	%	**80,9**
Physical - chemical analysis		
CaCO3	% DM	**5,8**
Loss on ignition (organic matter)	% DM	**6,0**
Fractions (sedigraph)		
Fraction < 2 µm	% DM	**37**
fraction < 16 µm	% DM	**43**
fraction < 63 µm	% DM	**67**
fraction (Sedigraaf) < 125 µm	% DM	**75**
fraction < 180 µm	% DM	**79**
fraction (Sedigraaf) < 250 µm	% DM	**82**
fraction (sedigraaf) <355 µm	% DM	**85**
fraction (Sedigraaf) < 500 µm	% DM	**87**
fraction (Sedigraaf) < 1 mm	% DM	**88**
fraction (Sedigraaf) < 2 mm	% DM	**88**
Pretreatment of metal analyses		
Digestion with aqua regia		**++**
Metals		
Arsenic (As)	mg/kg DM	**3,9**
Cadmium (Cd)	mg/kg DM	**<0,10**
Chromium (Cr)	mg/kg DM	**35**
Copper (Cu)	mg/kg DM	**50**
Lead (Pb)	mg/kg DM	**15**
Mercury (Hg)	mg/kg DM	**<0,05**
Nickel (Ni)	mg/kg DM	**27**
Zinc (Zn)	mg/kg DM	**60**
Pesticiden (OCB"s)		
DDT-Sum	mg/kg DM	**0,47** *x)*
Sum Drins (STI-Table)	mg/kg DM	**n.d.**
Sum HCH (STI-Table)	mg/kg DM	**n.d.**
Sum Heptachlor and -epoxide	mg/kg DM	**n.d.**
Sum alpha-Endosulfane and -sulfate	mg/kg DM	**n.d.**
o,p-DDE	mg/kg DM	**<0,050** *m)*
p,p-DDE	mg/kg DM	**<0,050** *m)*
o,p-DDD	mg/kg DM	**<0,050** *m)*

RvA L 005 TESTING

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***Order* 372753 Soil / Eluate**

	Unit	213072 101 (0-0.2)	213073 102 (0-0.2)	213074 103 (0-0.2)	213075 104 (0-0.2)	213076 105 (0-0.2)
Pesticiden (OCB"s)						
p,p-DDD	mg/kg DM	**0,25**	**0,28**	**41**	**0,090**	**57**
o,p-DDT	mg/kg DM	**1,1**	**1,1**	**190**	**0,57**	**300**
p,p-DDT	mg/kg DM	**4,7**	**5,0**	**720**	**1,3**	**1100**
alpha-HCH	mg/kg DM	**<0,050** m)	**<0,050** m)	**20**	**<0,050** m)	**29**
beta-HCH	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
gamma-HCH (Lindan)	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**10**
delta-HCH	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
Heptachlor	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
Aldrin	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
Telodrin	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
Isodrin	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
cis-Heptachloroepoxide	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
trans-Chlordan	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
alpha-Endosulfane	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
Dieldrin	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
Endrin	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
Endosulfan- Sulfat	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**<5,0** m)
Chlorobenzenes						
Hexachlorobenzene (HCB)	mg/kg DM	**<0,050** m)	**<0,050** m)	**<5,0** m)	**<0,050** m)	**7,1**

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Order 372753 Soil / Eluate

	Unit	213077 106 (0-0.2)	213078 107 (0-0.2)	213079 108 (0-0.2)	213080 109 (0-0.2)	213081 201 (0-0.5)
Pesticiden (OCB"s)						
p,p-DDD	mg/kg DM	**0,37**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
o,p-DDT	mg/kg DM	**1,5**	**24**	**<10 m)**	**<10 m)**	**0,16**
p,p-DDT	mg/kg DM	**5,6**	**91**	**31**	**30**	**0,58**
alpha-HCH	mg/kg DM	**<0,050 m)**	**210**	**<10 m)**	**<10 m)**	**<0,050 m)**
beta-HCH	mg/kg DM	**0,087**	**17**	**<10 m)**	**<10 m)**	**<0,050 m)**
gamma-HCH (Lindan)	mg/kg DM	**<0,050 m)**	**51**	**<10 m)**	**<10 m)**	**<0,050 m)**
delta-HCH	mg/kg DM	**<0,050 m)**	**23**	**<10 m)**	**<10 m)**	**<0,050 m)**
Heptachlor	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
Aldrin	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
Telodrin	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
Isodrin	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
cis-Heptachloroepoxide	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
trans-Chlordan	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
alpha-Endosulfane	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
Dieldrin	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
Endrin	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
Endosulfan- Sulfat	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**
Chlorobenzenes						
Hexachlorobenzene (HCB)	mg/kg DM	**<0,050 m)**	**<5,0 m)**	**<10 m)**	**<10 m)**	**<0,050 m)**

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***Order* 372753 Soil / Eluate**

	Unit	213082 202 (0-0.4)	213083 203 (0-0.4)	213084 204 (0-0.4)	213085 2 (0-0.5)	213086 Pond 5 (0-0.2)
Pesticiden (OCB"s)						
p,p-DDD	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**0,18**	**0,27**	**0,016**
o,p-DDT	mg/kg DM	**0,28**	**0,13**	**1,1**	**1,4**	**0,11**
p,p-DDT	mg/kg DM	**1,3**	**0,44**	**3,8**	**5,4**	**0,22**
alpha-HCH	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,0010**
beta-HCH	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**0,0015**
gamma-HCH (Lindan)	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,0010**
delta-HCH	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,0010**
Heptachlor	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,0010**
Aldrin	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,0010**
Telodrin	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**0,004**
Isodrin	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,001**
cis-Heptachloroepoxide	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,0010**
trans-Chlordan	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,001**
alpha-Endosulfane	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**0,0023**
Dieldrin	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,0010**
Endrin	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,0010**
Endosulfan- Sulfat	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,0010**
Chlorobenzenes						
Hexachlorobenzene (HCB)	mg/kg DM	**<0,10 m)**	**<0,050 m)**	**<0,050 m)**	**<0,050 m)**	**<0,001**

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***Order* 372753 Soil / Eluate**

	Unit	213087 5 (1-1.5)	213088 5 (4-4.5)	213089 Pond 6 (0-0.5)	213090 Pond 7 (0-0.2)	213091 Pond 8/9 (0-0.2)
Pesticiden (OCB"s)						
p,p-DDD	mg/kg DM	**<0,050 m)**	**0,0087**	**<0,050 m)**	**0,0016**	**<0,050 m)**
o,p-DDT	mg/kg DM	**0,10**	**0,037**	**0,10**	**0,0019**	**0,24**
p,p-DDT	mg/kg DM	**0,39**	**0,15**	**0,38**	**0,0063**	**1,2**
alpha-HCH	mg/kg DM	**<0,050 m)**	**0,0031**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
beta-HCH	mg/kg DM	**<0,050 m)**	**<0,0010**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
gamma-HCH (Lindan)	mg/kg DM	**<0,050 m)**	**<0,0010**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
delta-HCH	mg/kg DM	**<0,050 m)**	**<0,0010**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
Heptachlor	mg/kg DM	**<0,050 m)**	**<0,0010**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
Aldrin	mg/kg DM	**<0,050 m)**	**<0,0010**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
Telodrin	mg/kg DM	**<0,050 m)**	**<0,001**	**<0,050 m)**	**<0,001**	**<0,050 m)**
Isodrin	mg/kg DM	**<0,050 m)**	**<0,001**	**<0,050 m)**	**<0,001**	**<0,050 m)**
cis-Heptachloroepoxide	mg/kg DM	**<0,050 m)**	**<0,0010**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
trans-Chlordan	mg/kg DM	**<0,050 m)**	**<0,001**	**<0,050 m)**	**<0,001**	**<0,050 m)**
alpha-Endosulfane	mg/kg DM	**<0,050 m)**	**0,0071**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
Dieldrin	mg/kg DM	**<0,050 m)**	**<0,0010**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
Endrin	mg/kg DM	**<0,050 m)**	**<0,0010**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
Endosulfan- Sulfat	mg/kg DM	**<0,050 m)**	**<0,0010**	**<0,050 m)**	**<0,0010**	**<0,050 m)**
Chlorobenzenes						
Hexachlorobenzene (HCB)	mg/kg DM	**<0,050 m)**	**<0,001**	**<0,050 m)**	**<0,001**	**<0,050 m)**

TESTING RvA L 008

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Order 372753 Soil / Eluate

	Unit	213092 9 (4-5)
Pesticiden (OCB"s)		
p,p-DDD	mg/kg DM	**<0,050 m)**
o,p-DDT	mg/kg DM	**0,10**
p,p-DDT	mg/kg DM	**0,37**
alpha-HCH	mg/kg DM	**<0,050 m)**
beta-HCH	mg/kg DM	**<0,050 m)**
gamma-HCH (Lindan)	mg/kg DM	**<0,050 m)**
delta-HCH	mg/kg DM	**<0,050 m)**
Heptachlor	mg/kg DM	**<0,050 m)**
Aldrin	mg/kg DM	**<0,050 m)**
Telodrin	mg/kg DM	**<0,050 m)**
Isodrin	mg/kg DM	**<0,050 m)**
cis-Heptachloroepoxide	mg/kg DM	**<0,050 m)**
trans-Chlordan	mg/kg DM	**<0,050 m)**
alpha-Endosulfane	mg/kg DM	**<0,050 m)**
Dieldrin	mg/kg DM	**<0,050 m)**
Endrin	mg/kg DM	**<0,050 m)**
Endosulfan- Sulfat	mg/kg DM	**<0,050 m)**
Chlorobenzenes		
Hexachlorobenzene (HCB)	mg/kg DM	**<0,050 m)**

Explanation: "<" or "n.q." represent the fact that the concentration of the analyte is below the limit of quantification (LOQ).

x) The sum calculation is done without taking into account the report limits.
m) Due to matrix perturbation, the report limits have been increased.

Start of testing: 15.05.13
End of testing: 28.05.13

The analytical results are only valid for the delivered sample material.A plausibility check is hardly possible for samples of unknown origin.Duplication of this document or of parts of it requires the authorization from laboratory.

AL-West B.V. Dhr. Peter Wijers, Tel. +31/570788111
Customer Service
Applied methods

Solids

according to NEN 6961: Digestion with aqua regia

according to NEN 6966: Lead (Pb) Zinc (Zn) Nickel (Ni) Cadmium (Cd) Chromium (Cr) Copper (Cu)

EN-ISO 11885: Arsenic (As)

in-house method: Sum Drins (STI-Table) Sum HCH (STI-Table) Sum Heptachlor and -epoxide Isodrin Telodrin Hexachlorobenzene (HCB) trans-Chlordan DDT-Sum

in-house method: n) Sum alpha-Endosulfane and - sulfate

in-house method: $CaCO_3$

ISO 16772: Mercury (Hg)

ISO11465; EN12880: dry matter

laboratory-developed method: fraction (Sedigraaf) < 2 mm fraction (Sedigraaf) < 1 mm fraction (Sedigraaf) < 500 µm fraction (sedigraaf) <355 µm fraction (Sedigraaf) < 250 µm fraction < 180 µm fraction (Sedigraaf) < 125 µm fraction < 16 µm Fraction < 2 µm Loss on ignition (organic matter) fraction < 63 µm

NEN 5709: Homogenization by Samplemate

n) Not accredited

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Matthijs Bouwknegt
POSTBUS 133
7400 AC DEVENTER

Date	29.05.2013
Customer no.	35003840
Order nr.	373945
Page 1 of 4	

REPORT

Order **373945 Soil / Eluate**

Client	35003840 TAUW DEVENTER
Reference	1210169 Nubarashen, Armenia
Sample acceptance	22.05.13
Sample taker	Client

Dear sir, madam,

Please find enclosed the results of the laboratory tests you requested. Unless stated otherwise at applied methods, the analyses are accredited according to EN-ISO/IEC 17025 and were carried out using the methods listed in the most recent version of the annex of the accreditation certificate number L005 issued by the Dutch Accreditation Council (RvA).

Should you require details regarding the uncertainty of measurement of a method, we will be happy to supply these on request.

Allow us to draw your attention to the fact that the report enclosed may only be reproduced in its entirety.

Should you require any further information, please do not hesitate to contact the after-sales department.

We trust that the enclosed information will meet with your requirements.

Yours sincerely,

AL-West B.V. Dhr. Peter Wijers, Tel. +31/570788111
Customer Service

TESTING
RvA L 005

AL-West B.V.

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Order 373945 Soil / Eluate

Sample no.	Date of sampling	Sample code
219514	11.05.2013	Pond 1 (0-0.2)
219515	15.05.2013	3 (0-0.5)
219516	13.05.2013	4 (4-5)

	Unit	219514 Pond 1 (0-0.2)	219515 3 (0-0.5)	219516 4 (4-5)
Sample Pre-treatment				
Homogenization by Samplemate		++	++	++
dry matter	%	55,2	75,8	76,8
Physical - chemical analysis				
Residue after combustion	% DM	90,9	94,1	94,8
CaCO3	% DM	16	6,5	16
Loss on ignition (organic matter)	% DM	9,1	5,9	5,2
Fractions (sedigraph)				
Fraction < 2 µm	% DM	28	25	42
Pretreatment of metal analyses				
Digestion with aqua regia		++	++	++
Metals				
Arsenic (As)	mg/kg DM	19	7,6	4,5
Cadmium (Cd)	mg/kg DM	0,13	0,14	0,20
Chromium (Cr)	mg/kg DM	79	37	21
Copper (Cu)	mg/kg DM	99	54	51
Lead (Pb)	mg/kg DM	34	16	18
Mercury (Hg)	mg/kg DM	<0,05	<0,05	<0,05
Nickel (Ni)	mg/kg DM	93	42	27
Zinc (Zn)	mg/kg DM	110	60	64
Pesticiden (OCB"s)				
DDT-Sum	mg/kg DM	0,017 x)	12	0,14
Sum Drins (STI-Table)	mg/kg DM	n.d.	n.d.	n.d.
Sum HCH (STI-Table)	mg/kg DM	n.d.	n.d.	n.d.
Sum Heptachlor and -epoxide	mg/kg DM	n.d.	n.d.	n.d.
Sum alpha-Endosulfane and -sulfate	mg/kg DM	n.d.	n.d.	n.d.
o,p-DDE	mg/kg DM	<0,0010	0,15	0,013
p,p-DDE	mg/kg DM	0,0053	2,8	0,051
o,p-DDD	mg/kg DM	0,0027	0,13	0,0017
p,p-DDD	mg/kg DM	0,0087	0,21	0,0030
o,p-DDT	mg/kg DM	<0,0010	2,1	0,0089
p,p-DDT	mg/kg DM	<0,0010	6,5	0,065
alpha-HCH	mg/kg DM	<0,0010	<0,050 m)	<0,0010
beta-HCH	mg/kg DM	<0,0010	<0,050 m)	<0,0010
gamma-HCH (Lindan)	mg/kg DM	<0,0010	<0,050 m)	<0,0010
delta-HCH	mg/kg DM	<0,0010	<0,050 m)	<0,0010
Heptachlor	mg/kg DM	<0,0010	<0,050 m)	<0,0010

TESTING RvA L 005

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	Unit	219514 Pond 1 (0-0.2)	219515 3 (0-0.5)	219516 4 (4-5)
Pesticiden (OCB"s)				
Aldrin	mg/kg DM	**<0,0010**	**<0,050** m)	**<0,0010**
Telodrin	mg/kg DM	**<0,001**	**<0,050** m)	**<0,001**
Isodrin	mg/kg DM	**<0,001**	**<0,050** m)	**<0,001**
cis-Heptachloroepoxide	mg/kg DM	**<0,0010**	**<0,050** m)	**<0,0010**
trans-Chlordan	mg/kg DM	**<0,001**	**<0,050** m)	**<0,001**
alpha-Endosulfane	mg/kg DM	**<0,0010**	**<0,050** m)	**<0,0010**
Dieldrin	mg/kg DM	**<0,0010**	**<0,050** m)	**<0,0010**
Endrin	mg/kg DM	**<0,0010**	**<0,050** m)	**<0,0010**
Endosulfan- Sulfat	mg/kg DM	**<0,0010**	**<0,050** m)	**<0,0010**
Chlorobenzenes				
Hexachlorobenzene (HCB)	mg/kg DM	**<0,001**	**<0,050** m)	**<0,001**

Explanation: "<" or "n.q." represent the fact that the concentration of the analyte is below the limit of quantification (LOQ).

x) The sum calculation is done without taking into account the report limits.
m) Due to matrix perturbation, the report limits have been increased.

Start of testing: 23.05.13
End of testing: 29.05.13

The analytical results are only valid for the delivered sample material.A plausibility check is hardly possible for samples of unknown origin.Duplication of this document or of parts of it requires the authorization from laboratory.

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Applied methods

Solids

according to NEN 6961: Digestion with aqua regia
according to NEN 6966: Zinc (Zn) Nickel (Ni) Copper (Cu) Chromium (Cr) Cadmium (Cd) Lead (Pb)
EN-ISO 11885: Arsenic (As)
in-house method: Isodrin trans-Chlordan Telodrin Hexachlorobenzene (HCB) Sum Heptachlor and -epoxide Sum HCH (STI-Table) Sum Drins (STI-Table) DDT-Sum
in-house method: **n)**Sum alpha-Endosulfane and - sulfate
in-house method: CaCO3
ISO 16772: Mercury (Hg)
ISO11465; EN12880: dry matter
laboratory-developed method: Fraction < 2 µm Residue after combustion Loss on ignition (organic matter)
NEN 5709: Homogenization by Samplemate

n) Not accredited

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Supplement for Order nr. 373945

CONSERVATION, CONSERVATION TIME AND PACKING MATERIAL.

THE CONSERVATION TIME HAS EXPIRED FOR THE FOLLOWING ANALYSES:

Residue after combustion	219514, 219515, 219516
dry matter	219514, 219515, 219516

TESTING
RvA L 005

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TAUW DEVENTER
Matthijs Bouwknegt
POSTBUS 133
7400 AC DEVENTER

Date	28.05.2013
Customer no.	35003840
Order nr.	373957
Page 1 of 3	

REPORT

***Order* 373957 Water**

Client	35003840 TAUW DEVENTER
Reference	1210169 Nubarashen, Armenia
Sample acceptance	22.05.13
Sample taker	Client

Dear sir, madam,

Please find enclosed the results of the laboratory tests you requested. Unless stated otherwise at applied methods, the analyses are accredited according to EN-ISO/IEC 17025 and were carried out using the methods listed in the most recent version of the annex of the accreditation certificate number L005 issued by the Dutch Accreditation Council (RvA).

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Yours sincerely,

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TESTING RvA L 005

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***Order* 373957 Water**

Sample no.	*Sample code*	*Date of sampling*	*Sampling Location*
219564	1 (4-5)	22.05.2013	
219565	Pond 1	22.05.2013	
219566	7 (3-4)	22.05.2013	
219567	Pond 7	22.05.2013	
219568	9 (18.3-22.3)	22.05.2013	

	Unit	219564 1 (4-5)	219565 Pond 1	219566 7 (3-4)	219567 Pond 7	219568 9 (18.3-22.3)
Metals						
Arsenic (As)	µg/l	20,8	<5,0	<5,0	<5,0	<5,0
Barium (Ba)	µg/l	160	97	11	110	41
Cadmium (Cd)	µg/l	<0,10	<0,10	<0,10	<0,10	<0,10
Cobalt (Co)	µg/l	<2,0	<2,0	7,1	2,5	<2,0
Copper (Cu)	µg/l	9,2	3,9	3,0	4,3	<2,0
Lead (Pb)	µg/l	7,8	<5,0	<5,0	<5,0	50
Mercury (Hg)	µg/l	0,12	0,04	<0,03	<0,03	0,10
Molybdenum (Mo)	µg/l	24	23	5,3	20	7,8
Nickel (Ni)	µg/l	9,8	<5,0	19	5,4	<5,0
Zinc (Zn)	µg/l	9,1	<2,0	<2,0	<2,0	2,1
Aromatic solvents						
Benzene	µg/l	<0,2	<0,2	<0,2	<0,2	0,5
Toluene	µg/l	<0,5	<0,5	<0,5	<0,5	6,1
Ethylbenzene	µg/l	<0,5	<0,5	<0,5	<0,5	5,2
m,p-Xylene	µg/l	<0,2	<0,2	<0,2	<0,2	14
o-Xylene	µg/l	<0,50	<0,50	<0,50	<0,50	11
Naphthalene	µg/l	<0,1	<0,1	<0,1	<0,1	2,6
Sum Xylenes	µg/l	n.d.	n.d.	n.d.	n.d.	25
Mineral oil						
Hydrocarbon total C10-C40	µg/l	<50	<50	<50	<50	53
Hydrocarbon fraction C10-C12	µg/l	<10	<10	<10	<10	34
Hydrocarbon fraction C12-C16	µg/l	<10	<10	<10	<10	15
Hydrocarbon fraction C16-C20	µg/l	<5,0	<5,0	<5,0	<5,0	<5,0
Hydrocarbon fraction C20-C24	µg/l	<5,0	<5,0	<5,0	<5,0	<5,0
Hydrocarbon fraction C24-C28	µg/l	5,1	5,2	<5,0	<5,0	<5,0
Hydrocarbon fraction C28-C32	µg/l	5,1	5,1	<5,0	<5,0	<5,0
Hydrocarbon fraction C32-C36	µg/l	<5,0	<5,0	<5,0	<5,0	<5,0
Hydrocarbon fraction C36-C40	µg/l	<5,0	<5,0	<5,0	<5,0	<5,0
Pesticiden (OCB"s)						
o,p-DDE	µg/l	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]
p,p-DDE	µg/l	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]
o,p-DDD	µg/l	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]
p,p-DDD	µg/l	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]
o,p-DDT	µg/l	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]
p,p-DDT	µg/l	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]
Sum DDT, DDE, DDD	µg/l	n.d.	n.d.	n.d.	n.d.	n.d.
Heptachlor	µg/l	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]	<0,10 [m)]

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***Order* 373957 Water**

	Unit	219564 1 (4-5)	219565 Pond 1	219566 7 (3-4)	219567 Pond 7	219568 9 (18.3-22.3)
Pesticiden (OCB"s)						
cis-Heptachloroepoxide	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
Sum Heptachlor and -epoxide	µg/l	**n.d.**	**n.d.**	**n.d.**	**n.d.**	**n.d.**
alpha-Endosulfane	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
Sum alpha-Endosulfan+sulphate	µg/l	**n.d.**	**n.d.**	**n.d.**	**n.d.**	**n.d.**
Aldrin	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
Dieldrin	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
Endrin	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
Isodrin	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
Telodrin (Isobenzan)	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
Sum Drins (STI-Table)	µg/l	**n.d.**	**n.d.**	**n.d.**	**n.d.**	**n.d.**
trans-Chlordan	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
Pesticides						
Endosulfansulfat	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
HCH and HCB						
Hexachlorbenzol	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
alpha-HCH	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
beta-HCH	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
gamma-HCH (Lindan)	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
delta-HCH	µg/l	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**	**<0,10 m)**
Sum HCH (STI-Table)	µg/l	**n.d.**	**n.d.**	**n.d.**	**n.d.**	**n.d.**

Explanation: "<" or "n.q." represent the fact that the concentration of the analyte is below the limit of quantification (LOQ).

m) Due to matrix perturbation, the report limits have been increased.

Start of testing: 22.05.13
End of testing: 28.05.13

The analytical results are only valid for the delivered sample material.A plausibility check is hardly possible for samples of unknown origin.Duplication of this document or of parts of it requires the authorization from laboratory.

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Customer Service

Applied methods

eigen methode gelijkwaardig aan NEN-EN-ISO 6468: Hexachlorbenzol Sum DDT, DDE, DDD Sum Heptachlor and -epoxide Sum HCH (STI-Table) Sum alpha-Endosulfan+sulphate Isodrin Sum Drins (STI-Table) Telodrin (Isobenzan) trans-Chlordan

EN 1483: Mercury (Hg)

EN-ISO 11423-1: Ethylbenzene Benzene Toluene Sum Xylenes

EN-ISO 11885: Zinc (Zn) Nickel (Ni) Molybdenum (Mo) Copper (Cu) Cobalt (Co) Cadmium (Cd) Lead (Pb) Arsenic (As) Barium (Ba)

ISO 11423-1: Naphthalene

laboratory-developed method: Hydrocarbon total C10-C40

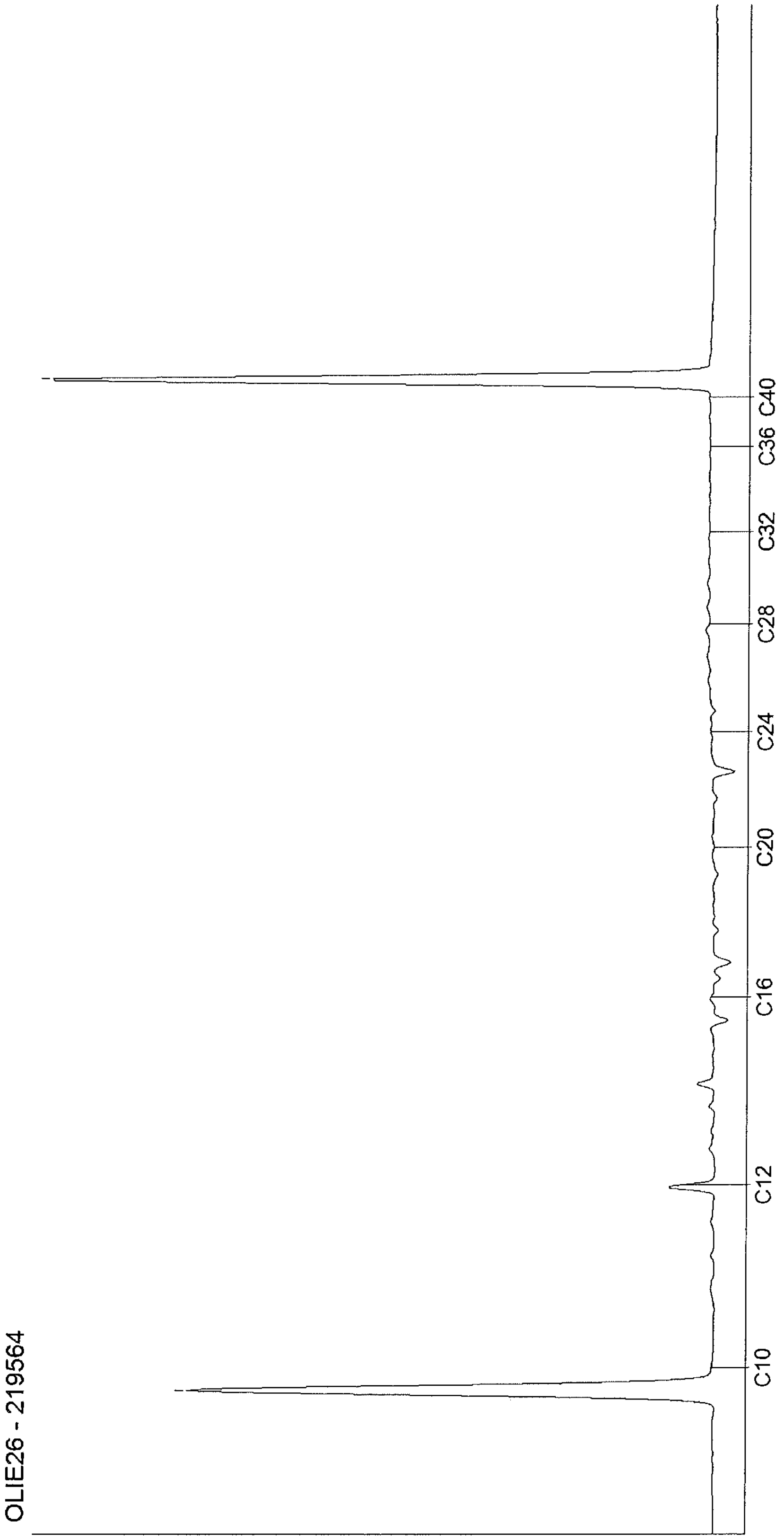
laboratory-developed method: n) Hydrocarbon fraction C24-C28 Hydrocarbon fraction C20-C24 Hydrocarbon fraction C32-C36 Hydrocarbon fraction C12-C16 Hydrocarbon fraction C10-C12 Hydrocarbon fraction C28-C32 Hydrocarbon fraction C36-C40 Hydrocarbon fraction C16-C20

n) Not accredited

TESTING RvA L 001

Chromatogram for Order No. 373957, Analysis No. 219564, created at 24.05.2013 17:58:16

Sample code: 1 (4-5)



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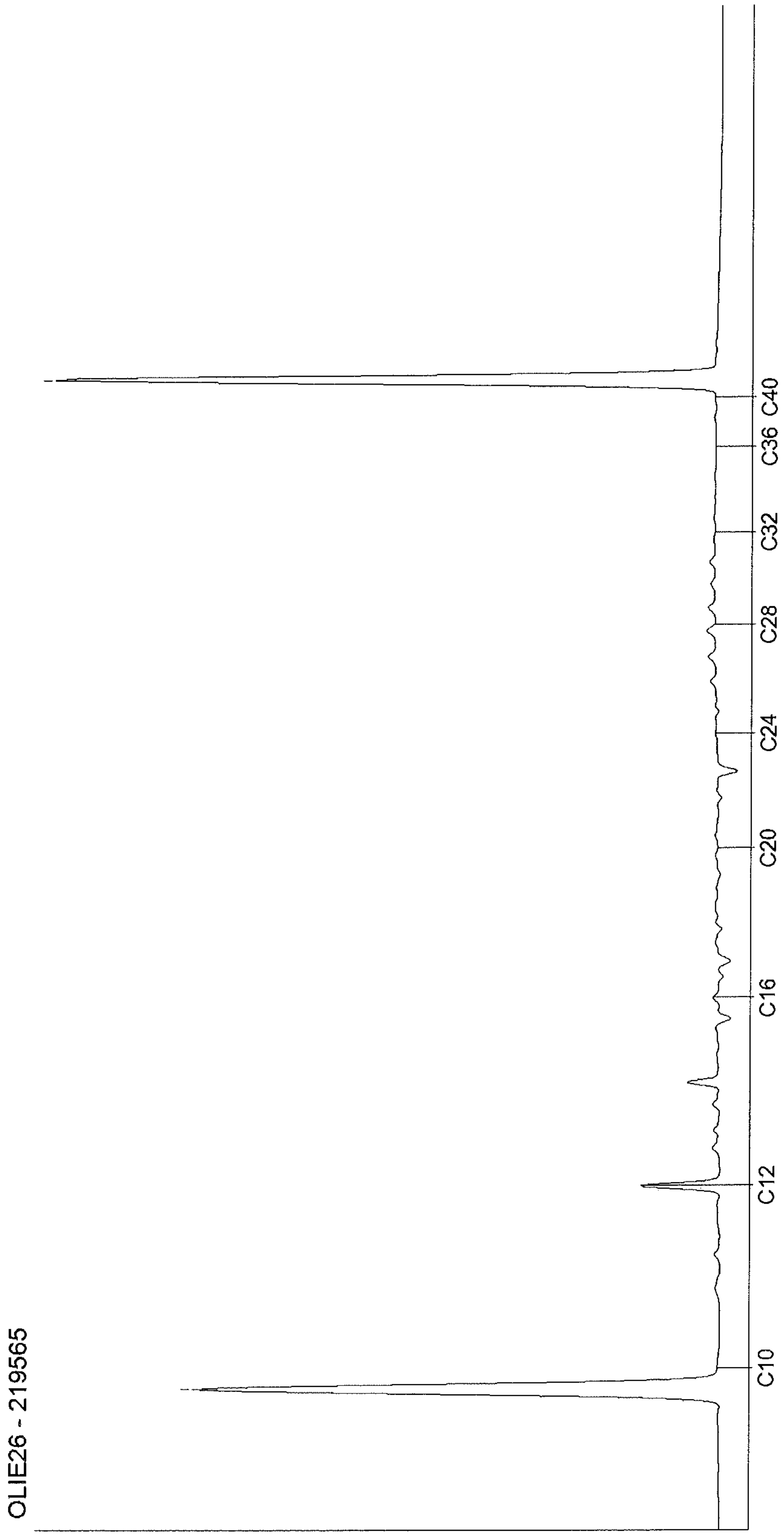
Chromatogram for Order No. 373957, Analysis No. 219565, created at 27.05.2013 08:44:20

Sample code: Pond 1



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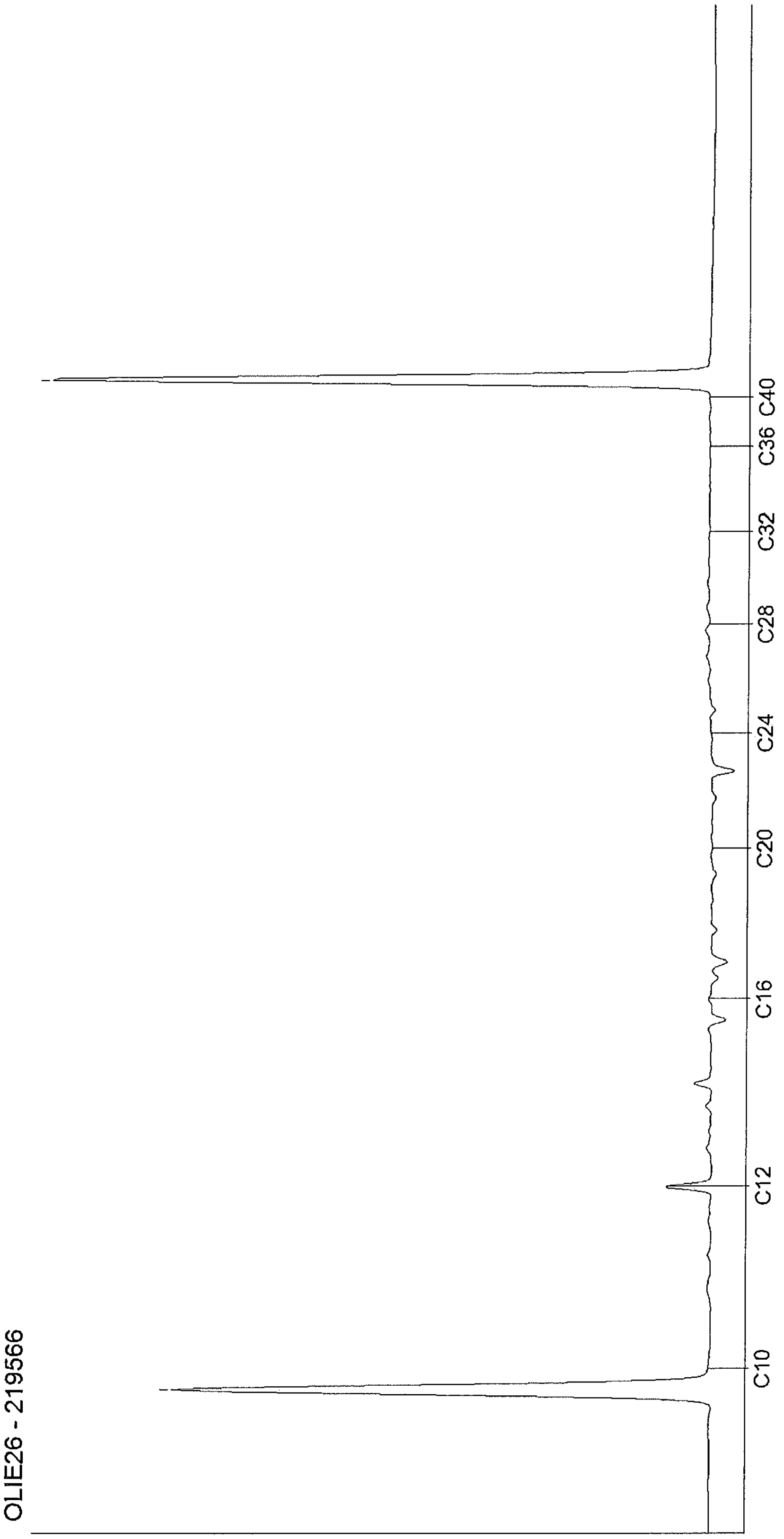
Chromatogram for Order No. 373957, Analysis No. 219566, created at 27.05.2013 08:44:19

Sample code: 7 (3-4)



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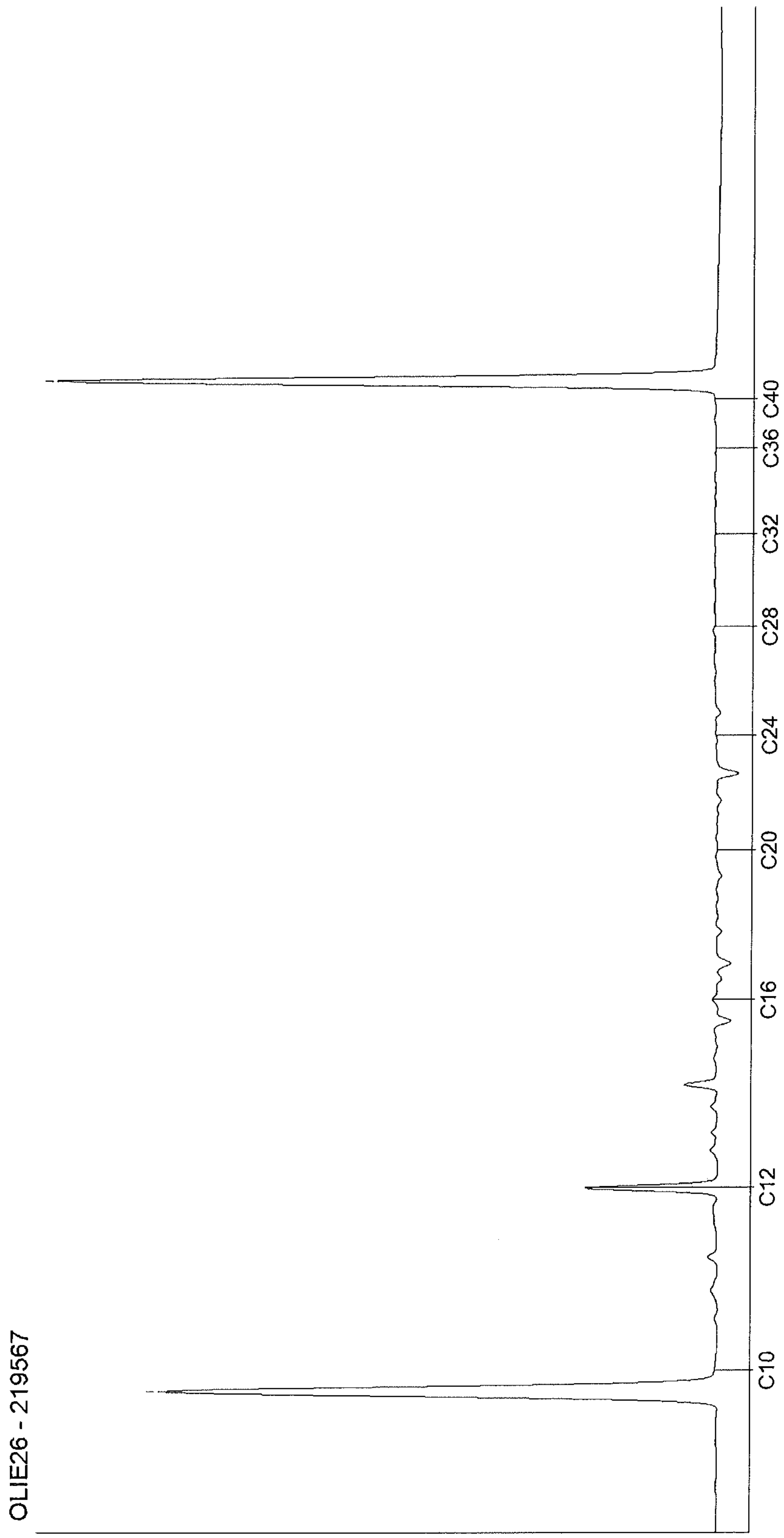
Chromatogram for Order No. 373957, Analysis No. 219567, created at 24.05.2013 18:02:48

Sample code: Pond 7



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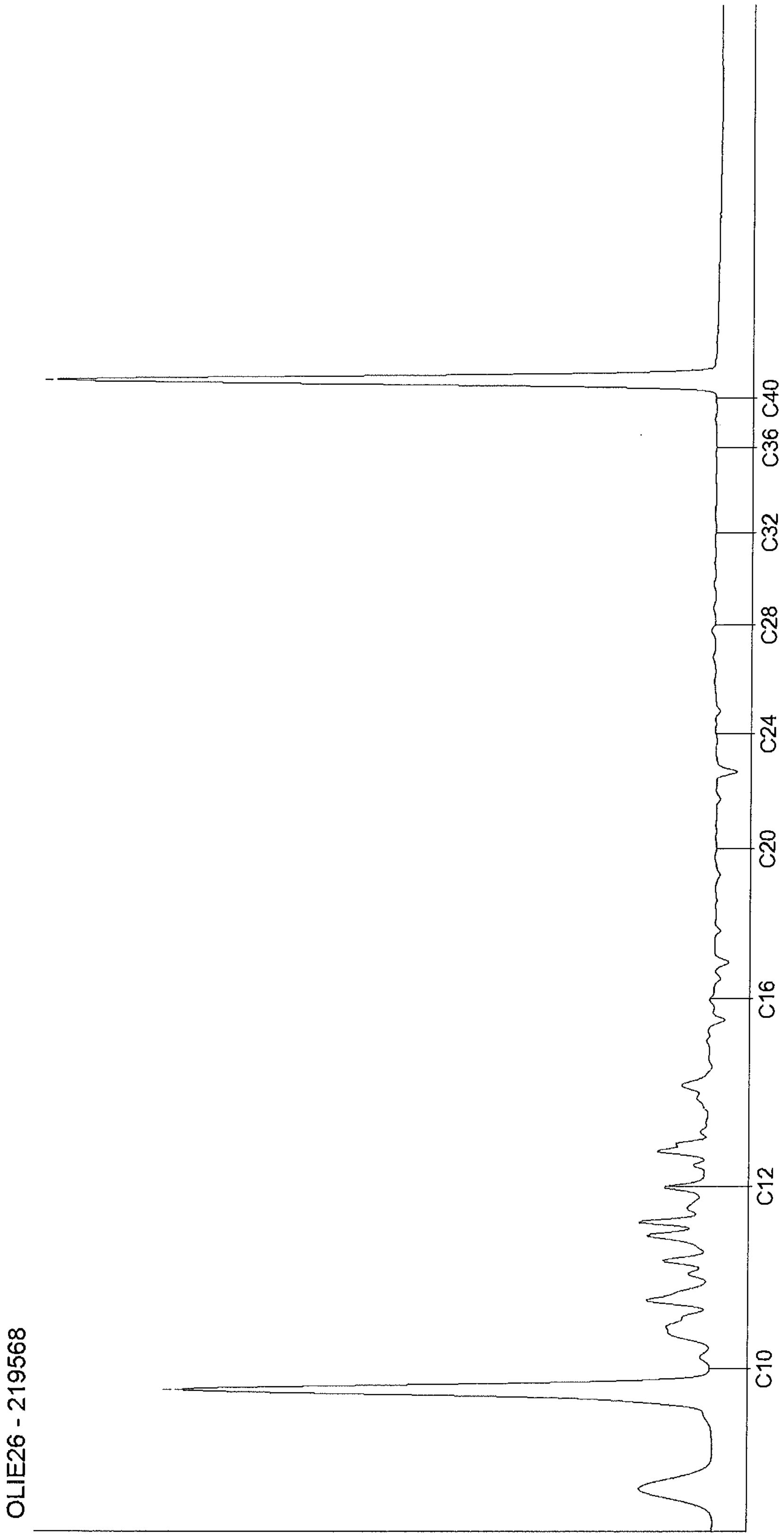
Chromatogram for Order No. 373957, Analysis No. 219568, created at 27.05.2013 08:44:15

Sample code: 9 (18.3-22.3)



TTT - Dutch STI framework_EN
date: 04 jun 2013

Clay size fraction	30%
Organic matter	7%

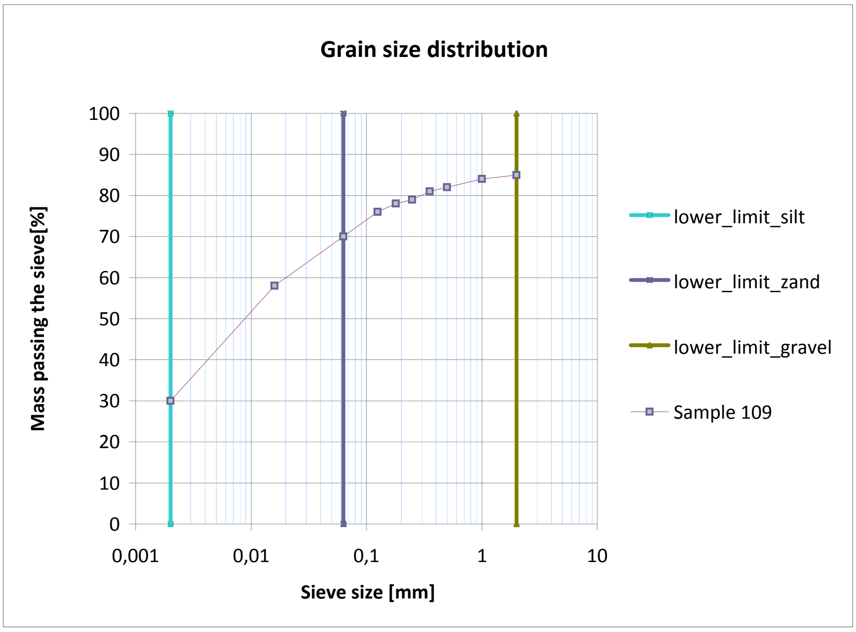
	Background value	Intermediate value	Intervention Value
METALS			
Arsenic (As)	21	49	78
Cadmium (Cd)	0,58	6,6	13
Chromium (Cr)	61	129	198
Copper (Cu)	41	119	196
Mercury (Hg) inorganic	0,16	19	37
Mercury (Hg) organic	-	2.1	4.2
Lead (Pb)	51	297	542
Nickel (Ni)	40	77	114
Zinc (Zn)	151	462	774
CHLORINATED HYDROCARBONS			
Hexachlorobenzene	0,007	0,7035	1,4
PESTICIDES			
Aldrin	-	0.112	0.224
alpha-Endosulfan	0.00063	1.4	2.8
alpha-HCH	0.0007	6.0	12
beta-HCH	0.0014	0.56	1.1
gamma-HCH	0.0021	0.42	0.84
Heptachlor	0.00049	1.4	2.8
DDT (sum)	0.14	0.67	1.2
DDE (sum)	0.070	0.84	1.6
DDD (sum)	0.014	12	24

Appendix

8

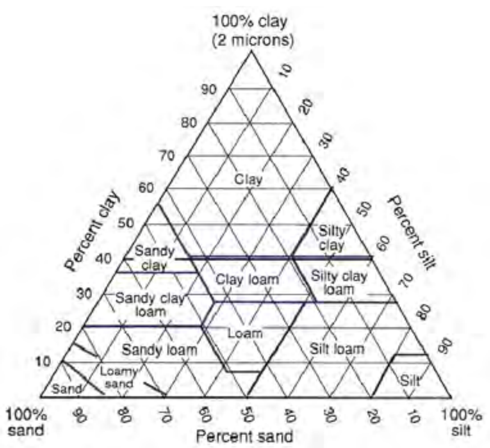
Geophysical data

Project	Site Assessment and Feasibility Study of the Nubarashen Burial Site of Obsolete and Banned Pesticides in Nubarashen, Armenia					
Contract №	ARM/01/2013					
Date	28-6-2013					
Description	Sieve analysis					
Version	1.0					
Sample	109	3	4			
Location	Direct surroundings landfill body, within fence boundary	site surrounding	Site surrounding			

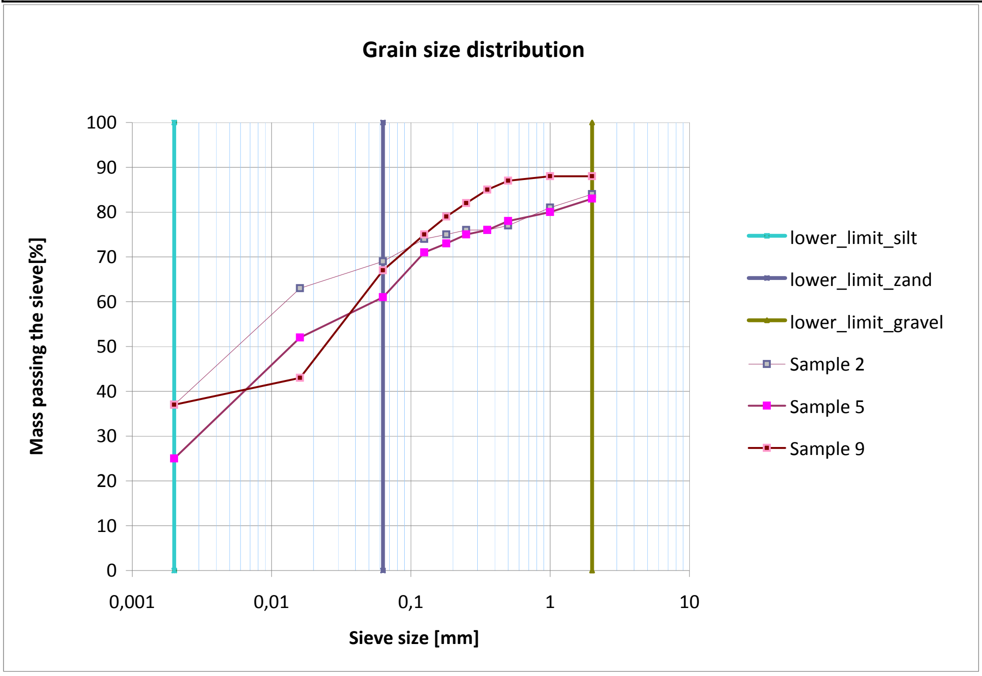


Name	Limit	Percentage Sample 109	Percentage Sample 3	Percentage Sample 4	Classification	
Clay	< 2 µm	30	25	42	Sample 110	Clay loam
Silt	2 µm - 63 µm	40			Sample 3	
Sand	63 µm - 2000 µm	15			Sample 4	
Gravel	> 2000 µm	15				

Grain size	Sample 109	Sample 3	Sample 4
Detph m blg	0.0 - 0.2	0.0 - 0.5	4.0 - 5.0
Calcium carbonate	6,8	6,5	16
Organic matter (%)	7,3	5,9	5,2
0,002	30	25	42
0,016	58		
0,063	70		
0,125	76		
0,18	78		
0,25	79		
0,355	81		
0,5	82		
1	84		
2	85		

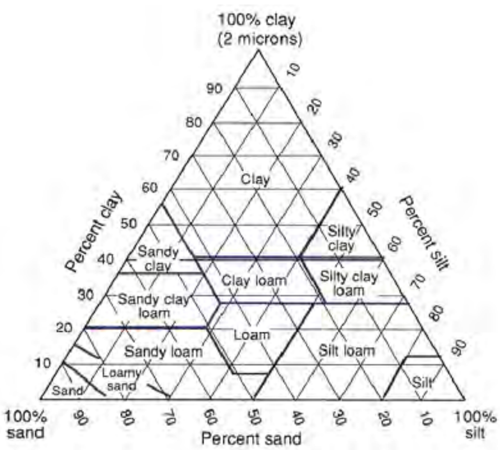


Project	**Site Assessment and Feasibility Study of the Nubarashen Burial Site of Obsolete and Banned Pesticides in Nubarashen, Armenia**
Contract №	ARM/01/2013
Date	28-6-2013
Description	Sieve analysis
Version	1.0
Samples	2, 5 and 9
Location	Surroundings landfill body

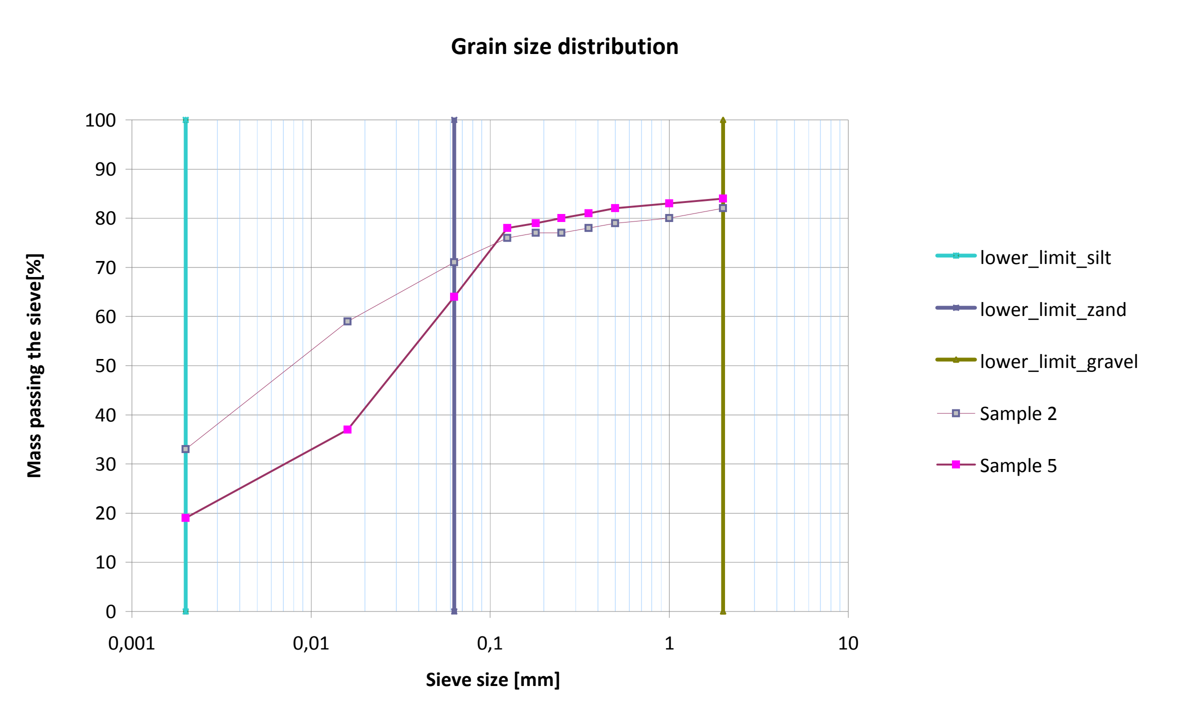


Name	**Limit**	**Percentage Sample 2**	**Percentage Sample 5**	**Percentage Sample 9**	**Classification**	
Clay	< 2 µm	37	25	37	**Sample 2**	**Clay loam**
Silt	2 µm - 63 µm	32	36	30	**Sample 5**	**Sandy loam**
Sand	63 µm - 2000 µm	15	22	21	**Sample 9**	**Clay**
Gravel	> 2000 µm	16	17	12		

Grain size	**Sample 2**	**Sample 5**	**Sample 9**
Detph m blg	0.0 - 0.5	1.0 - 1.5	4.0 - 5.0
Calcium carbonate	9,9	10	5,8
Organic matter (%)	6,7	6,3	6
Dry matter	77,3	81,4	80,9
0,002	37	25	37
0,016	63	52	43
0,063	69	61	67
0,125	74	71	75
0,18	75	73	79
0,25	76	75	82
0,355	76	76	85
0,5	77	78	87
1	81	80	88
2	84	83	88

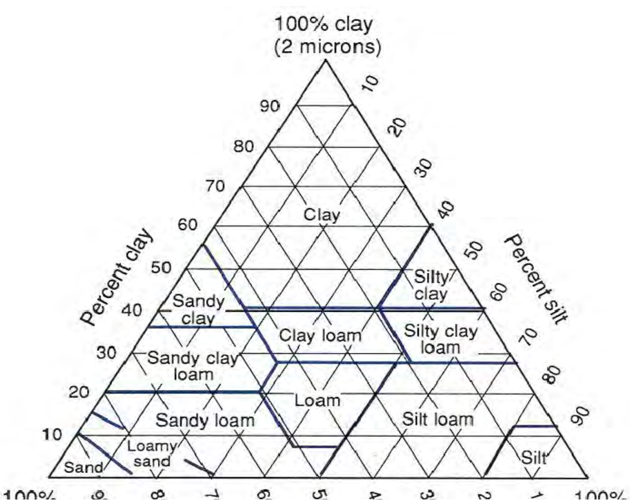


Project	Site Assessment and Feasibility Study of the Nubarashen Burial Site of Obsolete and Banned Pesticides in Nubarashen, Armenia
Contract №	ARM/01/2013
Date	28-6-2013
Description	Sieve analysis
Version	1.0
Samples	2, 5 and 9
Location	Surroundings landfill body



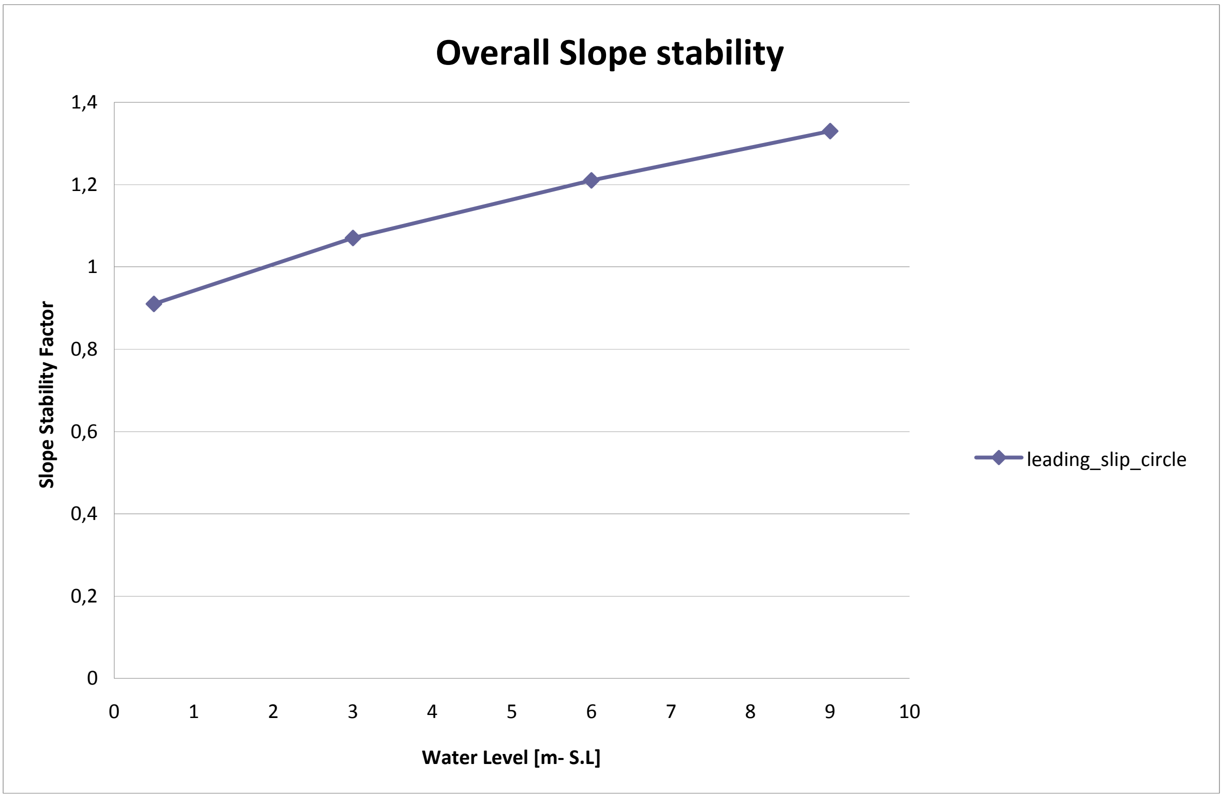
Name	Limit	Percentage Pond 5	Percentage Pond 8/9	Classification	
clay	< 2 µm	33	19	Pond 5	Clay loam
silt	2 µm - 63 µm	38	45	Pond 8/9	Loam
sand	63 µm - 2000 µm	11	20		
gravel	> 2000 µm	18	16		

Grain size	Sample 2	Sample 5
Detph m blg	0.0 - 0.2	0.0 - 0.2
Calcium carbonate	9,9	10
Organic matter (%)	6,7	6,3
Dry matter	77,3	81,4
0,002	33	19
0,016	59	37
0,063	71	64
0,125	76	78
0,18	77	79
0,25	77	80
0,355	78	81

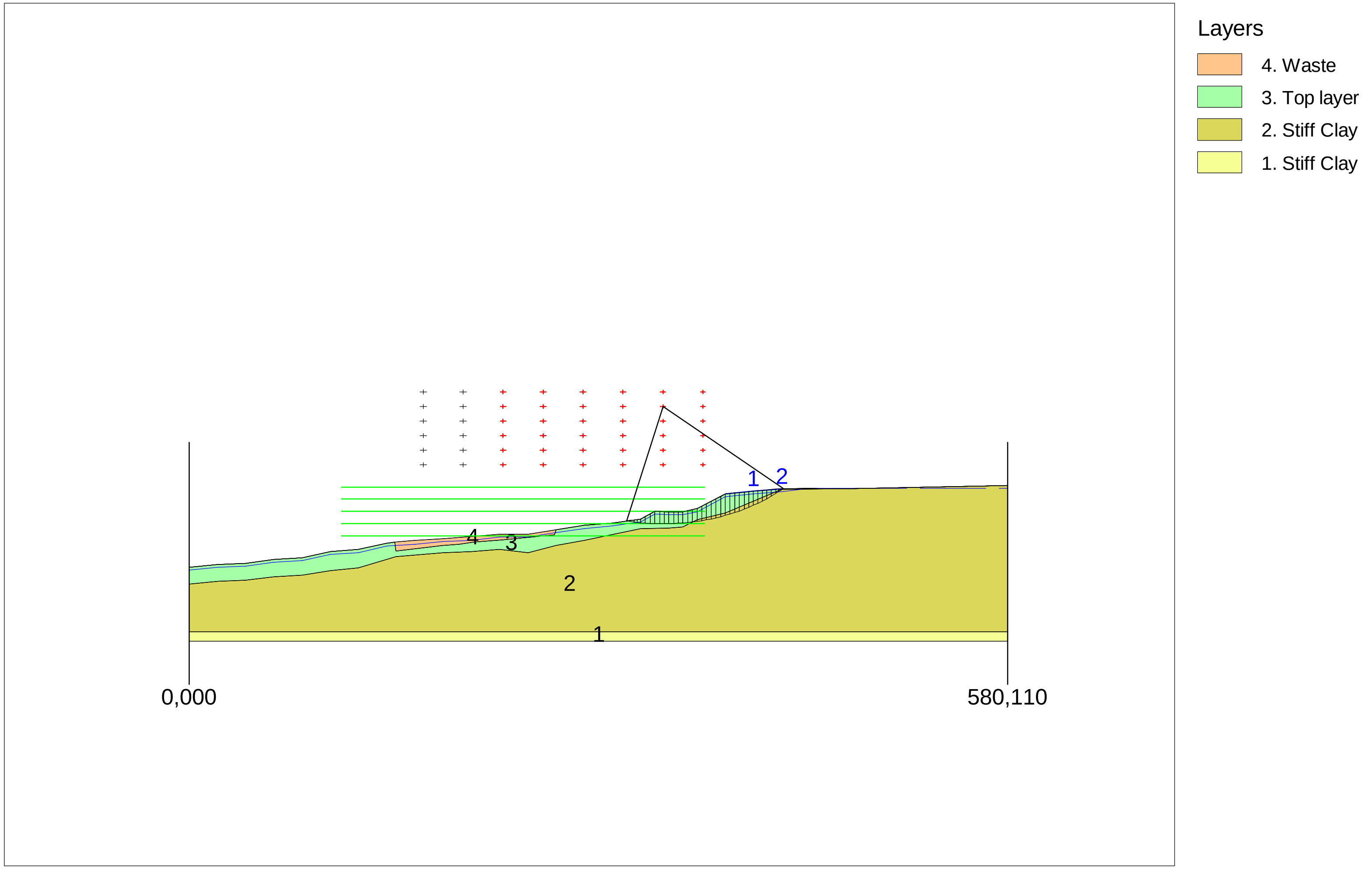


Project	Site Assessment and Feasibility Study of the Nubarashen Burial Site of Obsolete and Banned Pesticides in Nubarashen, Armenia
Contract №	ARM/01/2013
Date	28-6-2013
Description	Sieve analysis
Version	1.0
Samples	
Location	Surroundings landfill body

Layer number	Layer name	Vol. weight	Cohesion	Internal friction angle
1	Waste	15/15	2,5	15
2	Top layer	19/19	15	22,5
3	Stiff clay	19/19	15	22,5



Critical Circle Bishop



Xm : 335,79 [m]
Ym : 1509,02 [m]

Radius : 119,34 [m]
Safety : 1,06

D-Geo Stability 10.1 : stability_waste_site_annex3_v1.0_LW.sti

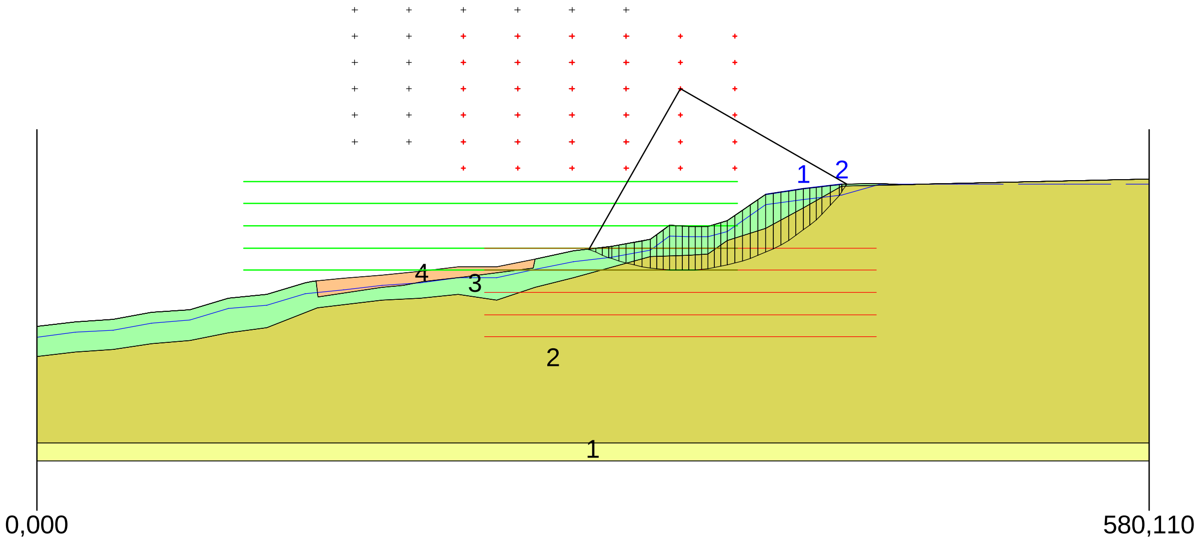
Phone
Fax

Annex

21-06-2013

date

Critical Circle Bishop



Layers
- 4. Waste
- 3. Top layer
- 2. Stiff Clay
- 1. Stiff Clay

Xm : 335,79 [m]
Ym : 1479,30 [m]

Radius : 102,13 [m]
Safety : 1,21

D-Geo Stability 10.1 : stability_waste_site_annex3_V1.0_DW.sti

Phone
Fax

date
21-06-2013

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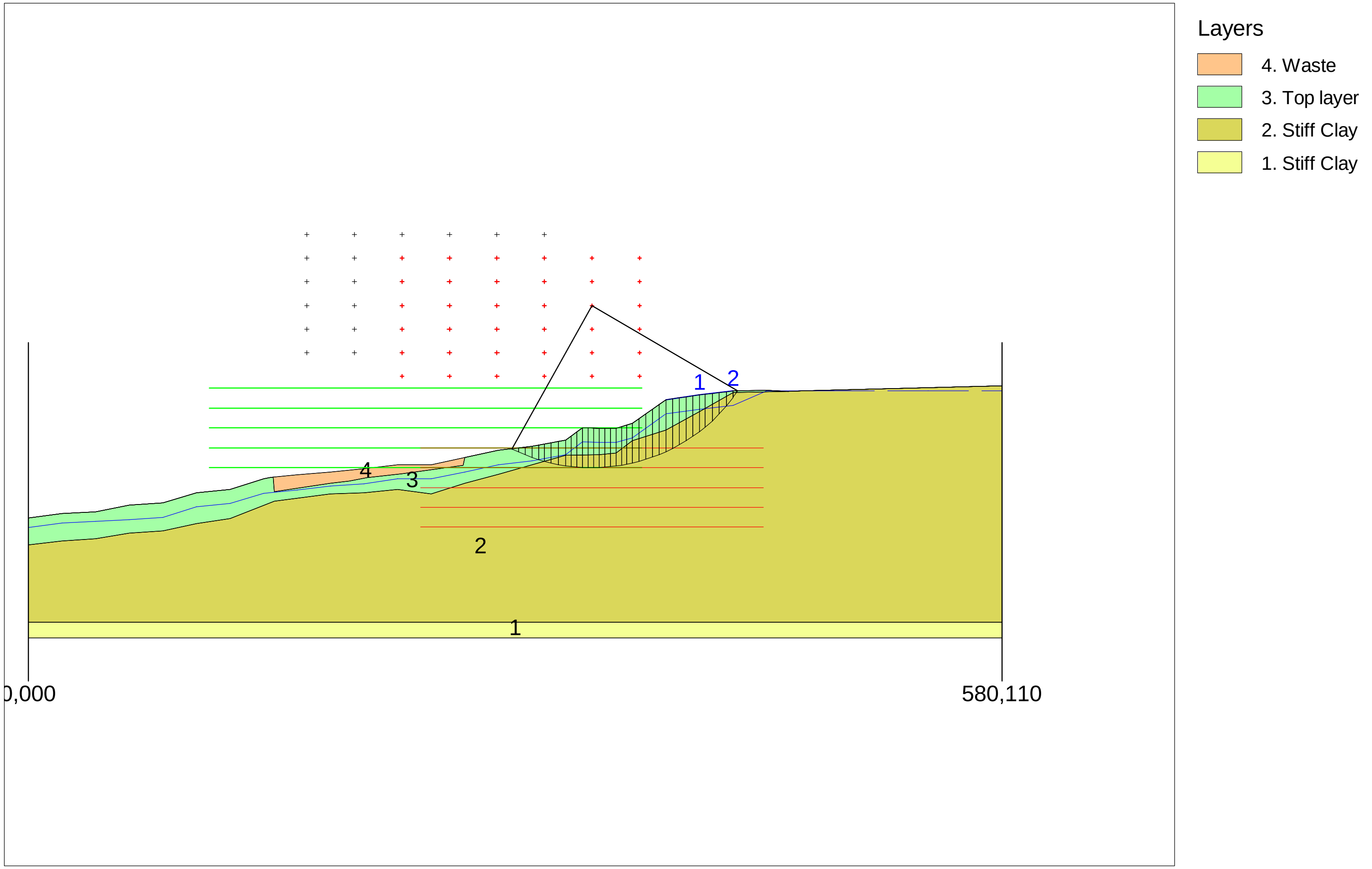


Xm : 335,79 [m]
Ym : 1479,30 [m]

Radius : 102,13 [m]
Safety : 1,33

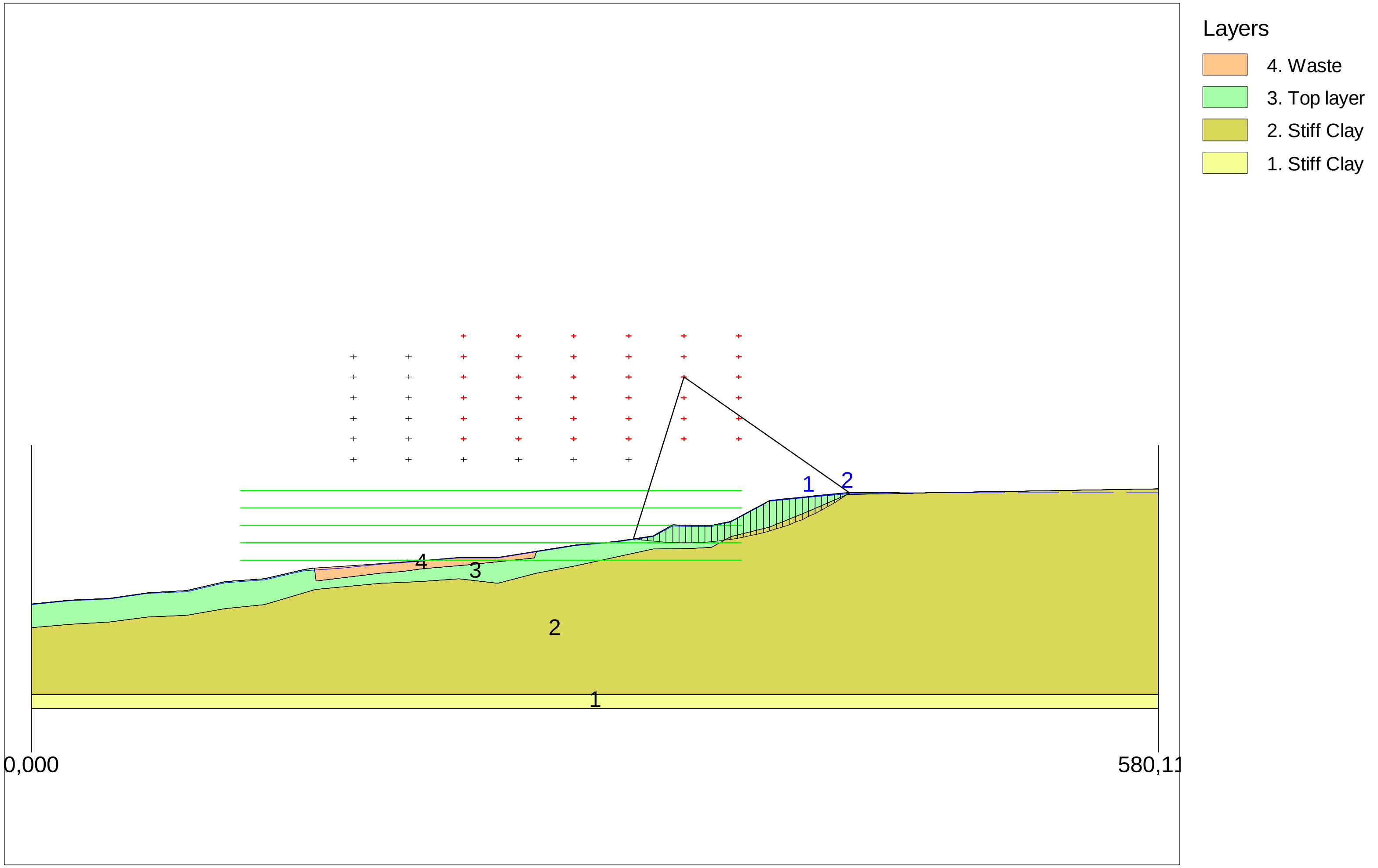
D-Geo Stability 10.1 : stability_waste_site_annex3_v1.0_EW.sti

Phone
Fax

date
21-06-2013

Annex

Critical Circle Bishop



Xm : 335,79 [m]
Ym : 1509,02 [m]

Radius : 119,34 [m]
Safety : 0,91

D-Geo Stability 10.1 : stability_waste_site_annex3_v1.0_HW.sti

Phone
Fax

date
21-06-2013

Annex

Appendix

9

Tier 2 Risk Assessment

A9.1 Introduction

The parameters used to calculate the risk limit values for soil (calculated with CSOIL2000, RIVM 2001) for workers on the site and for residents in the surroundings of the site are listed in this appendix. The tables A9.1 to A9.4 are used to present these data in a structured manner. This appendix also comprises additional calculations to estimate the contribution of the consumption of animal products like eggs and cream to the tolerable intake and additional information regarding soil quality criteria for agricultural use. At the end of this appendix a list of literature used is given.

A9.2 Information given in tables A9.1 to A9.4

- Table A9.1 represents the toxicity assessment and gives the toxicological limit values for long term exposure for humans for DDT, DDD, DDE as well as α-HCH and γ-HCH based on a report published by the Dutch Institute Public Health and Environment (Baars et al. (2001))
- Table A9.2 gives the calculated risk limit values for DDT, DDD, DDE as well as α-HCH and γ-HCH for workers on-site. The most important exposure routes taken into account are direct contact (ingestion of soil & dermal contact) and inhalation of soil particles. The table gives the calculated value for each individual pesticide compound. Furthermore for DDT (the pesticide determining the human health risks on the site due to the high concentrations) the table gives an overview of the contribution [%] of the individual exposure routes considered to the sum of the total calculated exposure corresponding to a soil content equal to the remediation target value
- Table A9.3a and b gives the calculated risk limit values for DDT, DDD, DDE as well as α-HCH and γ-HCH for residents/farmers in the surroundings of the site. The most important exposure routes taken into account are direct contact (ingestion of soil & dermal contact), the consumption of some plant crops grown on contaminated soil and inhalation of soil particles. The table gives the calculated value for each individual pesticide compound. Furthermore for DDT (the pesticide determining the human health risks on the site due to the high concentrations) the table gives an overview of the contribution [%] of the individual exposure routes considered to the sum of the total calculated exposure corresponding to a soil content equal to the remediation target value
- Indicative calculations are performed for the calculated contribution [%] of eggs to an intake of DDT equal to the value of the maximum permissible risk limit derived by the Dutch RIVM (see toxicity assessment)
- Table A9.4 gives Canadian Soil Quality Criteria for (total) DDT and Lindane for agricultural use
- At the end of the appendix an overview of the literature used is given

A9.3 Information regarding parameters used for calculations

Table A9.1 Toxicity assessment / Toxicological limit values long term exposure for human for different organochlorine pesticides long term toxicological limit values used in the risk assessment (MPR: maximum permissible risk limit, Baars et al. (2001), and criteria for drinking water use, WHO guideline values, GLV, WHO 2011)

Compound	Toxicological limit values for long term exposure in mg/kgd	Criteria for drinking water use µg/L
DDT, DDD and DDE	MPR (RIVM): 5*10-4	GLV (WHO): 1 (Sum total DDT)
Alpha HCH	MPR (RIVM): 1*10-3	
Gamma HCH	MPR (RIVM): 4*10-5	GLV (WHO): 2

Human exposure factors

The following basic assumptions for are used for human exposure factors in the calculation of the human health risk limit values:

- Body weight: 70 kg body weight (adult, worker and residential) and 15 kg body weight (child)
- Workers: exposed as adult
- Lifelong exposure residents: 6 years exposure as a child plus 64 years exposure as an adult
- Soil ingestion rate 20 mg/d (adult, worker; corresponding to twice the CSOIL default value); 50 mg/d (adult, residential, CSOIL default); 100 mg/d (child, residential, CSOIL default)
- Exposure time 2 h outside every day (worker), for residential exposure default values of CSOIL were used
- Residential, crop consumption: belowground crops: e.g. roots, tubers, potatoes 134 g/ adult person day
- Residential, crop consumption: aboveground vegetables: 250 g/adult person day

Table A9.2 Calculated risk limit values for DDT, DDD, DDE as well as α-HCH and γ-HCH for workers working on contaminated soil regularly 2 h per day. Contribution of exposure routes considered to total calculated exposure [% of total calculated exposure at a soil content corresponding to the risk limit value]; values for individual organochlorine pesticides are given in this table. * permeation of water pipes is not included as there are no shower facilities on site

Scenario	Exposure of workers, regularly working on contaminated soil 2 h/day outdoors											
Contaminant	Risk limit value mg/kg d.m.	Soil ingestion	Derm uptake ind	Derm uptake outd	Inhal soil	Inhal ind	Inhal outd	Plant ingestion	Perm* drinkw	Vapors shower*	Derm uptake shower*	Exposure air*
DDT	1,368	78%	0.7%	18.7%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
DDE	1,368	78%	0.7%	18.7%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
DDD	1,368	78%	0.7%	18.7%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.4%
a-HCH	2,073	78%	0.7%	18.7%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.5%
g-HCH	109	78%	0.7%	18.7%	2.4%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	2.5%

Table A9.3a Calculated risk limit values for DDT, DDD, DDE as well as α-HCH and γ-HCH for residents living on contaminated soil consuming vegetables and tubers grown on contaminated soil (fraction of home produced crops 10 %, fraction of market crops 90 %). Contribution of exposure routes considered to total calculated exposure [% of total calculated exposure at a soil content corresponding to the risk limit value]; values for individual organochlorine pesticides are given in this table. * inhalation indoors and exposure during showering is not included assuming the soil contamination is not present underneath the building

Scenario	Exposure of residents, living on contaminated soil, 10 % of vegetables produced on contaminated soil											
Contaminant	Risk limit value mg/kg d.m.	Soil ingestion	Derm uptake ind	Derm uptake outd	Inhal soil	Inhal ind*	Inhal outd	Plant ingestion	Perm* drinkw	Vapors shower*	Derm uptake shower*	Exposure air*
DDT	20.7	5.1%	0.0%	0.4%	0.0%	0.0%	0.0%	94.4%	0.0%	0.0%	0.0%	0.0%
DDE	11.50	2.8%	0.0%	0.2%	0.0%	0.0%	0.0%	96.9%	0.0%	0.0%	0.0%	0.0%
DDD	28.5	7.0%	0.0%	0.6%	0.1%	0.0%	0.0%	92.3%	0.0%	0.0%	0.0%	0.1%
a-HCH	66.5	8.2%	0.1%	0.7%	0.1%	0.0%	0.0%	91.0%	0.0%	0.0%	0.0%	0.1%
g-HCH	0.83	2.5%	0.0%	0.2%	0.0%	0.0%	0.0%	97.2%	0.0%	0.0%	0.0%	0.0%

Table A9.3b Calculated risk limit values for DDT, DDD, DDE as well as α-HCH and γ-HCH for residents living on contaminated soil consuming vegetables and tubers grown on contaminated soil (fraction of home produced crops 30 % for tubers/roots and 50 % for aboveground vegetables, fraction of market crops 70% and 50 %, respectively). Contribution of exposure routes considered to total calculated exposure [% of total calculated exposure at a soil content corresponding to the risk limit value]; values for individual organochlorine pesticides is given in this table.
*** inhalation indoors and exposure during showering is not included assuming the soil contamination is not present underneath the building**

Scenario	**Exposure of residents, living on contaminated soil, 30 % (roots) and 50 % (aboveground vegetables) of vegetables produced on contaminated soil**										
Contaminant	Risk limit value mg/kg d.m.	Soil ingestion	Derm uptake ind	Derm uptake outd	Inhal soil	Inhal ind*	Inhal outd	Plant ingestion	Perm* drinkw	Vapors shower*	Derm uptake shower*	Exposure air*
DDT	7.09	1.7%	0.0%	0.2%	0.0%	0.0%	0.0%	98.1%	0.0%	0.0%	0.0%	0.0%
DDE	3.89	1.0%	0.0%	0.1%	0.0%	0.0%	0.0%	99.0%	0.0%	0.0%	0.0%	0.0%
DDD	9.84	2.4%	0.0%	0.2%	0.0%	0.0%	0.0%	97.3%	0.0%	0.0%	0.0%	0.0%
a-HCH	23.20	2.8%	0.0%	0.2%	0.0%	0.0%	0.0%	96.9%	0.0%	0.0%	0.0%	0.0%
g-HCH	0.22	0.7%	0.0%	0.1%	0.0%	0.0%	0.0%	99.2%	0.0%	0.0%	0.0%	0.0%

Indicative estimation of the contribution (%) of consumption of eggs with a DDT concentration as reported in the supplementary material to the study by Dvorska and co-authors (2012).
In the study egg samples composed of 5 eggs from a village at 1.5 km and 2 km from the site were found to contain 16.7 µg/kg and 17.1 µg/kg DDT (o,p plus p,p isomers). For a child consuming 3 such eggs per week (corresponding to about 21 g per day) and assuming a body weight of a child of 15 kg, a daily intake of
(0.017 mg/kg*0.021 kg/d) / 15 kg = 0.00002 mg/kg can be calculated. Based on a MPR of 0.0005 mg/kgd, this daily intake of DDT corresponds to about 5 % of the MPR of DDT (using the MPR value from Baars et al (2001)).
It is noted that the number of egg samples is very low, so the concentrations measured might not be representative. Also, based on the current data given in this report and data from the study by Dvorska and co-authors there is no conclusive evidence for a causal relationship between the DDT in the egg samples and milk and cream samples taken at 1.5 km and at 2 km from the landfill site. Possible other sources (besides the landfill) of POP in the food items are household waste burning (as mentioned in the study), however it is also unclear whether DDT has been used on the sampling locations in the past or whether there is an elevated background concentration of POP pesticides in the area related to past use.

General remarks

It is difficult to estimate the contribution of food to the exposure of residents living at contaminated sites. Models often only calculate for a part of the food items (e.g. only vegetable and tuber crops as in CSOIL, see tables A9.3a and A9.3b) and often model calculations of food concentrations might be conservative resulting in an overestimation of the risks. Generally it is assumed that food, and especially animal products high in fat, are an important source of intake of POP pesticides. On contaminated sites, intake via food can be far more important than intake via direct contact to contaminated soil, especially if exposure occurs via different food items such as eggs and milk. Further data are needed for a better assessment of the importance of the contribution of different food items to total exposure. Also, the current data are not sufficient to establish a link between the landfill site in the current situation and the POP concentration reported for eggs, milk and cream.

The main focus of this risk assessment is to provide decision support for the definition of further steps to set up a site rehabilitation plan mitigating the environmental site risks posed by the Nubarashen Landfill site in the current situation. In this respect the focus of the risk assessment differs from studies such as the study by Dvorska and co-authors, as the risk assessments aims at supporting the determination of measures to be taken to improve the safety on the short term until further definition of outline and time planning of the rehabilitation plan for the site.

Soil Quality Criteria for Agricultural Use

Table A9.4 Canadian Soil Quality Guideline Values (GLV) for the Protection of Human Health and the Environment,
Guideline Values for Agricultural Use

Compound	Soil Quality GLV Agricultural Use mg/kg
(Total) DDT	0.7
Lindane	0.01

Literature used

- Advice of EU Scientific Committee regarding the evaluation of DDT (retrieved on 17 June 2013) http://www.favv.be/wetenschappelijkcomite/adviezen/_documents/ADVIES_AVIS01-2013_DossierSciCom2011-04_Anenx1_Fiche1.11_DDT_000.pdf
- Baars et al. (2001) Re-evaluation of human-toxicological maximum permissible risk levels. RIVM report nr. 711701025; National Institute for Public Health and the Environment, Bilthoven, The Netherlands
- Dvorska et al. (2012) Obsolete pesticide storage sites and their POP release into the environment-an Armenian case study. Environ Sci Pollut Res 19: 1944-1952 plus supplementary material
- Ritsema et al. (2006) Obsolete Pesticides in Armenia (Inception visit to Armenia) Milieukontakt International, Amsterdam / Tauw, Deventer, NL