

**Commentary
on the Ordinance of
1 July 1998 relating
to impacts on
the soil (OIS)**

2001



Swiss Agency for the Environment,
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Legal status of this publication

This publication is an implementation guide issued by SAEFL in its capacity as a supervisory authority, and is addressed primarily to the enforcement authorities. It seeks to clarify undefined legal concepts contained in the relevant Acts and ordinances so as to facilitate consistent enforcement practices. Authorities who give due consideration to these guides can safely assume that federal law is being correctly implemented. Alternative approaches are, however, permissible provided they comply with the legal requirements. Guides of this kind (also referred to as guidelines, guidance, recommendations, handbooks, enforcement aids, etc.) are published by SAEFL in the series entitled «Applying environmental law».

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Abbreviations

- CSO: Contaminated sites ordinance of 26 August 1998 (German: AltIV).
- EIA: Environmental Impact Assessment (German: UVP).
- FAL: Swiss Federal Research Station for Agroecology and Agriculture, *Agroscope* FAL-Reckenholz.
- LAg: Law on agriculture of 29 April 1998 (German: LwG).
- LFo: Law on forest of 4 October 1991 (German: WaG).
- LSP: Law on spatial planning of 22 June 1979 (German: RPG).
- LNN: Federal Law relating to the protection of nature and the national heritage (German: LHG).
- LPE: Federal Law relating to the protection of the environment of 7 October 1983 (German: USG).
- OAPC: Ordinance on air pollution control of 16 December 1985 (German: LRV).
- OFA: Swiss Federal Office for Agriculture (German: BLW).
- OFo: Ordinance on forest of 30 November 1992 (German: WaV).
- OIS: Ordinance relating to impacts on the soil of 1 July 1998 (German: VBBo).
- ORRChem: Ordinance on the reduction of the risks linked to the use of particularly dangerous substances, preparations and objects of 18 May 2005 (German: ChemRRV).
- SAEFL: Swiss Agency for the Environment, Forests and Landscape (German: BUWAL).

I Introduction

1 Purpose of this commentary

This commentary provides additional background information to facilitate implementation of the *Ordinance relating to impacts on the soil (OIS)*. It also serves the purpose of addressing recognised problems of enforcement and elaborating on these. In basing their actions on this commentary, the enforcement authorities may rest assured that they are lawfully implementing the OIS.

2 Principles

The commentary is based formally on Article 12 Paragraph 1 OIS, which obliges SAEFL to issue recommendations on implementation of the OIS. The content itself is based on the results of the formal consultations on the OIS, on scientific studies, and on previous practical experience of the Confederation and the cantons with soil protection issues. The commentary edited by *Prof. P. Tschannen* on Articles 33–35 LPE (*Law relating to protection of the environment of 7 October 1983*) was also drawn upon.

3 Brief history

- The first draft of the LPE of 1973 (*Schürmann* draft) placed high importance on soil protection. It contained provisions against chemical and physical impacts. However, this preliminary draft did not meet with general acceptance in the formal consultations.
- As a result, soil protection in the draft LPE of 1979 was restricted to various disconnected soil-relevant provisions concerning air pollution and substances hazardous to the environment.
- During the parliamentary consultations, the National Council added a new chapter on «Impact on the Soil», whose main purpose was to provide for precautionary protection of the soil against chemical contamination.
- The LPE provisions of 1983 were then spelt out in the *Ordinance relating to soil pollutants of 9 July 1986 (OSP)*.
- The preliminary draft of the revised LPE of 1990 proposed merely to extend Articles 33–35 LPE to include the protection of the soil against organisms hazardous to the environment.
- However, the reaction of numerous parties to the formal consultations, and particularly that of the cantons, provoked a fundamental reinforcement of soil protection in the LPE. In its Draft Amendment of 1993, the Federal Council proposed a major extension of soil protection law to include protection from physical impacts and the obligation to clean-up contaminated soils.
- This proposal – practically identical to the present LPE – was finally approved by parliament, and entered into force on 1 July 1997.
- A year later, the Federal Council issued the new *Ordinance relating to Impacts on the Soil of 1 July 1998 (OIS)*, in which the LPE amendments are implemented.
- The OIS entered into force on 1 October 1998.

II Initial position and objectives

1 Discussion of the term «soil protection»

Soil protection is taken to mean:

- protection of the soil from being sealed, i.e. overcovered (quantitative soil protection), and
- protection of unsealed, i.e. non-overcovered, soil from changes in its natural constitution (qualitative soil protection).

Quantitative soil protection is principally the concern of **spatial planning**, which is responsible for ensuring proper soil use and orderly settlement of the land. This dictates economical exploitation of the soil as required by the *Law on spatial planning of 22 June 1979* (Art. 1 Para. 1 LSP), in order to keep the loss of open space as low as possible. For forest areas, quantitative soil protection applies as specified in forest legislation (Art. 1 and 3 LFo – *Law on the forest of 4 October 1991*).

The purpose of **qualitative soil protection** is to ensure long-term preservation of soil fertility. This objective falls mainly within the ambit of environmental protection (Art.1 Para. 1 LPE). To maintain soil fertility, measures are required for the protection of the soil from harmful substances and organisms, and from excessive mechanical loads. Careful handling of excavated soil also comes within qualitative soil protection.

Furthermore, the Law relating to the Protection of Waters and the Agriculture Law also contain provisions on qualitative soil protection. For example, the *Law relating to the protection of waters* (Art. 27 LPW) requires that soils be worked in such a way that fertilisers and plant treatment products are not carried into surface waters. This requirement implies the need for measures against soil erosion.

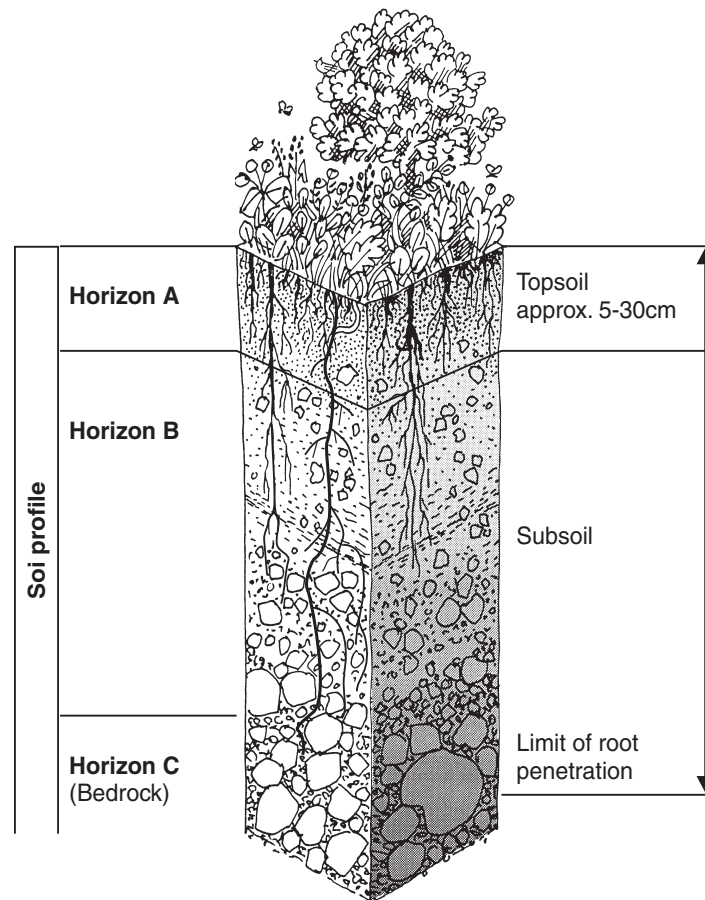
To take another example, the *Law on Agriculture of 28 April 1998* (LAg) requires agriculturists wishing to take advantage of direct payments (cross compliances) to submit a record showing compliance with ecological criteria («*ökologischer Leistungsnachweis*»). This must include «*suitable provision for soil protection*» (Art. 70 LAg). The law also regulates the handling of agricultural chemicals (Art. 158ff LAg).

2 Meaning of the term «soil» in the LPE

In soil science, soil is the upper weathered layer of the earth's crust, and is usually divided into three horizons A, B and C, formed in the course of time from the original bedrock under the influence of climate, surface profile and water, and as a result of animal, plant and human activity (cf. *fig. 1*).

The LPE restricts the term 'soil' to the «*topmost unsealed layer of the earth in which plants can grow*» (Art. 7 Para. 4^{bis} LPE). This so-called 'legal definition' follows from the defining clause of the LPE, whose purpose is to preserve the fertility of the soil. Only the topmost layers of the earth are biologically active and in fact fertile. The bedrock, i.e. the rocky substrate, does not come within the definition of soil as specified in the LPE.

Figure 1: Typical soil profile with root penetration.



The same applies to soils that have been built over, or covered with asphalt, concrete or other impermeable materials (sealed soils). The gas and water exchange in such soils is practically at a standstill – they have largely lost their capacity for filtering and decomposition, and no longer function as substrate and habitat for plants and soil organisms.

According to Article 33 Paragraph 2 LPE, physical soil impacts caused by «development uses» (construction etc. use) are therefore permissible from a soil protection standpoint. The term «development use» is, however, only applicable where the soil is permanently sealed. All undeveloped areas and non-sealed soils, and also soils associated with building development used temporarily for access or installations, come within the definition of soil protection in the LPE.

3 The Swiss soil protection strategy

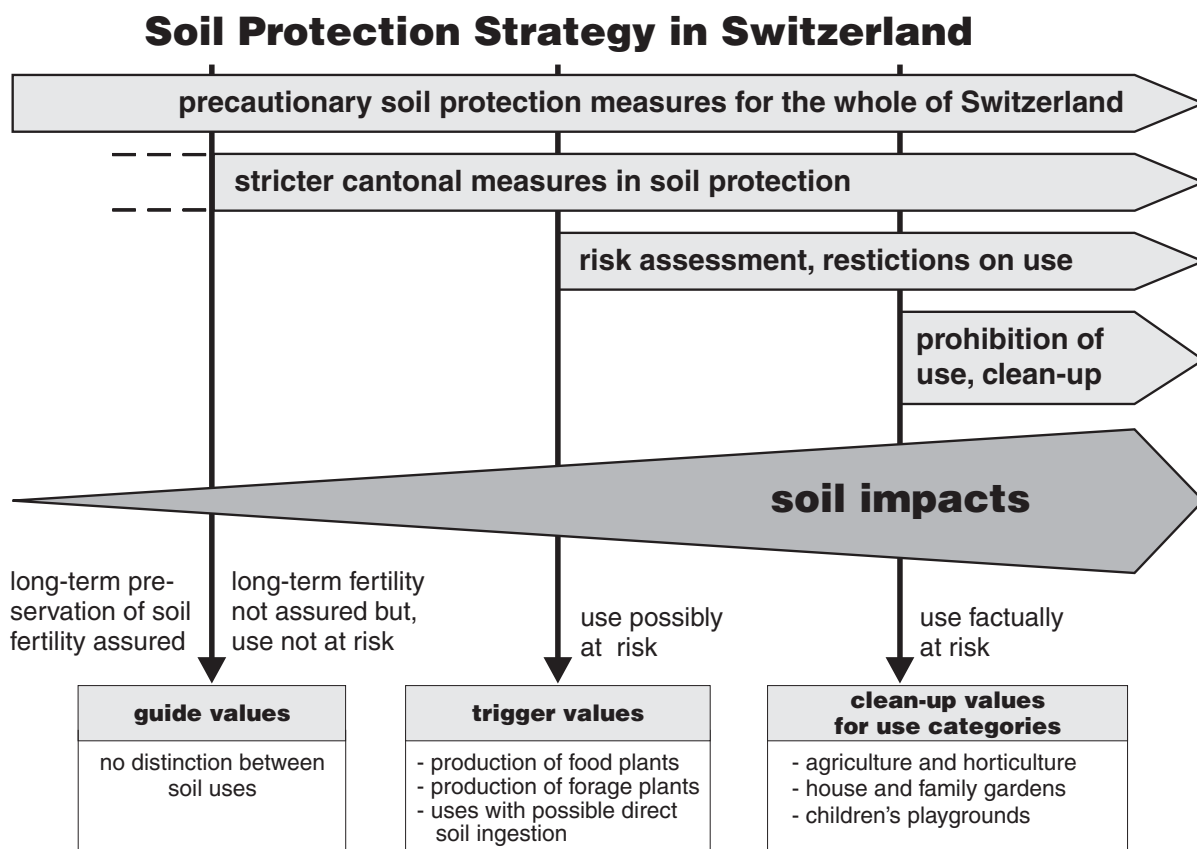
The soil protection strategy of the LPE and the OIS is shown in *figure 2*:

- Precautionary measures applied to the whole of Switzerland limit the input of hazardous substances and organisms to the soil. The Federal Council ordinances relating to waste water infiltration, soil-relevant environmentally hazardous substances (i.e. fertilisers, plant treatment products) and organisms, air pollutants (lead, PAH, acids) and hazardous wastes (e.g. contaminated excavation material), make it obligatory to provide for long-term preservation of

soil fertility (Art. 33 Para. 1 LPE). As, however, no general Federal ordinance exists to limit physical impacts on the soil, precautionary limitation of these is dealt with in the OIS itself (Art. 6 and 7 OIS).

- If in a particular area the precautionary measures should prove insufficient to ensure long-term soil fertility, i.e. to meet the so-called guide values, the cantons must take preventive action. As part of further-reaching measures for the area concerned, they may order emission control, or, alternatively, additional protection measures, to prevent further increase in chemical, physical or biological soil impacts (Art. 34 Para. 1 LPE). Together with the measures for the whole of Switzerland, the additional measures are intended to ensure the long-term preservation of the soil ecosystem and its essential functions in nature.

Figure 2: Swiss soil protection strategy.



- If the chemical impact on the soil exceeds the guide value, priority is given to protection of the health of humans, animals and plants. Here, a distinction is made between a **possible** hazard (trigger value exceeded) and a **factual** hazard (clean-up value exceeded). Contrary to the guide values, that apply to all soils and modes of exploitation, the trigger and clean-up values take account of the mode of use.
- The measures to be taken when the trigger and clean-up values are exceeded, i.e. risk assessment, restrictions on use, use prohibition or clean-up, are intended to provide protection from the hazards. On polluted soils, only those activities are permitted that can be performed without risk. For highly contaminated agricultural and horticultural soils, this is usually only possible following clean-up in the full sense (Art. 34 Para. 2 and 3 LPE).

- The implementation of this four-stage strategy requires ongoing, reliable, information on the impact situation of the soil. The Confederation and the cantons must therefore observe and monitor the soil regularly (Art. 44 LPE). The acquired data are also used to assess the performance of the measures prescribed.

III Comments on the articles of the ordinance

Article 1 Goal and scope definition

As already mentioned, the national measures for the protection of the soil in Switzerland against chemical and biological impacts derive from Federal regulations on air pollution control, substances hazardous to the environment, waste and organisms.

Further to this, the OIS specifies the procedures concerning observation, monitoring and evaluation of soil impacts. The OIS also specifies precautionary measures against persistent soil erosion and compaction and also the treatment of excavated soils. Finally, it specifies the measures to be taken at cantonal level where in certain areas soil impacts exceed the guide, trigger or clean-up values, so that soil fertility is no longer ensured in the long term, or when the soils concerned could represent a risk to humans, animals or plants.

The OIS is applicable to all soils in which plants may grow. Therefore, it is also applicable to stony and rocky ground, insofar as – albeit sparse – vegetation thrives, or may thrive, on it. The OIS deals with both naturally formed and artificially deposited or superimposed soils (so-called technogenic or anthropogenic soils).

However, sedimentation in surface waters is not included in the OIS. These belong to the aquatic ecosystems and are covered in water protection regulations. When dredged, they are dealt with under the provisions for wastes used as fertilisers or soil improvers.

The OIS is not applicable to soils that belong to an installation, and, when used for their intended purpose, are excluded from protection. Being part of the installation, they are no longer regarded as soils. Examples of these are playing fields of football stadiums, soils within firing ranges, moto-cross tracks, infiltration sites, clearly defined infiltration bands along roads, and regularly used official green parking lots at exhibition sites and for sporting events.

Article 2 Terminology

Paragraph 1: The definition of the term 'soil fertility' is very broad and goes well beyond productivity and yield in the agronomic sense:

- It pays due regard to the various functions of the soil (*let. a*);
- it includes agricultural and forestry use in appropriate ways (*let. b*), and
- accounts for direct and indirect (i.e. via plants) hazards arising from the soil (*let. c and d*).

Aggregate soil or soil in the form of dust particles may be taken up directly via the mouth, nose or skin, for example by children at playgrounds or by farm animals when grazing or on free range. *Letter d* was added to take account of this, and also to ensure that the activities concerned are free of risk.

Paragraph 2: The term 'chemical impact on the soil' also includes natural, e.g. geogenic, soil impacts. This is necessary since the health risk arising from soil pollution is assessed independently of its source. The OIS contains new impact values for organic pollutants arising artificially, or as by-products or waste in chemical processes. However, the pollutants may also arise naturally, for example from forest fires or volcanic eruptions. Impacts on the soil resulting from radioactive substances are not treated in the OIS. Pollution of this nature is dealt with in radiation protection and nuclear legislation (Art. 3 LPE).

Paragraph 3: Biological impacts on the soil are detrimental changes in soil life caused by non-pathogenic, pathogenic or genetically modified organisms being introduced or released to the soil and that are foreign to the site. Phytomedical impacts caused by pests that live in the soil and from there damage plants directly (e.g. nematodes), do not fall under biological impacts. The object of protection against biological soil impacts is to preserve the biological diversity and activity of the living soil communities typical of the site as laid down in Article 2 Paragraph 1 OIS. A definition of the term was deemed necessary, as this had already been used in Article 33 LPE, and also as a cross-reference to the *Ordinance on pollutant release (SFV) of 25 August 1999*, whose purpose is to ensure the protection of the soil from undesired organisms. At present, it is not possible to specify the precise form this protection should take. The provisions concerning quarantine in the *Ordinance relating to plant protection (SR 916.20) of 5 March 1962* are intended to help prevent the introduction of foreign plant pests via plant imports.

Paragraph 4: Physical impacts are detrimental changes in soil structure, constitution and thickness caused directly or indirectly by human activity. They may be manifested as erosion (soil denudation and transport of loose soil by water and wind), compaction (mechanical structure of soil cavities and destruction of soil aggregates), mixing of soil strata (changes in the natural structure of the soil, e.g. in building excavation) and soil mineralisation (loss of soil through mineralisation of organic soils following drainage).

Natural erosion of non-cultivated soils, debris flows and landslides, are not physical impacts in the sense employed in the OIS, provided these are not attributable to improper soil management (e.g. overgrazing by sheep).

Paragraph 5: The guide and clean-up values used in the OIS are defined in law in Article 35 LPE:

- **Guide values** serve prevention purposes and provide a means of assessing the long-term fertility of the soil. Their protection objective therefore includes the soil ecosystem as a whole.
- **Clean-up values** serve hazard protection purposes and are a measure of an existing risk to humans, farm animals and crops.
- **Trigger values:** these values introduced in accordance with Article 39 Paragraph 1 LPE represent the threshold to a possible danger of this kind. Under certain circumstances it is possible that even for impacts below the clean-up values, a danger to health may exist. When trigger values are exceeded, the cantons are obliged to assess whether a concrete hazard exists. This does not, however, lead to any direct protection measures (e.g. restrictions on use). Direct protection measures only become necessary if the investigation confirms the suspected hazard

in a particular case. The existence of trigger values in no way compromises the effectiveness of precautionary soil protection policy (i.e. 'undermining' of guide values).

Articles 3 and 4 Observation and monitoring of impacts on the soil

The observation and monitoring of impacts on the soil is essential for effective soil protection, and is the joint responsibility of the Confederation and the cantons.

The *National Soil Monitoring Network* (**Nationales Bodenbeobachtungsnetz – NABO**; cf. Art. 3 Para. 1 OIS), which is maintained by the **Confederation**, at present has 105 monitoring sites representative of different uses and soil types. The NABO network is designed for long-term observations, and is concerned with 'normal' impacts on the soil in Switzerland. NABO has been in operation since 1984. It is operated jointly by SAEFL and the Swiss Federal Office for Agriculture (SFOA). At present, only chemical parameters for which guide and trigger values are contained in the OIS are measured. The OIS is formulated so that, if necessary, NABO can be extended to include physical and biological data. Research is currently in progress to clarify this question.

The NABO results are expanded and pursued in more detail by the **cantons**, based on investigations of soils with established or anticipated higher impact, and on investigations involving local or regional characteristics or special problems of soil science, or politically sensitive questions. Particularly for heavily polluted soils ('hot spots'), that require emission limitation and risk prevention measures to be ordered, it is not sufficient for the cantons to merely perform occasional observations. They must monitor these impacts (Art. 4 Para. 1 OIS) in order to establish their effects and determine the efficacy of protection measures.

In order to ensure national comparability of the results of all soil investigations, NABO also sets up methodological procedures. Regular comparisons between the results of different soil laboratories are made to ensure adequate data quality.

Since the network density of NABO does not permit assessments to be made for the whole country, separate investigations are carried out to enable the impacts of particular emission sources (e.g. traffic) and particular pollutants (e.g. copper) to be determined on a nation-wide scale. To provide forecasts and early warning of hazardous soil impacts, and also to permit more precise interpretation of measured data, certain NABO sites also carry out material flow investigations.

The *Ordinance relating to impacts on the soil* obliges SAEFL and the cantons to mutually inform each other of the results. As the matter is also of public interest, the results must be published, and thereby made generally available. SAEFL is also responsible for providing information to other Federal authorities and to interested parties abroad (Art. 3 Para. 2 and 4 Para. 3 OIS).

The published data must be accompanied by a commentary to ensure that they are correctly understood and interpreted. All results concerning soil impacts over larger areas are published without reference to property ownership. The authorities are not obliged to provide private persons with unpublished measured data. These remain confidential until publication. On request, the authorities may provide owners with information on the pollution situation of their property. For other interested parties, the measured data may only be provided in general form without reference to property ownership (cf. *Commentary*, N 18 LPE on Art. 35).

In Article 4 Paragraph 2 OIS, SAEFL and SFOA (together with their research institutes) are required to provide the cantons with methods for monitoring soil impacts. In the coming years, the emphasis here will be on measurement of organic pollutants and persistent compaction. Following the present reorganisation of agricultural research in Switzerland, Agroscope FAL in Reckenholz near Zürich will become the competency centre for chemical and physical soil impacts.

Article 5 Assessment of impacts on the soil

Paragraph 1: Soil impacts are assessed by the competent authorities. In doing so, they are aided by the guide, trigger and clean-up values for chemical soil impacts, and the guide values for erosion on cultivated land (Annexes 1–3 OIS).

Guide, trigger and clean-up values apply in principle to the entire depth of soil penetrable by roots, although for methodological reasons they are mostly based on a soil sample taken from the topmost 5 or 20 cm of the soil.

Impact values are only specified for substances that are not, or only slightly, degradable and which therefore accumulate in the soil, and for which previous experience shows that they do, in fact, lead to problems of soil contamination. The substances in question enter the food chain via plants, are directly ingested, weaken soil organisms, diminish agricultural yields, or may cause detrimental changes in soil structure.

For this reason, guide, trigger and clean-up values have not been defined for phosphorus and nitrate. Neither of these are hazardous to the soil. The problems caused by the impact of these substances on ground and surface waters are covered in water protection legislation.

Guide values are only defined for substances relevant to the whole of Switzerland for which emission limitation measures may be ordered under Article 8 Paragraph 3 OIS. A guide value for arsenic, for example, would make little sense, since the use of arsenic is prohibited in all soil-relevant products in Switzerland. For the same reason, it was decided not to introduce a guide value for polychlorinated biphenyls (PCB).

Paragraph 2: It is not possible to specify guide values for all of the impacts that may adversely affect the soil. In the absence of guide values, individual cases are assessed on the basis of the legal definition of soil fertility (Art. 2 OIS) to determine whether long-term soil fertility is assured. To do this, the effects on the various characteristics and mechanisms in the soil must be investigated (cf. *Wegleitung Bodenfruchtbarkeit*, 1991).

Paragraph 3: Where trigger and clean-up values for particular uses and substances are not specified, an assessment must nevertheless be made of whether the impact may threaten human, animal or plant health. In such cases, no legal definition is available in Article 2 Paragraph 1 OIS. The method for deriving the existing trigger and clean-up values has, however, been published in the Environment Materials series of SAEFL in clearly comprehensible form (EM-Soil nos. 83 and 96). Because of the complexity of the subject, SAEFL is also obliged to provide consultation to the cantons. This partly takes the form of implementation guides, and partly of financial support for appropriate research projects.

Section 3 Prevention of persistent soil compaction and erosion; handling of excavated soil

General Remarks

In the OIS, three principal methods of physical soil protection are treated, namely:

- protection of soil from compaction, i.e. from changes in soil structure resulting from high compression and shear stresses that are transmitted to the soil by machines or vehicles (Art. 6 Para. 1 OIS);
- prevention of erosion, i.e. loss of soil through transport of soil particles at the surface (Art. 6 Para. 2 OIS), and
- protection of the soil from degradation caused by transport processes, dumping and reutilization of soil material in connection with mining operations and building sites (Art. 7 OIS).

Soil mineralisation, for example in the case of half-bog soils, is not mentioned in the OIS. Intact moorland soils are, however, adequately protected by the *Federal Law relating to the protection of nature and the national heritage* (Art. 23a–23d LNN), while the regeneration of moorland soils is not possible, since no practical measures for remediating soil mineralisation are available.

Here again, the protection objective is the long-term maintenance of the multifunctionality of the soil according to Article 2 OIS. The specific protection objective depends on conditions at the particular site, and must be defined on a case-by-case basis.

According to Article 33 Paragraph 2 LPE, only persistent, i.e. permanent, detriment to the structure and thickness of the soil must be considered. Erosion processes must be considered as persistent, i.e. as detrimental, if the annual depletion rate lies consistently (i.e. over several years in succession) above the guide values specified in Annex 3 OIS. In this case, the long-term fertility of the soil is no longer assured. In the same way, landslides on steep mountain slopes resulting from improper husbandry must be qualified as detrimental erosion.

In the case of soil compaction, it is more difficult to establish threshold values, since the effect that mechanical and physical pressure have on the soil at a particular site depends on soil structure (soil type, granulation, etc.), and on its condition (humidity, vegetation, precompaction, etc.) at any given time. Furthermore, the soil also has a certain – albeit limited – capacity for regeneration over time. Practical experience shows that persistent compaction is detrimental in the sense adopted in the LPE if its effects are still detectable after 5–7 years, i.e. if the soil – despite initial technical intervention (e.g. palliative tending) – is not naturally regenerated. This is particularly the case where the subsoil has been compacted.

At present, however, there are no generally accepted, practically applicable, methods or indicators that could be cast in the form of standards to cover the measurement and assessment of persistent soil compaction. Scientific studies are now underway to clarify these questions.

In principle, it should be possible to avoid irreversible physical impacts on the soil by good agricultural practice, as defined, for example, in the *Agriculture Law of 29 April 1998* for integrated production and organic agriculture. For this, however, the provisions covering compliance with ecological criteria must be enforced separately for each private plot (inspection and, if necessary, penalties for non-compliance), and agricultural practice must be periodically revised to account for new developments, e.g. by designing new types of farm machinery.

Also, in the case of physical soil protection, 'repairs' are only possible to a limited degree. Because scientific knowledge is as yet incomplete, efforts must be directed – as mentioned in the title of this chapter – particularly to **preventing** adverse effects.

Article 6 Prevention of soil compaction and erosion

Paragraph 1 applies to all activities leading to persistent compaction or to other permanent changes in soil structure (e.g. disruption of soil stratification). The rider in Article 33 Paragraph 2 LPE to the effect that the provisions covering physical soil protection do not apply to «use of the soil for building purposes», does not compromise this in any way. It merely states that the soil on which a building stands is not addressed by the provisions, since by definition these only concern non-sealed soils penetrable by roots (Art. 7 Para. 4^{bis} LPE). That is to say, the ground beneath a building is excluded from soil protection. Building access areas and temporary building installations, both within and outside of building zones, are, however, subject to the OIS.

Furthermore, the cantons are obliged to take measures to avoid detriment to the forest by reducing physical impacts on forest soils (Art. 28, Lett. d, *Ordinance on Forests, OFo*).

At many places, cultivated topsoils suffer to a greater or lesser extent from compaction as a result of previous agricultural methods, and may display a ploughpan. It would be a mistake to assume from this that these soils are capable of withstanding machines having greater wheel pressure than are used on comparable, non-compacted, soils. This would be equivalent to assuming that it is permissible to push existing impacts to the limit, thereby contradicting the prevention objective of soil protection. Thus all pedologically comparable soils must be treated in the same way as far as protection from physical impacts is concerned.

Paragraph 2: Although Annex 3 OIS only contains guide values for the erosion of cultivated areas, Paragraph 2 also applies to other soil uses that cause erosion, for example grading of ski slopes. Here, too, the principle of «*the shallower the soil, the lower the tolerable depletion ...*» applies.

Soil erosion and compaction may occur as a result of agricultural land improvement schemes where too little attention has been paid to soil protection, and subsequently if the soil is inappropriately managed. Where inappropriate management is identified, and the problem cannot be remedied by measures applied to individual enterprises, consultative solutions should be sought at regional level. Where necessary, these must be ordered by the canton. This applies particularly to the problem of so-called linear erosion. Linear erosion denotes erosion of cultivated soils by concentrated run-off of surface water.

Article 7 Management of excavated soil

Soil material in the horizons A and B is far from being an amorphous, or lifeless, material. On the contrary, it is structured, ventilated and teeming with life. It is these properties that permit the soil to fulfil its function in nature and are responsible for its fertility.

Although it is true to say that all development irreversibly disrupts the natural structure of the soil, the damage caused may be limited by managing the excavated material in a careful and knowledgeable manner, so that – following recultivation – the soil largely regains its earlier functional capabilities.

Paragraph 1 formulates a general duty of care in the management of excavated soil (= excavation of horizons A and B – contrary to mineral excavation material, mine overburdens or quarry wastes). The obligation applies whether or not the soil is reused. The duty of care ensures that healthy soil is not discarded on the grounds that it will in any case not be used. Paragraph 1 expresses the objective of soil protection, i.e. to reuse excavated soil as far as possible (also cf. Art. 30 Para. 2 LPE).

Paragraph 2 contains two special provisions relevant to reuse. *Letter a* relates to recultivation – e.g. of a building or material excavation site following intervention – and also to the procedure to be adopted when excavated material is used remote from the point of extraction – e.g. when remodelling terrain. The procedures comprise – among others – reinstatement of natural stratification, the use of low-impact machines, and appropriate subsequent cultivation. Here, «short-term» refers to a period of approx. 3–5 years.

The intention of *letter b* is to prevent soil from being freshly or additionally contaminated by the addition of contaminated excavated material. Since – on superficial inspection – chemical soil pollution is hardly detectable as such, there is a real danger of contaminated material being applied, and thereby new contamination caused – e.g. in the case of new garden or park areas, remodelling of agricultural terrain, or recultivation. This may occur unwontedly or intentionally in order to avoid disposal fees. In practice (in cases of doubt), it is therefore essential to determine the pollutant content of the soil to be excavated, and – to enable the soil in question to be properly reused or dumped – to notify the recipient and the soil protection authority accordingly. In reusing contaminated excavated material, prohibition of dilution according to Article 9 TVA applies. It is not permissible to artificially reduce the pollutant content of the excavated material by mixing it with unpolluted or less polluted soil.

The principles enumerated in Article 7 are implemented in several implementation guides. Examples of these at the national level are the handbook «*Bodenschutz beim Bauen*» (1996; «Soil protection in construction projects») and the «*Verwertung von ausgehobenem Boden*» guideline (2000; «Use of excavated soils»). A number of cantons also provide guidance. Of particular importance are the recultivation guidelines of the *Swiss Association for Sand and Gravel (ASG)* and the three new SN «*Erdbau, Boden*» standards (SN 640 581 a, SN 640 582 and SN 640 583 1999/2000). The standards were prepared in collaboration with the *Association of Swiss Road and Traffic Engineers (VSS)* on the basis of Article 12 Paragraph 2 OIS. These implement the premises of Articles 6 and 7 OIS in a form directly relevant to the building industry and – this makes them particularly valuable – are normally cited in the general conditions of building contracts.

Section 4 Further measures for contaminated soils

The national measures for the protection of the soil in the areas of air pollution control, substances hazardous to the environment, waste water filtration, waste etc., are based on soils that are, at most, only lightly contaminated. The heavy metal exposure limits in the *Ordinance on air pollution control of 16 December 1985 (OAPC)*, or the quantity limits on the use of sewage sludge in the ORRChem, cannot of course be applied to soils that are already more heavily contaminated. The LPE therefore stipulates more extensive, specific, local and situation-dependent measures to be applied by the cantons.

The more extensive measures are intended to prevent an increase in soil contamination that would cause detriment to soil fertility, and – where contamination has already occurred – at least to ensure that humans, animals and plants are not placed at risk from contaminated soils.

The more extensive measures fall into three stages (cf. *fig. 2*):

- measures where the guide values have already been exceeded or where there has been a marked increase in impact caused by pollutants and soil erosion, with and without guide values (Art. 8 OIS);
- measures to avoid risk when the trigger values have been exceeded where a danger to the health of humans, animals and plants may exist (Art. 9 OIS), and
- measures to avoid risk where the clean-up values have been exceeded and there is a demonstrable threat to the health of humans, animals and plants (Art. 10 OIS).

In Article 8 OIS, the soil is treated as victim to exterior influences, whereas in Articles 9 and 10 it is treated as a cause. Correspondingly, the protection object shifts, i.e. from soil fertility in Article 8, to the health of humans, animals and plants in Articles 9 and 10. As far as animals and plants are concerned, the emphasis is on higher animals and plants, that is to say, on farm animals and agricultural crops.

Article 8 Cantonal measures where guide values are exceeded

Should federal, cantonal or private soil investigations indicate that, in a particular area, one or more guide values have been attained or exceeded, and that long-term soil fertility is therefore no longer ensured, the cantons are obliged to take action. They must also take action if it is apparent that although soil impact is – as yet – within the guide values, the rise is sufficiently rapid to cause the guide values – in the absence of avoiding action – to be exceeded within a foreseeable period, thereby posing a threat to long-term fertility. The procedure to be adopted by the cantons is divided into several stages:

Paragraph 1: As an initial step, the cantons must determine the area of impact as precisely as possible, if necessary by means of further investigations. They must then determine the source of the soil-contaminating pollutants. This must be done because the obligation to take more extensive measures may only be placed on those natural or legal persons – either as individuals or in conjunction with other sources – to whom the increased impact may be attributed.

Paragraph 2: If the cause of the impact is known, the cantons must establish whether consistent execution of the preventive measures under Federal law in the areas of waste, air pollution control, environmentally hazardous substances, etc., would be sufficient to prevent the further rise in impact within reasonable time, that is to say, within about five years. In particular, they must check that the currently valid provisions are in fact being complied with by all emitting parties. They must also assess to what extent any pending remediations of emitting plant could help to reduce pollutant input to the soil. Should an enforcement backlog exist in connection with the Swiss national precautionary soil protection measures, it is not permissible for the cantons to compensate for this by taking more extensive measures in the area concerned.

Paragraph 3: If the cantonal investigations show that the normal measures under Federal law are insufficient to ensure long-term protection of soil fertility in a particular area, the cantons must take more extensive soil protection measures under Article 34 Paragraph 1 LPE. These involve tightening the national soil protection measures directed against emitting sources that are to be

closed down. Cantonal competency is, however, limited in this respect to the following areas enumerated definitively in Article 34 Paragraph 1: namely waste water filtration, use of substances and organisms, emission limitation in respect of installations, and physical soil impacts. The provisions concerning the remaining areas relevant to soil protection referred to in Article 33 Paragraph 1 LPE, such as disaster control, requirements for substances and organisms, and waste and incentive taxes, may not therefore be tightened by the cantons. The competency for this rests with the Confederation.

Furthermore, Paragraph 3 requires the measures to be prescribed only to the **necessary degree**, i.e. in reasonable measure, that is:

- The measure must make at least a significant contribution to emission control.
- While it must not go beyond what is necessary, it must not fall short of this.
- It must be in reasonable relation to the central aim of long-term preservation of soil fertility, whereby what is 'reasonable' must **not** be decided on the basis of technical or operational considerations or economic acceptability.

The more extensive measures of the cantons comprise, among others:

- more stringent requirements for waste water infiltration (e.g. prohibition of infiltration, pre-treatment of waste water);
- stringent emission limitations going beyond those of the OAPC for installations;
- restrictions on local **use** for substances such as insecticides, fertilisers, sewage sludge and compost, insofar as these contain soil pollutants;
- more stringent soil management measures to prevent further physical impacts.

The obligation to notify SAEFL still contained in Article 8 Paragraph 3 OIS must be taken in conjunction with Article 11 OIS. Here, it is quite conceivable that the local soil impact concerned may point to a national soil protection problem that could more effectively be dealt with by tightening Federal regulations than by local cantonal measures.

Paragraph 4: In general, soil impacts are not reversible. While the objective of avoiding such impacts by precautionary measures remains, quick action must be taken in cases where an unacceptable level of soil contamination is identified. For this, a relatively short period of 5 years is provided for in the OIS.

Article 9 Cantonal measures where trigger values are exceeded

The OIS contains trigger values for the use categories of food and fodder plant cultivation, and for uses with possible direct, i.e. oral, inhalative or dermal, soil uptake. These three use categories represent the principal potentially hazardous, causative, paths to the objects of protection, i.e. humans, animals and plants. Although reduced growth rate is an indicator of impaired plant health, no trigger values have been specified for this. If such a trigger value were not met, agriculturists would automatically take the necessary actions, so that restrictions on use are in fact superfluous.

A further potentially hazardous causative path is the transport of pollutants to groundwater. In general, however, this is covered by the *Water Protection Law of 24 January 1991* and, for contaminated sites, by the *Contaminated sites ordinance*.

Paragraph 1: If one or more trigger values are exceeded in a particular area, the possibility cannot be excluded that persons playing, working or following sporting activities, animals grazing, or plants growing there, may be at risk from direct uptake of contaminated particles or pollutants from soil solution.

The LPE requires that all protection measures ordered be based on proof of a definite risk, so that when trigger values are exceeded, the cantons must analyse and evaluate the hazardous circumstances on a case-by-case basis. For this, SAEFL provides support to the cantons via consultation and scientific documentation.

If the investigations show that no definite risk exists, current soil use may be maintained. However, according to Article 4 OIS, the sites concerned must be intensively monitored, since when use or soil conditions change, the hazardous circumstances may alter.

Paragraph 2: Where the investigation confirms a definite risk in a particular case, the cantons must restrict use to the necessary extent. The type of measures adopted depends on the individual case. This may range from recommendations and restrictions to prohibition of use as strictest measure. Where the risk is low, the emphasis is on recommendations for use. For medium risk, restrictions on use must be ordered. Where the risk is large, and no other suitable means are available to avoid it, use must be prohibited.

Recommendations on use may, for example, comprise advice on suitable handling of fertilisers, and information to agriculturists on the accumulation behaviour of plants in regard to soil pollutants. The recommendations are made directly to those concerned, for example in the form of information brochures.

Restrictions on use comprise measures ordered by the authorities, such as restrictions on the cultivation of food and fodder plants with low pollutant accumulation potential. Use prohibition permits no leeway for alternatives. Typical examples are prohibition of access (e.g. to playground areas), and prohibition of grazing, harvesting and selling. Use restrictions and prohibitions are served in the form of official orders.

A further means of risk prevention is redesignation to other uses in spatial planning. Thus, for example, a cultivated area can be redesignated as an open area. Redesignation requires the collaboration of the spatial planning authorities.

The LPE contains no actual obligation to clean-up the soil, i.e. to reinstate soil fertility. That is to say, the enforcement authority has no power to order clean-up.

The object of all restrictions and changes of use is the avoidance of risk. It is possible that restrictions on use under Article 34 Paragraph 2 LPE may lead to financial loss on the part of property owners or leaseholders. This applies especially to horticultural, forestry and agricultural uses. However, the commune is not subject to any **liability to recompensate** for the expropriation of property rights, since use restrictions of this nature represent a legal curtailment of property rights directed against the causing party with the object of avoiding an overt risk to public health (risk to humans, animals and plants). The restrictions on use spell out an existing legal prohibition to this effect (Art. 34 Para. 2 LPE). To obtain compensation for loss of yield, property owners or leaseholders of contaminated soils may file a complaint against the party causing the soil contamination – e.g. against the owner of an emitting installation – on the basis of private liability law (e.g. Art. 41 *Swiss code of obligations*, Art. 679 *Swiss civil code*, or the newly introduced Art. 59a LPE).

Article 10 Cantonal measures where clean-up values are exceeded

Clean-up values are designed as absolute limits. If the impact lies above these, current soil use is regarded as a hazard to health, whatever the circumstances. Contrary to the trigger values, further investigation of potential risk is therefore unnecessary. This is because the clean-up values are set so high that the risk cannot be avoided by changing to a less sensitive form of use. The clean-up values are therefore specified for use categories that include the relevant forms of use.

Where the clean-up values are exceeded in an individual case, or when no clean-up values have been specified, the cantons are obliged to take counteractive measures without delay if the assessment points to an unavoidable risk to health. Despite the fact that the OIS – contrary to non-compliance with guide values – does not specify remediation periods when trigger and clean-up values are exceeded, the principles of police law dictate immediate and effective action in cases of an acute danger to health. Apart from that, impacts of this nature must be removed for ethical reasons in regard to future generations. But – happily – there is good reason to assume that the extent of such highly contaminated soils in Switzerland is relatively small. Where these occur, they will mostly be found to concern locally restricted contaminated sites.

Paragraph 1: As an immediate measure, the cantons must prohibit the use for which the clean-up value is exceeded. As already mentioned, the change to another form of use within the use category concerned (e.g. from food to fodder production) is unacceptable. Prohibitions are normally served in the form of an order.

Paragraph 2 details Article 34 Paragraph 3 LPE, which specifies a legal obligation to clean-up highly contaminated soils that are to be used for agricultural, horticultural or forestry purposes and that support a main or secondary livelihood, in accordance with zonal designation under spatial planning. By making this provision, parliament has in effect reinforced spatial planning law, whose objective is to ensure an adequate basis of food production for humans and animals by the protection of crop rotation areas. It is clear from this that the obligation to clean-up only applies to soils that are used commercially for agricultural, horticultural or forestry purposes.

For **house and family gardens** used in leisure time, there is no legal obligation to clean-up under soil protection legislation. This also applies to other highly contaminated soils assigned to other uses in land use planning, e.g. children's playgrounds or park areas. In such cases, the cantons must confine themselves to prohibition of the uses involving risk to health. Alternatively, they may of course assign such soils to completely different uses, e.g. building, if the risk to health may thereby be avoided.

Vineyards in which plant protection agents containing copper have been used for many decades, are exempted from the obligation to clean-up. Although the clean-up value for copper, particularly in long-standing vineyards, may well be exceeded at some points, as long as these continue to be planted with grapevines, no risk to the health of humans, animals and plants is to be expected according to current knowledge, and no remediation need be carried out. If such vineyards are reassigned to other purposes, their exemption is no longer justified, and the situation must be reassessed.

No clean-up values have been specified for **forest soils**, since no practicable remediation methods are at present known. Protection measures can nevertheless be prescribed for highly contaminated forest soils, e.g. for those within 300 m of firing ranges (whose bullet stops are

often located at the forest fringe), if the case assessment according to Article 5 Paragraph 3 OIS indicates a risk to the health of humans, animals or plants.

The objective of clean-up highly contaminated soils is solely to avoid risk. Those obliged to clean-up can therefore not be required to reinstate the unreserved fertility of the soil, i.e. to clean-up it beyond guide value niveau. In the course of remediation, soil contamination must, however, be reduced **at least** as far below the niveau of the clean-up values as is necessary to accord with the intended soil use, this being assumed to be characteristic of the site. However, clean-up below trigger value niveau is recommended from the start, since the authorities are otherwise obliged to carry out a case assessment under Article 9 Paragraph 1 OIS. If evidence of a definite risk were then to exist, this would entail restriction of use, which can hardly be the objective of a time-consuming and expensive clean-up.

The objective of clean-up is to reinstate the previous horticultural, agricultural and forestry exploitation **characteristics of the site**. The proviso of exploitation being characteristic of the site is intended to avoid the situation arising of future exploitation only being possible with the aid of excessive quantities of artificial production materials, by recourse to plants that are particularly tolerant to pollutants, or to exotic plants foreign to the site.

Overcovering of contaminated soils with uncontaminated earth is not a clean-up measure under soil protection legislation. For one, the guide, trigger and clean-up values are applicable to the entire depth of soil penetrable by roots, and for another, this method does not constitute a genuine solution. Although by this means a potential risk to health may temporarily be avoided, in time the pollutants will appear again at the surface (for example as a result of agricultural or building activities, or working of the soil by worms), resulting in renewed soil protection problems. It should further be mentioned that the obligation to clean-up does not cease should the owner refrain from using the contaminated property for agricultural or horticultural purposes. The soil *must* be cleaned-up if the clean-up value is exceeded, or, where no clean-up value is specified, if the risk has been established and the property is designated for agricultural or horticultural use in spatial planning. Thus – for example – the manager of a landfill lying in a designated agricultural zone is not permitted to cover this with heavily contaminated soil in anticipation of its use being prohibited. This would contradict the intention of parliament stated in Article 34 Paragraph 2 LPE to ensure an adequate basis of food production.

Article 11 Reinforcement of Federal provisions

It is possible that the more extensive cantonal measures stipulated in Article 8 Paragraph 3 OIS could prove insufficient to preserve soil fertility in the areas concerned, so that reinforcement of those soil protection provisions lying in the sole competency of the Confederation becomes necessary. Examples are the specification of threshold exposure values for air pollution, and requirements on the constitution of substances and products intended for application to the soil (e.g. sewage sludge and compost as fertilisers).

In combination with the obligation to notify in Article 8 Paragraph 3, Article 11 signals the Confederation's desire to achieve the best possible solution to the soil question. It is certainly not its intention to interfere in the enforcement prerogative of the cantons.

Article 12 Recommendations of the Confederation

The OIS was conceived as a lean and flexible instrument. It lays down the basic principles, and where necessary, these are complemented by guides, handbooks, standards, memoranda, etc., and implemented on the basis of voluntary agreements. The value of the pragmatic approach has been demonstrated time and again in the course of implementation in the cantons. Implementation guides are much more readily accepted if those concerned have the opportunity to bring their professional knowledge and reservations to bear in the preparation of the document. In distributing this to their professional associates, they may also draw attention to the contribution they have made to soil protection. In fact, for precautionary soil protection to be successful, a procedure along these or similar lines is essential, since this is not possible by measures applied to the soil itself. Rather, it depends on the understanding and actions of all those responsible for causing, or – as the case may be – restricting, soil impacts. In preparing implementation guides, those responsible for soil protection are therefore well advised to enlist the cooperation of all relevant organisations, namely: agriculture, the building industry, the communes, the military services, the gas industry, the rifle association, traffic bodies, and the authorities responsible for air pollution control, water protection, spatial planning, nature and landscape protection, and regulations on hazardous substances and contaminated sites, and also the waste organisations.

IV Annexes in the OIS

1 Analytical methods

To assess soil impacts on the basis of guide, trigger and clean-up values, these must first be determined using recognised analytical methods. The values for **inorganic pollutants** have already been determined and validated, and have been in use since 1986. To ensure comparability of the results and for reasons of continuity, the previous analytical methodology has therefore been retained for these pollutants.

The «*Wegleitung für die Probenahme und Analyse von Schadstoffen im Boden*» of February 1987 (guideline for sampling and analysis of hazardous substances in soils) is at present being completely revised. Only the sections concerning sampling and sample preparation will be retained in the new version. A completely new section will be devoted to the subject of sampling on highly contaminated sites. Concerning analysis, reference is made to the agricultural research institutes' *book of methods* («*Methodenbuch*»; cf. Literature).

For **inorganic pollutants**, the OIS differentiates between guide values for total content and those for soluble content. The total content specifies the sum of the naturally occurring (geogenic) pollutants and the pollutants input during exploitation and from deposition, that are extracted from the solvent. The soluble content represents the concentration in a neutral salt solution (0.1 M NaNO₃) that is available to plants and microorganisms. For total content, the OIS stipulates nitric acid (2 M HNO₃) as solvent, whereas other European states use aqua regia (HCl/HNO₃). No practicable methods of conversion between the two are at present available. Although the different extraction methods make it difficult to compare the results with those obtained abroad, the OIS at least ensures a consistent method within the country, so that this is not a disadvantage where Switzerland is concerned.

For **organic pollutants**, no generally valid standard method is prescribed. To do so would be to pay too little respect to developments in organochemical analysis. The principal methods for the extraction and analysis of dioxins, furans, PAH and PCB, optimised in respect of effort required and detection sensitivity, are chosen, and the papers published. As far as possible, internationally harmonised and generally accepted methods are selected (e.g. ISO standard).

Because of the legal connotations of the guide, trigger and clean-up values, comparability of the analytical results of the various laboratories is essential. This can only be achieved by periodical comparison of laboratory results. Agroscope FAL has therefore instituted a program of interlaboratory tests for interested laboratories within NABO, and prepares a publicly available laboratory list on a yearly basis. Additionally, SAEFL has published a special quality assurance procedure for the analysis of organic pollutants in its «Vollzug Umwelt» series.

2 Sampling depths

To ensure comparability of the measurement data in space and time, a universal sampling depth of 20 cm is applied both for inorganic and organic pollutants. Excepted are uses with possible direct soil uptake and for children's playgrounds, for which a sampling depth of 0–5 cm is specified. In such cases, a sampling depth of 20 cm would not mirror the health risk correctly, since this results from a high pollutant concentration at the surface.

In justified cases, the sampling depths specified in the tables in Annexes 1 and 2 OIS may be deviated from – for example if mop-up samples are taken to assess the existence of an acute risk to health at the soil surface, or if contaminated material is present at a lower level as a result of previous disturbance of the soil strata. The guide, trigger and clean-up values then apply at the new depths.

3 Annex 1: Guide, trigger and clean-up values for inorganic pollutants

31 *Introductory remarks*

The general level of pollution of soils with heavy metals and fluoride in Switzerland was elucidated for the first time in detail in the NABO general report of June 1993. The results of research over the last 10 years are also available. Based on this information, the previous guide values for heavy metals and fluoride used as precautionary values underwent a critical assessment. As mentioned above, the guide values are fixed so that critical uses still remain possible on sensitive soils, and, in case of non-compliance with the guide values, sufficient time remains for the authorities to take measures under Article 8 Paragraph 3 OIS to prevent further impacts before soil fertility is in fact impaired.

The trigger and clean-up values are based on well-founded analytical investigations at Agroscope FAL. In these, not only soil use (protection objective), but also the ecotoxicological significance of individual pollutants, was taken into account.

Further general comments on the guide, trigger and clean-up values are to be found in the comments on Article 5.

32 *Guide values for inorganic pollutants*

The table of guide values contained in the former *Ordinance relating to soil pollutants (OSP)* of 1986 was amended as follows:

- The guide values for cobalt and thallium, and also soluble lead content, were deleted.
- The total content of fluoride was raised.
- The total contents of chromium, copper, mercury and zinc were lowered.
- The soluble contents of cadmium and fluoride were lowered.

These amendments are justified for the individual substances as follows:

- **Chromium:** the previously measured frequent content of chromium in Swiss soils lies below 50 mg/kg (ppm). In view of the definite risk to microbiological soil processes, the previous guide value of 75 ppm for total content was clearly too high. The new value was therefore set at 50 ppm.
- **Nickel:** this heavy metal does not in itself represent a problem for the soil. The measured frequent content generally lies below 50 ppm. Although nickel is not a micro-nutrient, higher concentrations in the soil can, under certain site conditions, hinder plant growth, so that the previous guide values for this heavy metal were retained.
- **Copper:** the previous guide values for copper were too optimistic. The frequent content in Swiss soils not subject to particular impact mostly lies below 40 ppm. The guide value for total content has now been set at 40 ppm, mainly for soil microbiological reasons.
- **Zinc:** the measured frequent content of zinc in Swiss soils lies below 120 ppm. For ecotoxicological reasons, the guide value has now been set at 150 ppm.
- **Molybdenum:** from an ecotoxicological standpoint, this heavy metal is unproblematic. However, owing to its toxicity to ruminants, the previous guide value for total content of 5 ppm was retained. Above a molybdenum content of 5–10 ppm in the dry matter (dm) of the fodder, cattle and sheep may suffer from *molybdenitis*. Plants may heavily accumulate molybdenum from the soil without any harm to plant tissues.
- **Cadmium:** depending on site conditions, cadmium can accumulate significantly in plants at a soluble soil content as low as 0.004 ppm. The frequent content of cadmium in Swiss soils lies below 0.015 ppm. The present guide value for the soluble content of 0.03 ppm is clearly too high, particularly in view of the high toxicity of cadmium. For analytical reasons (reproducibility), the guide value has been only moderately reduced to 0.02 ppm.
- **Mercury:** the measured frequent content of mercury in Swiss soils lies below 0.25 ppm. In consideration of microbiological soil processes, the previous guide value of 0.8 ppm for total content was too high. The new guide value has been set at 0.5 ppm.
- **Lead:** as lead is practically insoluble, the guide value for total content is invariably exceeded before the guide value for soluble content is reached. The guide value for soluble content was therefore deleted.
- **Fluoride:** resulting from geogenic factors, measurements frequently show values that are heavily in excess of the guide values for total content. The guide value was therefore raised to 700 ppm on the basis of frequent content. However, the clay humus complex, which is particularly important for soil fertility, suffers harm at soluble fluoride contents as low as 25 ppm. The guide value for soluble content has therefore been set at 20 ppm.
- **Cobalt:** the guide value of 25 ppm for cobalt (total content) is very rarely attained in Swiss soils. Furthermore, exposure to this heavy metal has proved to be of little significance. The guide value for cobalt was therefore deleted.
- **Thallium:** this guide value was introduced in 1986, particularly in connection with anticipated emissions from the cement industry. As a result of air pollution control measures, and especially owing to the introduction of an environmentally sound manufacturing process, the emissions could be avoided, allowing the guide value for this heavy metal to be deleted.

33 **Trigger and clean-up values for inorganic pollutants**

From an impact standpoint, the emphasis was on trigger and clean-up values for the heavy metals lead, cadmium, copper and zinc. The trigger and clean-up values represent limits for possible, or manifest, risks to **health**. The report by *Hämmann and Gupta (SAEFL, ED n° 83)* provides a lucid description of:

- how the risk may be estimated;
- how the trigger and clean-up values are derived, and
- how the calculated values may be justified.

The report also shows how the relevant parameters have been selected, and why certain values have been excluded (e.g. trigger value for zinc).

The derivation of these values is thus not described here in detail. Reference may also be made to the commentary on Article 10.

4 **Annex 2: Guide, trigger and clean-up values for organic pollutants**

41 **Introductory remarks**

Until quite recently, it was thought that the existence of even the minutest quantities of pollutants in the soil called for emission control measures under Article 8 OIS. Guide values were therefore not specified for these substances. Meanwhile, it has become evident that anthropogenic emissions, and thus the pollution of the soil with organic substances, are significant. Investigations have also shown that substances previously thought to be foreign to the environment also occur naturally. A basis of assessment is therefore called for. The OIS now contains guide, trigger and clean-up values for persistent organic pollutants. Non-persistent substances are, however, not included, since they usually decompose in the soil and have no long-term effects. Should it be necessary to assess a non-persistent organic pollutant in a particular case, this may yet be done on the basis of Article 4 Paragraphs 2 and 3 OIS.

42 **Guide, trigger and clean-up values**

Standards are specified for **dioxins and furans** (polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans – PCDD/F), **polycyclic aromatic hydrocarbons** (PAH) and **polychlorinated biphenyls** (PCB). Values for other soil-relevant groups of organic pollutants are not at present under study.

As these three groups of organic substances are treated in depth in the literature, no detailed description of origin and effects is given here. The standards specified in Annex 2 OIS are based on emission and exposure measurements, and on domestic and foreign enforcement experience.

The values for **dioxins and furans** were drawn from the *«Bund-Länder Liste»* (German Republic-States List). Although the main PCDD/F pollution path for humans, animals and plants does not pass via the soil but rather via the air (deposition), it is nevertheless necessary to introduce normative regulations for soil protection for precautionary and practical reasons. Based as they are on the fairly stable exposure conditions existing in the soil, the measured data do in fact permit a good general assessment to be made of the environmental impact situation. Standards for dioxins and furans are specified not least for the reason that the public is currently sensitised to the so-called *«Seveso toxin»*.

Polycyclic aromatic hydrocarbons are included since they:

- occur ubiquitously;
- result mainly from human activities, and
- can affect human health owing to their carcinogenic effect.

They comprise the 16 indicator substances specified by the US Environmental Protection Authority (EPA), and have been adopted internationally. Among the PAH, benzo(a)pyrene is particularly important, since this is highly carcinogenic, and its incidence in ecologically relevant PAH can amount to as much as 10 %. For these substances, therefore, separate standards are specified. The principles upon which these are based and a justification of the values are given in SAEFL publication EM no. 96.

In the case of the highly toxic and ubiquitous **polychlorinated biphenyls**, no guide values were introduced, since all possible legal measures to arrest their emission have already been implemented under Article 8 OIS (prohibition of PCB in the *legislation on toxics* and the *Ordinance on substances*). Trigger and clean-up values are therefore only specified for existing soil impacts, if and when these should occur. Among the numerous PCB combinations, only the seven indicator congeners are considered (IUPAC numbers according to K. Ballschmiter). Reasons for this selection are their presence in industrial compounds, their continued extensive presence in the environment, their amenability to analysis and their toxicity. Moreover, they are also recommended by the *Institute for Reference Materials and Measurements (IRMM)* in Brussels.

The following concentrations can be regarded as **frequent contents** in Swiss soils for the three pollutant groups:

- | | | |
|--|------------|-------------------------------|
| • PCDD and PCDF | 0.5–2 | mg I-TEQ/kg soil ¹ |
| • PAH (sum of the 16 EPA indicator substances) | 0.2 | mg/kg soil ² |
| • PCB (sum of the 7 IUPAC congeners) | 0.006–0.08 | mg/kg soil ³ |

5 Annex 3: Guide values for erosion of cultivated soils

The loss of soil outside of cultivated plots caused by natural and anthropogenic erosion amounts on average to less than 0.5 tonnes per hectare per annum. With very strong precipitation it can rise to 50 tonnes, and in exceptional circumstances to as much as 100 tonnes. This may be compared with the natural regeneration of the soil of at most 0.2 to 1 tonne per hectare per annum. If in a particular case 10 tonnes of soil were carried away, it would take at least 10 to 50 years to replace this by natural regeneration. It is estimated that for some 40 % of cultivated land in Switzerland, erosion exceeds new soil generation.

Although erosion is a natural process that can be found in most soils, human activity (exploitation, changes to the terrain, development, land improvement, etc.) can nevertheless influence the extent of erosion. Activities that may cause heavier erosion must be limited in the interests of the long-term preservation of soil fertility.

¹ SAEFL, «Dioxines and Furans – Current Position, Basis of Assessment», Environment Series no. 290, 127 p. (1997).

^{2,3} Berset J., Holzer R., «Organic Micropollutants in Swiss Agriculture (PAH, PCB)», Intern.J. Environ. Anal. Chem., vol. 59, 145–165 (1995).

⁴ Wischmeier W.H., Smith D.D., «Predicting rainfall erosion losses – a guide to conservation planning», USDA Agriculture Handbook, no. 537, 58 p., Washington, (1978).

Not only soils with 'insufficient' vegetation, e.g. cultivated land, but also lightly inclined plots are at risk. Cultivated land is defined as land used for crop rotation according to Article 10 of the *Ordinance on agricultural terms* (OAT; SR 910.91), and planted with annuals. This land is normally worked each year, and is therefore exposed to erosion. This also includes artificial grassland. For these plots, guide values for tolerable soil loss due to erosion were established based on comprehensive research studies, especially on those of the «*NFP–22 Boden*» (National Research Program no. 22 on soils). The «*Konzept zur Umsetzung der Vorschriften im USG und in der VBBo*» (Concept on implementation of environmental regulations of LPE and OIS, 1999) of the *Swiss Soil Science Society* also provides a valuable scientific basis.

The annex on erosion is based methodically on the general soil erosion equation (*Wischmeier and Smith 1978*)⁴, that was developed internationally. This is a scientifically approved model for estimating the average sheet and gully erosion on cultivated land (plot). Based on this, a method by which managers and consultants may estimate soil erosion without recourse to other information was developed. This was validated and adapted to the conditions existing in the Jura and the Central Lowlands.

Annex 3 contains guide values for sheet, rill and gully erosion for two soil thicknesses. No trigger or clean-up values were defined, since per definition these are intended to avoid risk to the health of humans, animals or plants, and are therefore not applicable to erosion phenomena.

The guide values and the estimation procedure are not applicable to linear erosion, in which, as a result of concentrated surface run-off from ground depressions, the soil is disturbed and washed from such plots into surface waters and other biotopes. The OIS requires that linear erosion be combated at all costs.

V Relationship between the OIS and the contaminated sites ordinance

Locally restricted soil impacts resulting from waste represent contaminated sites according to Article 32c LPE, and are therefore subject to the *Ordinance on contaminated sites (Contaminated sites ordinance, CSO) of 26 August 1998*. These soils are equivalent to contaminated sites, so that the procedure for their clean-up is subject to this Ordinance (recording of site in register, performance of preliminary and detailed investigation, imposition of clean-up costs). To assess the necessity of clean-up of these soil impacts (Art. 12 CSO) and to decide the clean-up measures to be taken (Art. 16 Lett. c, CSO), the *Contaminated sites ordinance* makes reference to the soil protection provisions in the LPE and the OIS. Whether or not a particular soil impact is in need of clean-up therefore depends on the extent to which the guide, trigger and clean-up values specified in the OIS are exceeded. Therefore, the clean-up measures specified in the OIS, i.e. emission control, limitation or prohibition of use, and reinstatement of soil fertility, are applicable.

For soil impacts subject to the *Contaminated sites ordinance*, the competent enforcement authorities for soil protection and contaminated sites must work closely together.

⁴ Wischmeier W.H., Smith D.D., «*Predicting rainfall erosion losses – a guide to conservation planning, USDA Agriculture Handbook*», no. 537, 58 p., Washington (1978).

For soil impacts not arising from waste, or not locally restricted (i.e. that are diffuse), the OIS alone is applicable.

VI Bibliography

1 Legal commentaries on soil protection

- Tschannen Pierre, «*Kommentar zum Umweltschutzgesetz, Erläuterungen zum Bodenschutz (Art. 33–35)*», Vereinigung für Umweltrecht und Helen Keller (eds.), Zurich (1999).
- Zäch Christoph, «*Das neue Bodenschutzrecht*»; in: Umweltrecht in der Praxis, Vereinigung für Umweltrecht, Band 10, Heft 5/1 (1996).

2 NABO publications

- Cf. NABO website <http://www.nabo.admin.ch>.

3 SAEFL publications

- «*Quality Assurance Concept – Analysis of PAH, PCB and Dioxins in Soil*», Guidelines, Environment in practice, 35 pp. (updated 2005).
- «*Reduction of the environmental risks of fertilisers and pesticides*», Report adopted by the Swiss Federal Council on behalf of the Motion 94.3005 of the Committee for Environment, regional planning and energy of the Council of States, 121 p. (2005).
- «*Phosphor in Böden*», Schriftenreihe Umwelt Nr. 368, 174 p. (2004).
- «*Schadstoffgehalte in Holzabfällen – Analysenresultate der Holzkampagne 98*», Umwelt-Materialien Nr. 178 – Abfall, 124 p. (2004).
- «*Schwerpunkt Boden – Bodenschatz, Bodenschutz*», Sonderdruck Umweltschutz Nr. 2, 63 p. (2004).
- «*A survey of the composition of household waste 2001/02*», Environmental series n° 356, 62 p. (2004).
- «*Determination of polychlorinated biphenyls in soil by GC/MS – Method recommendation*», Guidelines soil, Environment in practice, 25 p. (2003).
- «*Sampling and sample pretreatment for soil pollutant monitoring – Soil sampling manual OIS*», Manual soil, Environment in practice, 104 p. (2003).
- «*Assessment of risks to health and the environment from cadmium in mineral fertilisers*», Technical report «soil», Environmental Documentation no. 167, 62 p. (2003).
- «*Bodenschutz beim Bauen*», Leitfaden Umwelt Nr. 10, 83 p. (2001).
- «*Determination of polychlorinated dioxins and furans in soil – Method recommendation*», Guidelines soil, Environment in practice, 44 p. (March 2001).
- «*Determination of polycyclic aromatic hydrocarbons in soil by GC/MSI – Method recommendation*», Guidelines soil, Environment in practice, 26 p. (January 2001).
- «*Reuse of excavated soils – Soil excavation guideline*», Guideline soil, Environment in practice, 20 pp. (2002).
- «*Bodenschutz beim Bauen*», Leitfaden, Vollzug Umwelt, 83 p. (2001).
- «*Böden der Schweiz – Schadstoffgehalte und Orientierungswerte (1990–1996)*», Umwelt-Materialien Nr. 139 Boden, 115 p. (2001).
- «*Erstellung des Katasters der belasteten Standorte*», Vollzug Umwelt, 128 p. (2001).
- «*Boden – Unterrichtsideen und Arbeitsblätter für Schülerinnen und Schüler, Kommentare für Lehrpersonen*» (samt CD ROM), Arbeitsmappe (2000).

- «Nationales Bodenbeobachtungsnetz – Veränderungen von Schadstoffgehalten nach 5 und 10 Jahren», Schriftenreihe Umwelt Nr. 320, 129 p. (2000).
- «Dioxine und Furane – Stoffflussanalyse», Schriftenreihe Umwelt Nr. 312, 116 p. (1999).
- «Erosionsschutz im Landwirtschaftsbetrieb – Praxishilfe», Vollzug Umwelt, 150 p. (1999).
- «Richtlinie für die Verwertung, Behandlung und Ablagerung von Aushub-, Abraum- und Ausbruchmaterial – Aushubrichtlinie», 20 p. (1999).
- «Die saubere Kehrlichtverbrennung: Mythos oder Realität?», Schriftenreihe Umwelt Nr. 299, 117 p. (1998).
- «Richt-, Prüf- und Sanierungswerte für organische Schadstoffe im Boden – Fallbeispiel PAK», Umwelt-Materialien Nr. 96, 111 p. (1998).
- «Schwerpunkt Boden», Sonderdruck Umweltschutz Nr. 2, 35 p. (1998).
- «Cadmium – Stoffflussanalyse», Schriftenreihe Umwelt Nr. 295, 74 p. (1997).
- «Die Regenwurm-Fauna von Dauergrünland des Schweizer Mittellandes – Synthesebericht», Schriftenreihe Umwelt Nr. 291 (with an extended English summary), 91 p. (1997).
- «Dioxine und Furane – Standortbestimmung, Beurteilungsgrundlagen, Massnahmen», Schriftenreihe Umwelt Nr. 290, 127 p. (1997).
- «Herleitung der Prüf- und Sanierungswerten für anorganische Schadstoffe im Boden», Umwelt-Materialien Nr. 83, 100 p. (1997).
- «Bodenschutz- und Entsorgungsmassnahmen bei 300m-Schiessanlagen», Wegleitung Boden, Vollzug Umwelt (gemeinsam mit GS-VBS), 49 p. (1997).
- «Schlüssel zur Identifikation gesteinsbedingter Richtwertüberschreitungen», Vollzug Umwelt, 26 p. (1996).
- «Verwertung und Beseitigung von Holzaschen», Schriftenreihe Umwelt Nr. 269, 204 p. (1996).
- «Vom Menschen verursachte Luftschadstoff-Emissionen in der Schweiz von 1900–2010», Schriftenreihe Umwelt Nr. 256, 121 p. (1995).
- «Métaux dans les sédiments», Cahier de l'environnement no. 240, 181 p. (1995).
- «Dioxinmissionen von Holzfeuerungen», Schriftenreihe Umwelt Nr. 208, 55 p. (1993).
- «Nationales Bodenbeobachtungsnetz – Messresultate 1985–1991», Schriftenreihe Umwelt Nr. 200, 175 p. (1993).
- «Bodenverschmutzung durch den Strassen- und Schienenverkehr in der Schweiz», Schriftenreihe Umwelt Nr. 185, 144 p. (1992).
- «Hilfsstoffeinsatz in Haus- und Familiengärten», Schriftenreihe Umwelt Nr. 187, 97 p. (1992).
- «Schwermetalle und Fluor in Mineraldüngern», Schriftenreihe Umwelt Nr. 162, 44 p. (1991).
- «Platinmissionen aus Automobil-Katalysatoren», Schriftenreihe Umwelt Nr. 95, 58 p. (1988).
- «Risk assessment and measures at impacted soils», Manual, Environment in practice (draft in preparation).

4 Third-party publications on implementation

- Arbeitsgruppe Bodenschutz OCH/FL-FABO ZH, Vollzugsordner für die Umsetzung der VBBo (2001).
- Bundesamt für Energie, Richtlinien zum Schutze des Bodens beim Bau unterirdisch verlegter Rohrleitungen (Bodenschutzrichtlinien; 1997).
- Kt. Baselland, Mittelland 1 und 2, Suisse romande, Bodenerosion selber einschätzen – ein Schlüssel für Betriebsleiter und Berater.
- PUSCH/BGS, Bodenschutz in der Gemeinde, Broschüre und Merkblätter (2000).
- Schweizerischer Fachverband für Sand und Kies (FSK), Rekultivierungsrichtlinien, Bern (2001).
- Vereinigung Schweizerischer Strassenfachleute – VSS, SN-Normen Erdbau, Boden: SN 640 581a, SN 640 582, SN 640 583, Zürich (1999/2000).

5 Selected scientific publications

- Agroscope FAL, «Schwermetallbilanzen von Landwirtschaftspartellen der nationalen Bodenbeobachtung (NABO)», Schriftenreihe Nr. 54, 55 p. (2005).
- Agroscope FAL, «Risikoabschätzung zur landwirtschaftlichen Abfalldüngerverwertung», Schriftenreihe Nr. 48, 127 p. (2003).
- Agroscope FAL, «Ausmass und mögliche Auswirkungen der Abtrift von Pflanzenschutzmitteln auf ökologische Ausgleichsflächen», Schriftenreihe Nr. 40, 49 p. (2002).
- Agroscope FAL, «Arsen in Böden der Schweiz», Schriftenreihe Nr. 32, 37 p. (1999).
- Agroscope FAL, «Methodenbuch für Böden-, Pflanzen- und Lysimeterwasser-Untersuchungen», Schriftenreihe Nr. 27 (1998).
- Agroscope FAL, «Vanadium in Böden der Schweiz», Schriftenreihe Nr. 22, 31 p. (1997).
- Agroscope FAL, «Erfassung und Ausmass der flächenhaften Kupferbelastung in Rebbergböden der Schweiz», Schriftenreihe FAC Nr. 20, 44 p. (1995).
- Agroscope FAL/BUWAL, «Wegleitung zur Beurteilung der Bodenfruchtbarkeit», 89 p. (1991).
- Berset J.D. und Holzer R., «Organic micropollutants in Swiss agriculture: Distribution of PAH and PCB in soil, liquid manure, sewage sludge and compost samples – a comparative study», Intern. J. Environ. Anal. Chem., 59, 145–165 (1995).
- Bucheli Th.D. et al, «Polycyclic aromatic hydrocarbons, black carbon, and molecular markers in soils of Switzerland», Chemosphere, 56, 1061–1076 (2004).
- Desaulles A., Dahinden R., «Zum Einfluss von Trocknungstemperaturen und Kunststoff-Kontakten auf PAK- und PCB-Analysen in Bodenproben bei Routineuntersuchungen», NABO, Agroscope FAL Reckenholz, 34 p. (2000).
- Desaulles A., Dahinden R., «Die Vergleichbarkeit von Schwermetallanalysen in Bodenproben von Dauerbeobachtungsflächen», NABO, Agroscope FAL Reckenholz, 27 p. (1994).
- Flückiger R. et al, «Bodenkunde», Landwirtschaftliche Lehrmittelzentrale, ISBN 3-906679-23-3, 96 p. (1993).
- Landwirtschaftliche Beratungszentralen SRVA/LBL, «Bodenbeurteilung im Feld», Merkblatt, 16 p. (2001).
- Lingner S., Bork E., «Präventiver Bodenschutz – Problemdimensionen und normative Grundlagen», Europäische Akademie zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen, Bad Neuenahr-Ahrweiler, Graue Reihe Nr. 23, ISSN 1435-487 X, 69 p. (2000).
- Meyer C., «Bodenverschmutzung in der Schweiz – Untersuchungen und ausgewählte Ergebnisse über die Stoffbelastung von Böden (Stand 1990)», Synthesebericht NFP-22 «Boden», 240 p. (1991).
- Mosimann Th. et al, «Erosionsbekämpfung in Ackerbaugebieten, Leitfaden für die Bodenerhaltung», Bericht NFP-22 «Boden», ISBN 3-907086-61-9, 187 p. (1991).
- Schmid P. et al., «Correlation of PCDD/F and PCB concentrations in soil samples from the Swiss soil monitoring network (NABO) to specific parameters of the observation sites», Chemosphere, 58, 227–234 (2005).
- Schweizerische Referenzmethoden der Eidg. landw. Forschungsanstalten (Agroscope FA), Band 3 (annually re-issued).
- Swiss Soil Science Society, «Physikalischer Bodenschutz, Konzept zur Umsetzung der rechtlichen Vorgaben im USG und in der VBB», BGS Dokument Nr. 9, ISBN 3 260 05430 8 (1999).
- Swiss Federal Statistical Office and SAEFL, Kapitel 10 «Boden», Separatdruck aus «Umwelt in der Schweiz – Daten, Fakten, Perspektiven», ISBN 3-303-02034-5, 376 p. (1997).
- Weisskopf P. et al, «Die Verdichtungsgefährdung schweizerischer Ackerböden», Bericht Nr. 20, NFP-22 «Boden», ISBN 3-907086-12-0, 128 p. (1988).

6 Selected international publications

- Blume H.-P. et al., «*Ergänzbare Handbuch der Bodenkunde*», ecomed Verlagsgesellschaft mbH, 86899 Landsberg/Lech, ISBN 3-609-72227-4 (from 1996 onwards).
- Bundesamt und Forschungszentrum für Landwirtschaft, «*Bodenschutz in Österreich*», 455 p. (1997).
- Council of Europe, «*European Soil Resources*», Nature and Environment no. 71, 99 p. (1995).
- De Clercq et al., «*Nutrient management legislation in European countries*», ISBN 90-806537-2-1 (2001).
- Deutsche Bundesregierung, «*Bundes-Bodenschutz- und Altlastenverordnung (BbodSchV)*», TerraTech, 4, 22–36, (1999), sowie: Sanden J., «*Die Bundes-Bodenschutz- und Altlastenverordnung – eine Einführung*», TerraTech, 4, 38–40 (1999).
- Freistaat Sachsen, Landesamt für Umwelt und Geologie, «*Bodenatlas des Freistaates Sachsen*», Teil 3 «*Bodenmessprogramm*», Materialien zum Bodenschutz, Lössnitz-Druck GmbH, D-01445 Radebeul, 119 p. (1999).
- Litz N. et al, «*Bodengefährdende Stoffe – Bewertung, Stoffdaten, Ökotoxikologie, Sanierung*», ergänzbarer Bodenschutz-Ordner, ecomed Verlagsgruppe, ISBN 3-609-52001-9 (2005).
- Rosenkranz D. et al, «*Ergänzbare Handbuch Bodenschutz*», E. Schmidt Verlag Berlin, ISBN 3-503-02718-1 (from 1988 onwards).
- UNEP European Environment Agency, «*Down to earth: Soil degradation and sustainable development in Europe*», Environm. Iss. Ser., no. 16, ISBN 92-9167-398-6, 32 p. (2000).

VII Appendix

- **Orinance relating to impacts on the soil of 1 July 1998 (OIS)**
- **Excerpts from LPE**

Ordinance
Relating to Impacts on the Soil
(OIS)

SR 814.12

of 1 July 1998

The Swiss Federal Council,

Pursuant to Articles 29, 33, Paragraph 2, 35 Paragraph 1 and 39 Paragraph 1 of the Law Relating to Protection of the Environment of 7 October 1983⁵ (LPE),

hereby ordains:

Section 1: Purpose, Object and Definitions

Art. 1 Purpose and Object

To maintain the long-term fertility of the soil the present Ordinance shall regulate:

- a. the observation, monitoring and evaluation of chemical, biological and physical impact on soils;
- b. measures to prevent persistent soil compaction or erosion;
- c. measures to be taken to treat excavated soil;
- d. more extensive measures which the cantons shall take to combat impact on soils (art. 34 LPE).

Art. 2 Definitions

¹Soil shall be deemed to be fertile if:

- a. it demonstrates a diversified and biologically active biocenosis, a structure typical for its site and an intact capability for decomposition;
- b. natural or cultivated plants and plant communities can grow and develop normally and their characteristics are not adversely affected;
- c. the foodstuffs and fodder produced on it are of good quality and do not present a hazard to the health of humans or animals;
- d. ingestion or inhalation of it does not present a hazard to humans or animals.

²Chemical impacts on the soil shall be deemed to be contamination of the soil through naturally occurring or man-made substances (pollutants).

³Biological impacts on the soil shall be deemed to be contamination of the soil through genetically modified or pathogenic organisms.

⁴Physical impacts on the soil shall be deemed to be damage of the soil through artificial changes in the structure, layers or thickness of the soil.

⁵Trigger values indicate for a given type of use the level of impacts on the soil, which, if exceeded, could present a hazard to humans, animals or plants, according to current scientific knowledge. They serve to indicate whether soil usage should be reduced according to article 34 paragraph 2 LPE.

¹ SR 814.01

Section 2: Observation, monitoring and evaluation of impacts on the soil

Art. 3 Observation of impacts on the soil by the Confederation

¹The Swiss Agency for the Environment, Forests and Landscape (SAEFL) in collaboration with the Swiss Federal Office for Agriculture (SFOA) shall manage the Swiss National Observation Network for impacts on the Soil (NABO).

²SAEFL shall inform the cantons of the results of this observation and shall publish them.

Art. 4 Monitoring of impacts on the soil by the cantons

¹The cantons shall make provision for the monitoring of impacts on the soil in certain regions if it has been established or is anticipated that such impacts will adversely affect the fertility of the soil.

²SAEFL, in collaboration with SFOA, shall arrange to provide the technical bases necessary for monitoring the impact on the soil and shall advise the cantons.

³The cantons shall inform SAEFL of the results of this monitoring and shall publish them.

Art. 5 Evaluation of impacts on the soil

¹The Confederation and the cantons shall evaluate the impact on the soil on the basis of the guide, trigger and clean-up values laid down in the Annexes to the present Ordinance.

²If guide values are not available, determination of whether the long-term fertility of the soil can be guaranteed shall be made case by case on the basis of the criteria in article 2 paragr.1.

³If trigger or clean-up values are not available for certain types of soil usage, evaluation of whether the impact on the soil presents a hazard to humans, animals or plants shall be made case by case. SAEFL shall advise the cantons on this.

Section 3:

Prevention of persistent compaction or erosion; handling of excavated soils

Art. 6 Prevention of compaction and erosion

¹A person who constructs an installation or who exploits the soil shall choose and utilise vehicles, machines and tools such that compaction and other changes in soil structure which may threaten its long-term fertility can be prevented, taking into account the physical characteristics of the soil and its level of humidity.

²A person who intends to carry out modifications of the terrain or exploits the soil shall ensure that appropriate kinds of building and exploitation are used, in particular through anti-erosion building or cultivation techniques, rotation and adaptation of crop cultivation, so that the fertility of the soil is not threatened in the long term by erosion. If protection of the soil against erosion so requires, the cantons shall order measures to be taken jointly by several enterprises, particularly in the case of erosion caused by concentrated run-off (thalweg erosion).

Art. 7 Treatment of excavated soils

¹A person who manipulates or excavates the soil shall do so in such a way that it can eventually be used again as soil.

²If excavated soil is reused (e.g. for recultivation or remodelling of terrain), it shall be brought on in such a way that:

- a. the fertility of the existing soil and the reused soil is affected only temporarily by physical impacts;
- b. the existing soil is not further contaminated by chemicals.

Section 4: More extensive measures in the case of impacts on the soil

Art. 8 Cantonal measures where guide values are exceeded (art. 34 para. 1 LPE)

¹If in a given region the guide value has been exceeded or the impact on the soil is increasing markedly, the cantons shall investigate the source of the impact on the soil.

²They shall examine whether the measures taken according to the provisions of the Confederation in the areas of water pollution control, disaster prevention, air pollution control, on environmentally hazardous substances and organisms, on waste and on physical impacts on the soil are adequate to prevent further increase of the impact on the soil in the region concerned.

³If these measures are not adequate, the cantons shall take more stringent measures under article 34 paragraph 1 LPE. They shall first inform SAEFL of this.

⁴The cantons shall implement these measures within five years of the impact on the soil having been detected. They shall set deadlines according to the urgency of each individual case.

Art. 9 Cantonal measures where trigger values are exceeded (art. 34 para. 1 LPE)

¹If in a given region the trigger value has been exceeded, the cantons shall determine whether the impact on the soil presents a hazard to humans, animals or plants.

²If this is the case, the cantons shall restrict soil use as far as is necessary to eliminate the hazard.

Art. 10 Cantonal measures where clean-up values are exceeded (art. 34 para. 1 LPE)

¹If in a given region the clean-up value has been exceeded, the cantons shall prohibit the uses concerned.

²If the soil is to be used for horticulture, agriculture or silviculture, they shall stipulate measures whereby the impact on the soil shall be reduced sufficiently below the clean-up value to permit cultivation in the customary manner without presenting a hazard to humans, animals or plants.

Art. 11 Reinforcement of federal provisions

If in order to maintain the fertility of the soil, reinforcement of federal provisions under art. 33 LPE is necessary, in addition to the more extensive cantonal measures or in place of them, the Federal Department for the Environment, Transport, Energy and Communications (DETEC) shall make application to the Federal Council.

Section 5: Recommendations of the Confederation

Art. 12

¹SAEFL and the other federal agencies concerned shall jointly draw up recommendations on the implementation of the present Ordinance. They shall collaborate with the cantons and the industrial organisations concerned.

²In doing so they shall examine whether the voluntary measures proposed by sectorial trade agreements are appropriate for the implementation of the present Ordinance.

Section 6: Final Provisions

Art. 13 Implementation

¹The implementation of the present Ordinance is the task of the cantons insofar as it does not fall under the responsibility of the Confederation.

²The federal authorities which, on the basis of other federal laws, are already implementing provisions on installations, shall also implement the present Ordinance.

Art. 14 Repeal of the previous Ordinance

The Ordinance of 9 June relating to Pollutants in the Soil⁶ is repealed.

Art. 15 Entry into force

The present Ordinance shall enter into force on 1 October 1998.

1 July 1998

In the name of the Swiss Federal Council

Federal President: Cotti

Federal Chancellor: Couchepin

⁶ AS 1986 1147, 1996 2243

Guide, trigger and clean-up values for hazardous inorganic substances in soil

1 Guide, trigger and clean-up values

11 Guide values

Pollutants	Content in soils (mg/kg dm up to 15 % humus, mg/l for soils >15 % humus)	
	total content	soluble content
Chromium(Cr)	50	-
Nickel (Ni)	50	0.2
Copper (Cu)	40	0.7
Zinc (Zn)	150	0.5
Molybdenum (Mo)	5	-
Cadmium (Cd)	0.8	0.02
Mercury (Hg)	0.5	-
Lead (Pb)	50	-
Fluorine (F)	700	20

dm = dry matter

12 Trigger values

Use	Content in soils (mg/kg dm up to 15 % humus, mg/l for soils >15 % humus)						Sampling depth (cm)
	Lead (Pb)		Cadmium(Cd)		Copper (Cu)		
	t	s	t	s	t	s	
Plants for human consumption	200	-	2	0.02	-	-	0 - 20
Plants for animal consumption	200	-	2	0.02	150	0.7	0 - 20
Use of soils with possible direct ¹ uptake	300	-	10	-	-	-	0 - 5

dm = dry matter

s = soluble content

t = total content

¹ oral, inhaled, dermal

13 *Clean-up values*

Use	Content in soils (mg/kg dm up to 15 % humus, mg/l for soils >15 % humus)								Sampling depth (cm)
	Lead (Pb)		Cadmium (Cd)		Copper (Cu)		Zinc (Zn)		
	t	s	t	s	t	s	t	s	
Agriculture and horticulture	2000	-	30	0.1	1000	4	2000	5	0 - 20
Home and family gardening	1000	-	20	0.1	1000	4	2000	5	0 - 20
Children's play-grounds	1000	-	20	-	-	-	-	-	0 - 5

dm = dry matter

s = soluble content

t = total content

2 **Determination and evaluation of pollutant content**

¹A guide value is exceeded if the soluble or total content of a hazardous substance in a representative, mixed sample taken from the top 20 cm of soil is exceeded.

²A trigger or clean-up value is exceeded if the soluble or total content of a hazardous substance in a representative, mixed sample taken at the soil depths shown in the tables according to paragraph 1 exceeds these values.

³In well-founded cases, other sampling depths may be applied.

⁴The soil samples are dried in the air at a temperature of 40°C until a constant weight has been reached. They are sieved to a particle diameter of 2 mm. To convert the results of the analysis into mg/kg dry matter (dm), representative sub-samples are dried at 105°C until a constant weight has been reached.

⁵After extraction the total or soluble pollutant content is calculated according to the procedure in the following table:

Parameter	Solvent	Proportion of weight of soil sample to the volume of solvent (w/v)
Heavy metals (total content)	2 molar HNO ₃	1 : 10
Heavy metals (soluble content)	0.1 molar NaNO ₃	1 : 2.5
Total fluorine	NaOH smelt	0.5 : 200
Soluble fluorine	water extract	1 : 50

w = weight

v = volume

⁶To calculate pollutant content in soils with a humus content above 15% mg/kg dm in mg/l, the content in mg/kg is multiplied by the dry density.

Guide, trigger and clean-up values for hazardous organic substances in soil**1 Guide, trigger and clean-up values****11 Values for dioxins (PCDD) and furanes (PCDF)**

Values	Content of PCDD/F ¹ (ng I-TEQ/kg dm soil up to 15 % humus, ng I-TEQ/l for soils >15 % humus)	Sampling depth (cm)
<i>Guide value</i>	5	0 - 20
<i>Trigger values</i>		
Use of soils with possible direct ² uptake	20	0 - 5
Plant production for human consumption	20	0 - 20
Plant production for animal consumption	20	0 - 20
<i>Clean-up values</i>		
Children's playgrounds	100	0 - 5
Home and family gardening	100	0 - 20
Agriculture and horticulture	1000	0 - 20

I-TEQ = International Toxicity Equivalent

dm = dry matter

¹ PCDD/F = sum of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofuranes² oral, inhaled, dermal

12 Values for polycyclic aromatic hydrocarbons (PAH)

Values	Content of PAH ¹ (in mg/kg dm up to 15 % humus, mg/l for soils >15 % humus)		Sampling depth (cm)
	Sum of PAH*)	Benzo(a)pyrene	
<i>Guide value</i>	1	0.2	0 - 20
<i>Trigger values</i>			
Use of soils with possible direct ² uptake	10	1	0 - 5
Plant production for human consumption	20	2	0 - 20
<i>Clean-up values</i>			
Children's playgrounds	100	10	0 - 5
Home and family gardening	100	10	0 - 20

dm = dry matter

¹ The assessment values are applicable to the sum of the following 16 PAH compounds of the Priority Pollutants List: naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene.

² oral, inhaled, dermal

13 Values for polychlorinated biphenyls (PCB)

Values	Content of PCB ¹ (in mg/kg dm up to 15 % humus, mg/l for soils >15 % humus)	Sampling depth (cm)
<i>Trigger values</i>		
Use of soils with possible direct ² uptake	0.1	0 - 5
Plant production for human consumption	0.2	0 - 20
Plant production for animal consumption	0.2	0 - 20
<i>Clean-up values</i>		
Children's playgrounds	1	0 - 5
Home and family gardening	1	0 - 20
Agriculture and horticulture	3	0 - 20

dm = dry matter

¹ Sum of 7 congeners according to IRMM (Institute for Reference Materials and Measurements), IUPAC nos. 28, 52, 101, 118, 138, 153, 180.

² oral, inhaled, dermal

2 Determination and evaluation of pollutant content

¹A guide, trigger or clean-up value is exceeded if the content of a hazardous substance in a representative, mixed, sample taken at the soil depths shown in the tables according to paragraph 1 exceeds these values.

²In well-founded cases, other sampling depths may be applied.

³The organic pollutants are extracted as completely as possible (total content). The Federal Agency issues recommendations on sampling and analysis.

⁴To convert pollutant content from ng I-TEQ/kg dry matter to ng I-TEQ/l or from mg/kg dry matter to mg/l in soils with a humus content above 15 %, the content in ng I-TEQ/kg or mg/kg is multiplied by the dry density.

Guide values for erosion on arable land⁷

1 Guide values

Depth through which roots can penetrate	Total mean erosion ¹ (in tonnes dm per hectare and year)
Up to 70 cm	2
More than 70 cm	4

dm = dry matter

¹ total mean erosion = sum of the sheet erosion and linear erosion

2 Determination of the loss of soil on arable land

¹The mean sheet erosion is estimated per plot. To do this, precipitation and erosibility of the soil in this region are taken into account, as well as the length and gradient of an incline, and crop rotation (mulching and tilling of the soil) on the plot. If these erosion-relevant factors vary strongly within a plot, they are estimated for the areas which are particularly at risk.

²The mean linear erosion on the plot is estimated on the basis of information covering observations of the past five years. In doing this, account is taken of the frequency in time of the formation of gullies, their number and their depth.

⁷ Article 18 of the Ordinance of 7 December 1998 Relating to Agricultural Terminology (SR 910.91)

Swiss Federal Law relating to the Protection of the Environment

of 7 October 1983 (amended on 21 December 1995)

The Federal Assembly of the Swiss Confederation, having regard to Article 74 and 120 of the Federal Constitution, having considered the Opinion of the Federal Council of 31 October 1979,

has adopted this law:

Part 1: Principles and general provisions

Chapter 1: Principles

Art 1 Purpose

¹The purpose of this law is to protect humans, animals and plants, their biological communities and habitats against harmful effects or nuisances and to maintain the fertility of the soil.

²In order to limit effects which could be harmful or a nuisance precautionary measures shall be taken at an early stage.

Chapter 2: general provisions

Art. 7 Definitions

^{4bis}Impacts on the soil means physical, chemical and biological alterations of the proper quality of the soil. Soil means the topmost unsealed layer of the earth in which plants can grow.

Art. 28 Environmentally safe handling

¹Substances shall only be handled in such a way that they, their derivatives, or any wastes may not endanger neither the environment nor indirectly humans.

²Manufacturer or importer instructions shall be complied with.

Chapter 5: Impacts on the Soil

Art. 33 Measures against impacts on the soil

¹For the long-term preservation of soil fertility, measures against chemical and biological impacts on the soil shall be laid down in the implementing regulations on the law of 24 January 1991 relating to water pollution control, or else regulations on disaster prevention, on air pollution control, on environmentally hazardous substances and organisms as well as regulations on waste and incentive taxes.

²The soil may be physically affected only to the extent that its fertility is not permanently degraded; such shall not apply to building areas. The Federal Council may issue regulations or recommendations on measures against physical impacts on the soil such as erosion or compaction.

Art. 34 More stringent measures against impacts on the soil

¹If soil fertility in specific areas can no longer be guaranteed in the long term the cantons shall introduce, in agreement with the Confederation, and to the required extent stricter regulations on requirements for sewage seepage, limitations of emissions from facilities, the use of substances and organisms, or else physical impacts on the soil.

²If impacts on the soil endanger humans, animals or plants the cantons shall restrict the use of the soil to the extent required.

³If the soil shall be used for horticulture, agriculture or silviculture, but cannot on the site in question be cultivated in the usual way without endangering humans, animals or plants, the cantons shall enact at least such measures that the impacts on the soil are reduced to such an extent as to allow a non-hazardous cultivation.

Art. 35 Guide values and soil clean-up values

¹The Federal Council may set guide values and soil clean-up values for assessing the impacts on the soil.

²The guide values shall indicate the impact level above which in the light of current scientific knowledge or experience the soil fertility is no longer guaranteed in the long term.

³The soil clean-up values shall indicate the impact level above which in the light of current scientific knowledge or experience specific uses of the soil are no longer possible without endangering humans, animals or plants.
