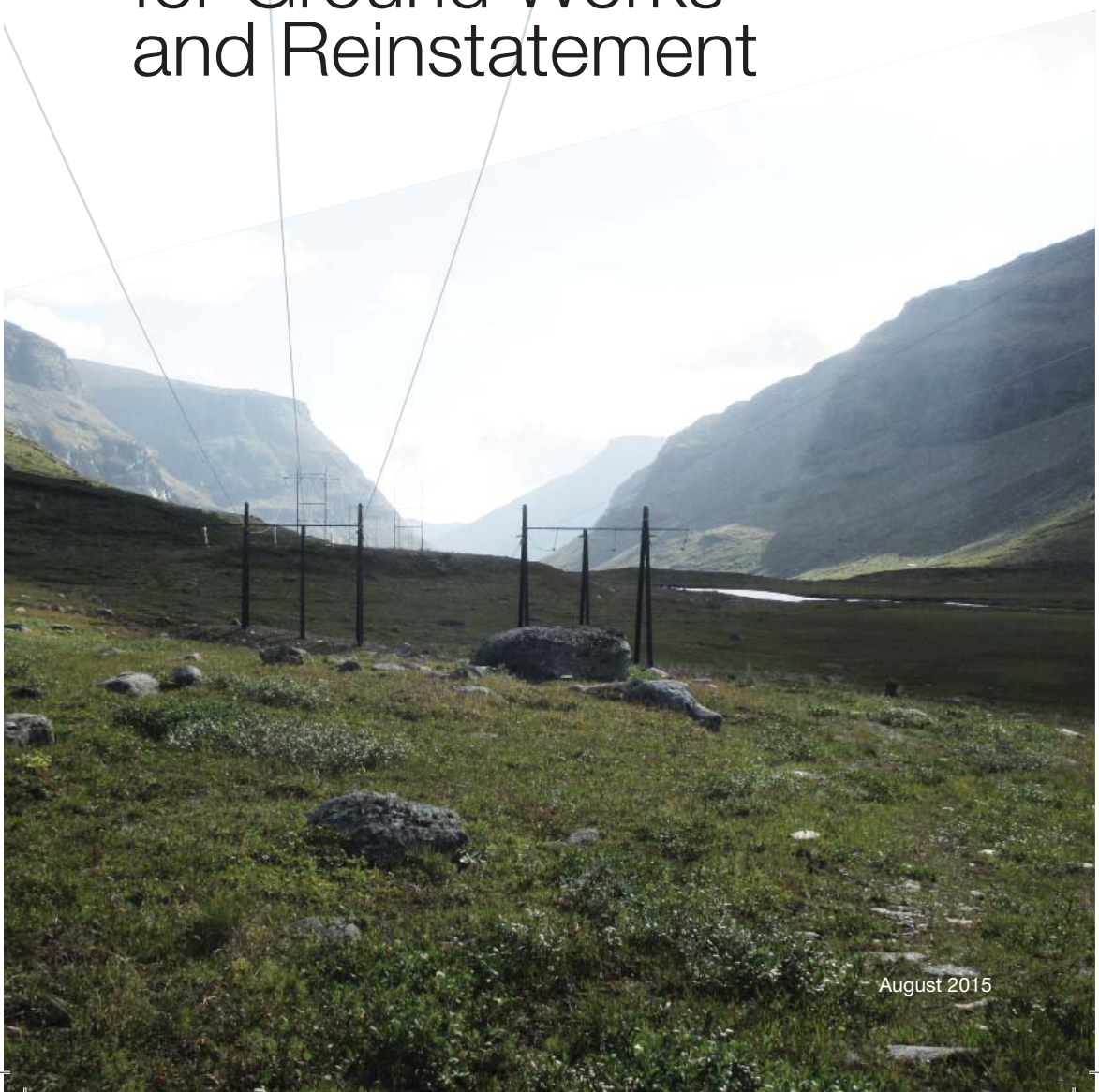
Statnett

Handbook
for Ground Works and Reinstatement



August 2015

Ground Works and Reinstatement

This handbook has been prepared for operators of mechanical excavators and other machines undertaking ground works on Statnett's construction projects. The handbook presents principles for how ground works can be undertaken so as to reduce long term and permanent terrain damage.

Figure 1
The three phases of construction works with key focus areas.

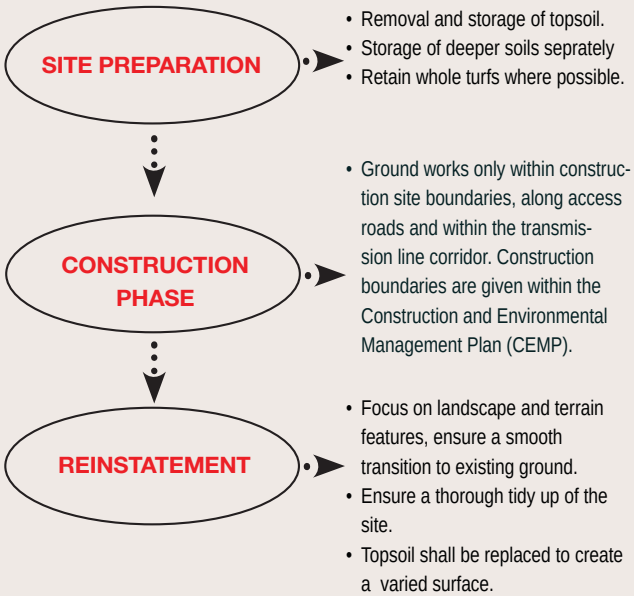


Figure 2
Ground works in previously undisturbed areas requires knowledge about how different landscapes and vegetation types should be treated to minimise damage. In this picture, the road had to follow the edge of the bog instead of crossing directly over due to poorer ground conditions than previously anticipated.

Contents

Front Page:
Photo from Melhusskardet in Bardu Council, Troms County. The transmission lines will be dismantled and the terrain reinstated.

Unless otherwise stated, all photos within this handbook are taken by Statnett and Norconsult.

Roads

New roads should sit well in the landscape, key considerations are:

- Use natural features
- Use natural features
- Avoid cuttings/fillings
- Gentle transition to surroundings
- Retain topsoils for use in reinstatement

PLANNING OF ACCESS ROADS SHOULD CONSIDER THE FOLLOWING:

- Follow and adjust to natural features.
- Avoid placing too high compared to surrounding ground.
- Avoid cuttings and fillings/embankments.
- Consider the need for drainage to avoid erosion.
- Vary the incline of the road and the angle of filled areas.

WHEN BUILDING ACCESS ROADS, IT IS IMPORTANT TO CONSIDER THE FOLLOWING:

- Retain topsoil for use in reinstatement. Store alongside the road with a max 2 m height.
- Retain complete turfs and larger natural stones for use in reinstatement, reinstated soils shall not be smoothed out.
- In boggy areas, retained turfs/peat should be kept moist to avoid drying out.
- Cuttings, fillings and embankments should be rounded off to give a smooth transition to surrounding areas.
- Damaged trees shall be removed, roots may be used in reinstatement but should not be visible on the surface.
- Soils shall not be filled up over the roots of existing trees (see also page 18).

Figure 3

Avoid teeth marks from excavator buckets. The surface shall be roughly levelled off, but not smoothed out or compacted.

Figure 4

A good example of a smooth transition from road to the surrounding natural ground. An individual tree has been retained during the construction period.

Figure 5

Topsoil should be removed and stored temporarily alongside the construction area. Where this is not possible, it should be stored in designated areas.

Figure 6

Overhanging turf or soil on new cuttings should be avoided. Cuttings should be rounded off.

Figure 7

Soil material should be placed around rock outcrops with a thicker layer at the base and thinner near the top.

Figure 8

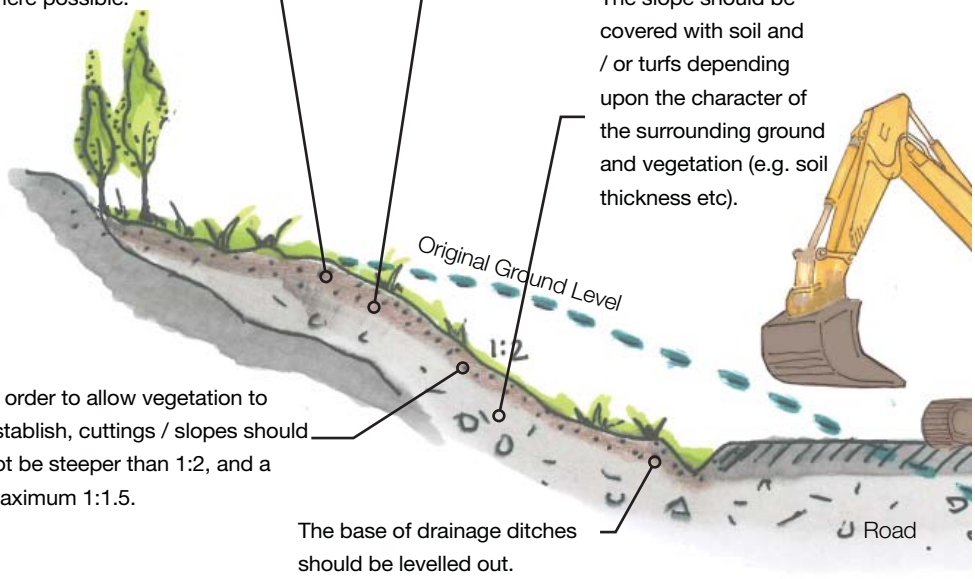
Topsoil and turf should not be compacted as this will encourage a quicker revegetation.

SOIL CUTTINGS

Cutting / slope profile should be softened in order to provide a smooth transition to surrounding ground where possible.

Protruding roots and turfs at the top of the cutting / slope should be removed.

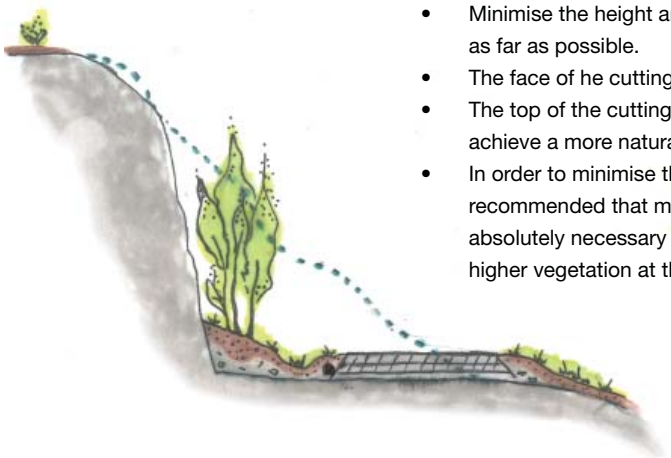
The slope should be covered with soil and / or turfs depending upon the character of the surrounding ground and vegetation (e.g. soil thickness etc).



In order to allow vegetation to establish, cuttings / slopes should not be steeper than 1:2, and a maximum 1:1.5.

The base of drainage ditches should be levelled out.

ROCK CUTTINGS

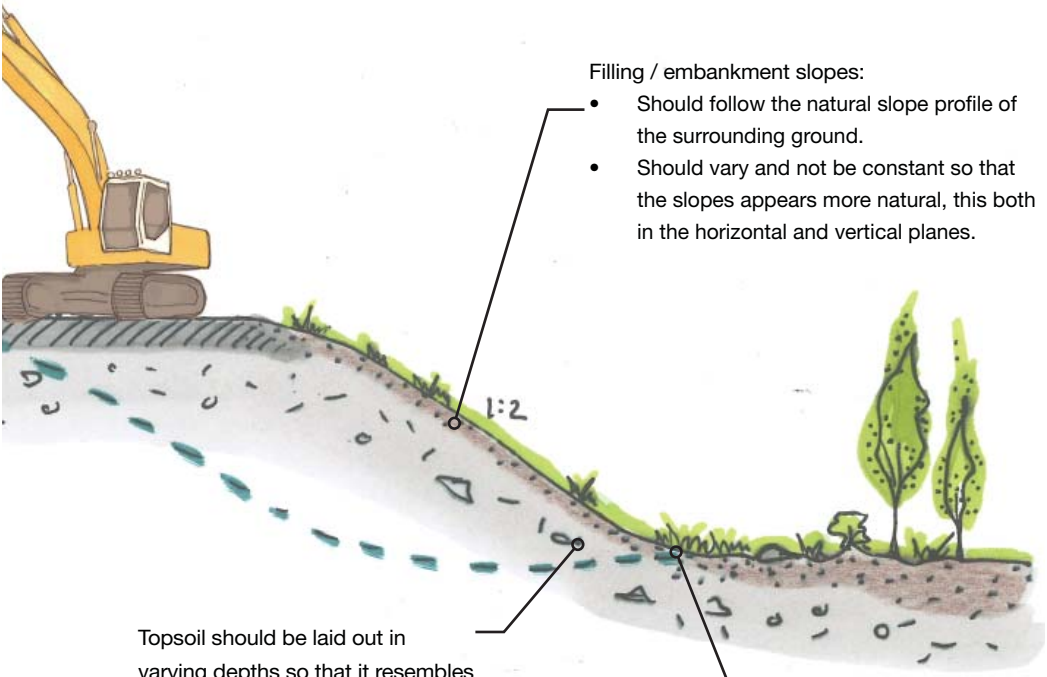


- Minimise the height and length of rock cuttings as far as possible.
- The face of he cutting should be around 5:1.
- The top of the cutting should be rounded off to achieve a more natural profile.
- In order to minimise the visual impact, it is recommended that more rock is removed than absolutely necessary in order to allow space for higher vegetation at the base of the cutting.

FILLINGS AND EMBANKMENTS

In especially difficult areas, or where there are unstable soils, then geotextiles should be used to secure slopes. Geotextiles which decompose within 5 – 10 years should be used.

Soils should be placed loosely on slopes and fillings so that surface water can infiltrate the soil, this to avoid surface run-off which causes erosion.



Filling / embankment slopes:

- Should follow the natural slope profile of the surrounding ground.
- Should vary and not be constant so that the slopes appears more natural, this both in the horizontal and vertical planes.

Topsoil should be laid out in varying depths so that it resembles the local situation. Where available, clumps of turf should be spread over the area. Typically a topsoil thickness of 10 – 20 cm is appropriate, but this can vary from area to area.

Where the base of the filling meets natural ground, one should aim to match the surrounding ground and vegetation so as to achieve a smooth transition.

Larger stones and boulders, preferably with natural surfaces, can be placed within the slope to provide a variation in the surface.

Off-Road Transport

Terrain damage should be kept to a minimum when driving off-road.

Off-road transport shall follow a single route, and avoid creating parallel tracks, this especially in wetter areas. It is preferable to choose routes around the edge of peat bogs.

Choose the correct route based on the vegetation type, terrain and topography.

Choose the correct driving technique, drive in straight lines over wet ground and maintain a constant speed.

- Driving over bogs and wetter areas. Peat bogs generally have a low surface strength. Those with a lot of grass will generally have a greater surface strength than those dominated by mosses. The rate of revegetation is relatively good in lowland areas although is slower in upland / mountainous areas, this due in part to the short growth season.

- Driving in mountainous areas and over exposed rock. These areas have a good carrying capacity although the vegetation which is present is often sensitive and slow to recover. With extensive traffic it may be necessary to cover vegetation so as to protect it.

- Driving on agricultural land. In these areas, off-road transport may result in compaction of soils reducing the agricultural quality of the soil. Geotextiles and other temporary road structures can reduce the risk of compaction.

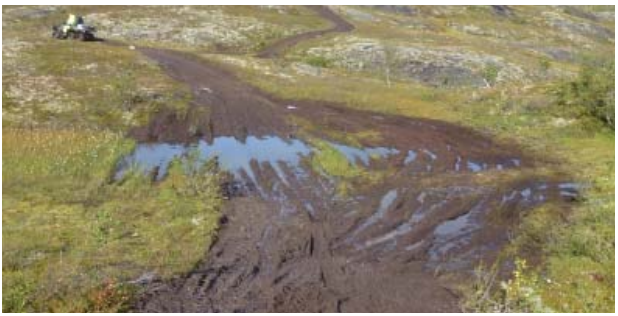


Figure 9
An example of a track which been extended to avoid the wettest ground. Measures should be implemented to avoid this.

Figure 10
Sharp corners with larger tracked vehicles can result in extensive damage. Off-road transport should aim to drive in straight lines where possible. The use of the excavator arm can help to reduce damage where sharp corners area necessary, alternatively sharp corners should be planned on drier ground.

Figure 11

Off-road transport when the ground is frozen is preferable.

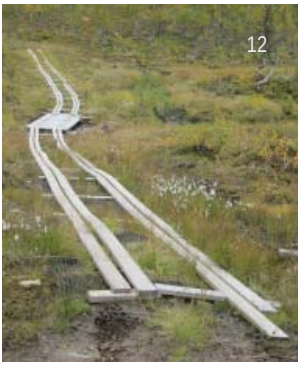


Figure 12

Wooden planks combined with geomembranes provide good support for lighter off-road vehicles (Photo: Norwegian Army).

Figure 13

Twigs, branches and other wood left after forest clearance can be used to improve carrying capacity and to protect existing vegetation along the transport route.

MITIGATION MEASURES

- The best conditions for off-road driving are when the ground is frozen or there is snow cover.
- Wooden planks may be used in wetter areas to create a firmer surface for off-road transport, these may last several seasons. Logs laid perpendicular to the transport route may also be used in wetter areas and / or areas with soft ground.
- Twigs / branches may be used in dryer areas that are not so hardwearing, such as dry areas in forests. When used with lighter off-road vehicles, branches may also provide support in areas with softer ground.
- Mats and plates may be used in wetter areas to avoid deep ruts, but also in areas with sensitive vegetation. Mats and plates provide effective protection but can result in anaerobic ground conditions, and as such should be lifted during periods without transport.
- Geotextiles provide additional ground strength and are most often used in areas with soft ground conditions along with geomembranes as well as wooden planks.

Figure 14, 15,16

Deep ruts from heavy vehicles can be avoided by placing logs in the track.

Construction Compounds

The following principles should be applied to construction compounds:

- Topsoil should be removed and stored for use in the reinstatement. Whole turfs and larger natural stones can also be stored to help obtain a more natural reinstatement.
- Topsoils may be left in-situ where there will be little traffic, assuming that this does not result in anaerobic conditions.
- Where construction compounds shall be retained as permanent areas, there should be focus on obtaining a smooth transition to surrounding ground, micro-siting and revegetation / landscaping around the compound.

Figure 17
Fill material is placed on a geomembrane.

Figure 18
Construction compound used in the construction phase.

Figure 19
Concrete spillages should be removed.

Figure 20
Photo visualisation of reinstated construction compound.

Cable Trenches

Figure 21
Storage of soils in front of work site.

- Be aware of the natural hydrogeological situation. Cable trenches should not lead to the draining of naturally wet areas.
- The cable trench and associated road should have a smooth transition to surrounding ground.
- Topsoils and natural stones which are removed along the route corridor should be retained for use in the reinstatement.
  - Where there is sufficient space, soils may be stored along both sides of the trench/road.
  - Where there is insufficient space alongside the work site, soils may be temporarily stored in front / behind the work site, or removed to temporary storage.
- See also the section relating to roads.

Figure 22, 23
The sketch shows a wide construction area that allows sufficient space for storage of topsoils along the route corridor.
When the trench / road are reinstated, the built road should be retained beneath the soil to provide a track with good carrying capacity.

Tower Sites

Figure 24
Avoid concrete spillage during foundation works.
Figure 25
A good example of refill and reinstatement around foundations.
Figure 26
A bad example of earthing where the earth wire is clearly visible (red line).
Figure 27
A good example of earthing where the earth wire is concealed (blue line).

Careful works around tower sites is a key factor in ensuring that visual impacts are kept to a minimum. Key aspects include:

- Earth wires should be buried in areas with soil and not be visible on the surface. In areas without soil, the earthing wire should be concealed as far as possible in cracks in the rock, and along areas with vegetation.
- Tower sites shall be tidied up following works. Concrete spillage, blasted rock and other waste shall be removed and not left on site.
- Blasting shall be undertaken in a controlled way, and blasted rock shall be placed around the tower foundations or in natural dips in the ground. Blasted rock shall be covered by soils where available.

SOIL FOUNDATIONS

- Topsoil should be scraped off and retained for use in the reinstatement of the area.
- Soils should be refilled so as to cover the base of the foundations (see the diagram below).

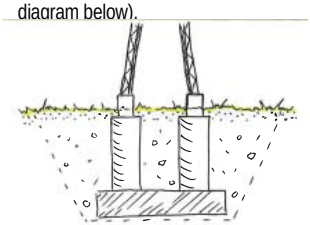
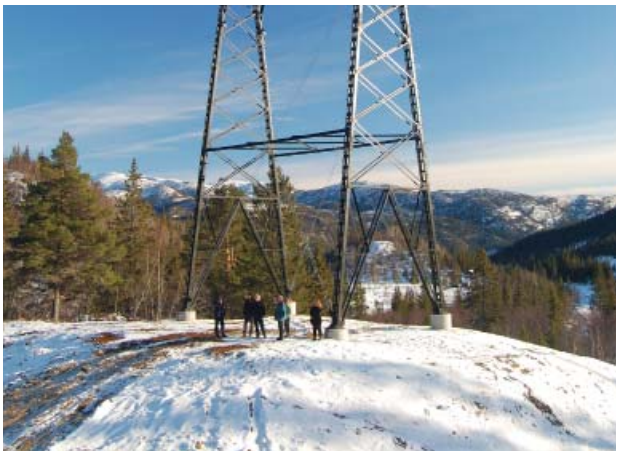


Figure 28 og 29

Soil refill around foundations

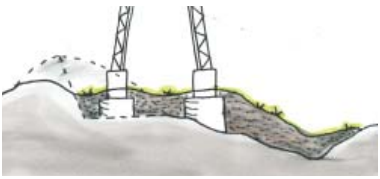


ROCK FOUNDATIONS

- Where there are soils present, these should be scraped off and retained for use in the reinstatement of the area. They should be refilled so as to cover the base of the foundations.
- Stone and rock remains from blasting should be used as refill material, and should be covered with soil to obtain a good surface finish.

Figure 30, 31 og 32

Exposed foundations should be avoided (photo 30), the base of the foundations should be covered with fill material / topsoil (photo 31). A sketch of reinstatement is shown below.



Electricity Sub-Station

Figure 33
Ofoten substation is located in a sheltered and secluded area.
Figure 34
Balsfjord substation with a row of planted birch trees.

- Sub-stations should be sited so as to use surrounding topography and landscape as screening and reduce the visual effects. Retained or new vegetation screens should be planned so as to appear natural.

- Where possible, vegetation around the substation, including larger trees, should be retained. These areas should be marked to avoid damage during works. Where individual trees are to be retained, an assessment should be made as to the risk of wind throw.


33


34

Decommissioning

A thorough clean-up of decommissioned tower sites is important.

- Rock Foundations. The part of the foundation located above the ground should be removed, and reinforcement bars should be cut at the surface and rounded off to avoid injury.

- Soil Foundations. Foundations should be removed to a depth of 20 cm, and 70 cm on farmland. The excavation should be refilled and re-vegetated. Clean and crushed concrete may be used as fill material although it should be covered with soil.

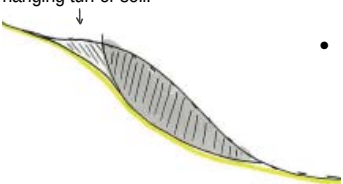
- Earth wires should be cut below the surface. Those which are fixed to rock on the surface should be removed including clips.

- Tower dismantling should be undertaken in a controlled manner to avoid excessive damage to surrounding areas. All material from dismantled towers should be removed from sites.

Excavation of Soils, Stone and Rock

Figure 35

Adjusting of the edges of an excavation is important. The photo and sketch show a good example of this with little sign of erosion and no overhanging turf or soil.



- Where soil or rock / stone is needed for construction works, they may be sourced locally such as along access roads or from borrow pits / quarries. Alternatively, small scale rockoutcrops or moraine materials can be removed. It can often be simpler to reinstate an area where the entire feature has been removed, notably with regard to a reduced risk of erosion.
- It is important that the edges of the borrow pit / quarry are rounded off to provide a smooth transition to the surrounding, natural ground. The edges should be reinstated to match as far as possible the soil thickness and vegetation of the surrounding area.

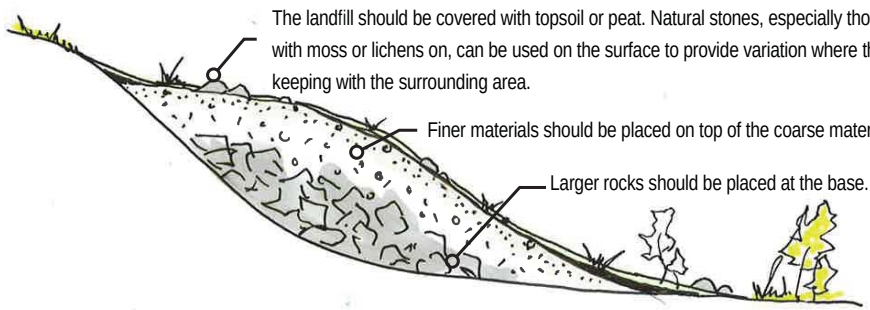
Landfills

Soil and rock landfills should be placed in areas with a suitable topography.

- Landfills should be constructed in such a way that they are stable. Retaining structures should be considered where there are large amounts of peat, and these should be covered with soil and slope angles should be limited.
- Rock fill in the landfill should be covered with soil once filled. Soil cover should be appropriate for the proposed vegetation.
- Where the landfill contains a high level of peat, it may be appropriate to spread limestone to adjust the pH and facilitate revegetation. It may also be advantageous to seed the area with a seed mixture appropriate to the local area.

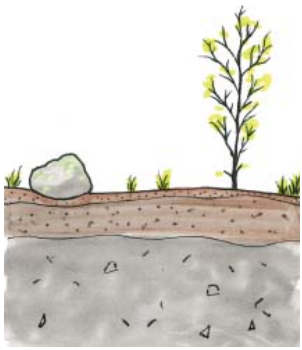
Figure 36

A sketch of a typical landfill and how it should be constructed.



Reinstatement

Figure 37
Sketch of optimal reinstatement with coarse material underlying middle grade material. Finer topsoils should be placed on the surface. Natural stones and turfs can be used to provide variation on the surface.



The following general principles should be taken into consideration during reinstatement and revegetation works:

- Topsoil and turfs scraped off and stored earlier, should be used in the reinstatement.
- Coarse materials should be placed lower down with finer topsoils on the surface.
- When refilling with coarse materials, it is important to avoid topsoil disappearing into this coarser material. Middle grade material should be used in the transition between coarse rock fill and topsoil as shown in the sketch to the left.
- Aim for a smooth transition to surrounding ground, and that the reinstated ground is in keeping with the surroundings.
- Aim to use natural stones and complete turfs on the surface of the reinstatement
- Ensure the reinstated area is tidied up following completion of the works.
- As a general rule, reinstated ground shall not be seeded and should be left to re-vegetate naturally.

FARMLAND

- Not all temporary access roads necessarily require the removal of topsoil. In some cases temporary access roads can be constructed directly on the surface using a geonett or geotextile.
- Following transport and construction works on farmland, affected areas should be seeded so as to out-compete weeds. Natural re-vegetation should be avoided in these areas.

FOREST

Figure 38

An example of soil being filled up around tree trunks. Trees do not cope well with this and it should either be avoided, or the affected trees felled.

Forest areas generally offer good opportunities for reinstatement and re-vegetation in part due to soil and seed availability. Reinstatement in forest areas should also consider the following:

- Forest clearance in the transmission line corridor and around construction compounds should be kept to a minimum to avoid introducing an unnatural feature in the landscape.
- Trees which do not grow higher than 2 – 3 m should be retained where possible.
- Where tree roots have been damaged by works, where roots are protruding from cuttings or where soil has been filled up around the tree trunk, then these affected trees should be felled to avoid the risk of wind throw and disease.

UPLAND AND MOUNTAINOUS AREAS

Upland and mountainous areas generally have a short growing season which gives a slower re-vegetation. There are a number of challenges associated with reinstatement in upland and mountainous areas.

- Areas with exposed bedrock or with shallow soils in upland areas are especially sensitive for damage due to off-road transport. The limited amount of available soil makes reinstatement with local topsoil difficult.
- Preventative measures to reinforce and protect the surface prior to construction works should be considered. Where vegetation needs to be removed, it should be removed as complete turfs where possible as these will generally be less prone to erosion when used in the reinstatement of the area. The use of biodegradeable nets, such as coconut nets, can be considered to stabilise soils.

BOULDER FIELDS AND SCREE

Boulder fields and scree slopes are often located on steep ground and are unstable, with little or no soil. Vegetation comprises primarily moss and lichen.

- In areas dominated by stones and boulders, the reinstatement should aim to match the size of stones on the surface with the surrounding area.
- Where possible, the side of stones and boulders with moss and lichen on should be placed facing upwards.

Figure 39 Ground damage following off-road transport. Pasvik, spring 2010.

Figure 40 A successful reinstatement of the same area. Pasvik, summer 2012.

Figure 41 In some situations, it can be necessary to seed an area in order to speed up the re-vegetation. In this situation, a peat landfill (bottom right) was seeded in order to help stabilise the fill material.

Figure 42 Following one growth season, the re-vegetation is well underway.

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