

Svalbard Global Seed Vault

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The Svalbard Global Seed Vault is a store for duplicates of the world's crop collection in a safe environment, thus ensuring that the seed duplicates are safe from seed extinctions during large-scale regional or global crises. The vault contains seeds that are essential food crops, such as beans, wheat and rice.

Soon after the opening of the vault in 2008, meltwater from thawing seasonal snow melt and rainwater runoff, found its way into the access tunnel. The access tunnel links the iconic portal building to the rock tunnel system. The problems with water in the access tunnel escalated after the extreme warm summer and autumn that occurred in Svalbard in 2016. This event was quickly linked to climate warming, even though the root of the problem is mainly related to engineering and construction challenges that commonly occur in permafrost regions.

The Svalbard Global Seed Vault is located near Longyearbyen, Svalbard (78° 13'N, 15 ° 33'E) at 130 meters above sea level. This location is considered ideal because of the area's relatively low tectonic activity, the presence of permafrost (permanently frozen ground) and it is 130 meters above the present-day sea level, thereby allowing for future sea level rise. The mean annual air temperature in Longyearbyen has increased from approximately -6.7 °C in 1989 to -3.8 °C in 2020, creating concerns related to the stability of permafrost soils. In 2016 the mean annual air temperature was only -0.1 °C and there were several unusual precipitation events in the autumn of 2016 that caused extensive landslide activity and flooding.

The Norwegian government decided in 2017 to upgrade the Svalbard Global Seed Vault and Instanes Consulting Engineers was responsible for the geotechnical design and supervision of the earth works during the upgrade 2017-2019. The main objective of the upgrade was to construct a storage facility for seeds, that will remain cold, dry, and dark for the next centuries, even under the most extreme climate warming scenarios. This design was achieved by a combination of construction procedures including watertight concrete, low permeability backfill material and artificial cooling of the permafrost soils and rock.

The upgrade included opening a 20 meters deep excavation in the permafrost and replacing the access tunnel from 2008 with a new water-tight concrete tunnel. The access tunnel through the soil is approximately 40 meters long with a slight inclination towards the vault. The excavation was then backfilled with well-graded sandy soils with low hydraulic conductivity and three layers of bentonite (clay) liners. Artificial cooling of the backfill material was applied to ensure a frozen material after closure of the excavation. A new refrigeration system and technical service building were included in the project. The vault is designed to maintain subzero temperatures without artificial cooling for at least 100 years under extreme warming scenarios.

After completion, the tunnel system has multiple barriers to prevent water from entering the vaults, including water-tight access tunnel, low permeable soils as backfill, clay liners, and temperature in the backfill permafrost and rock lowered to approximately -10 °C.

Construction work in permafrost regions is challenging, especially in a climate warming scenario. The construction principles highlighted are important for all types of structures on permafrost and could prevent construction of facilities that have to be replaced shortly after completion.