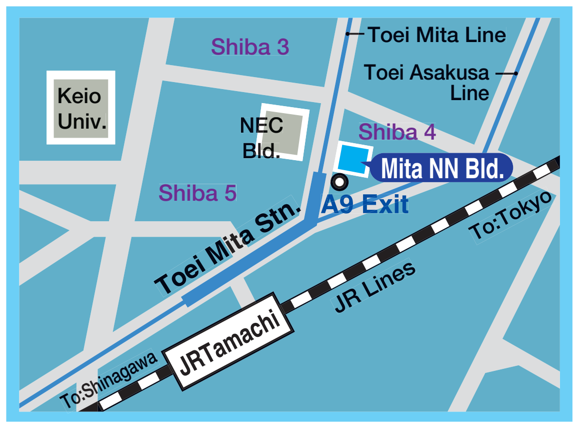
Nuclear Waste Management Organization of Japan (NUMO)

Site Planning and Public Relations Department
Mita NN Building 2F.
1-23, Shiba 4-chome, Minato-ku, Tokyo 108-0014
TEL: +81-3-4513-1116
FAX: +81-3-4513-1299
Website URL: http://www.numo.or.jp




Toei Mita Line, Toei Asakusa Line (Mita Station Exit A9)
JR (Tamachi Station): 5-minute walk

# Open Solicitation for Candidate Sites for Safe Disposal of High-Level Radioactive Waste

December 2002
Nuclear Waste Management Organization of Japan

**Direct inquiries about this document or the open solicitation procedure to**


Site Selection Group, Site Planning and Public Relations Department
Nuclear Waste Management Organization of Japan
Mita NN Building 2F
1-23, Shiba 4-chome, Minato-ku, Tokyo, 108-0014
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# Message from NUMO's President

The mission of nuclear waste management is to maintain the environmentally friendly nature of Japan's nuclear energy program by implementing safe disposal of high-level radioactive waste (HLW). In order to implement this mission, in accordance with the "Specified Radioactive Waste Final Disposal Act" (the Final Disposal Act), the Nuclear Waste Management Organization of Japan (NUMO) was established in October 2000 as the implementing organization.

## Assurance of safety is NUMO's top priority

In 1976 the Japan Atomic Energy Commission (AEC) decided that management of HLW in Japan be based on the concept of geological disposal. In 1999, the Japan Nuclear Cycle Development Institute (JNC) published a technical report that compiled all relevant research and development on HLW disposal and outlined the feasibility of such a disposal program in Japan. Based on this technical foundation, NUMO's responsibility is to develop the HLW disposal project with particular emphasis on ensuring safety at all stages, from the selection of a repository site, through design, construction, operation, closure and finally post-closure monitoring, by cooperating with our nation, national organizations and electric power companies.

## Open solicitation for candidate sites

According to our national policy, we will implement the site selection process in three stages, with selection of a final disposal site between 2023 and 2027. To initiate the first stage, NUMO has chosen an "open solicitation" approach for finding candidate sites in the belief that the support of local communities is essential to the success of this highly-public, long-term project for more than a century. Therefore, we would like to invite municipalities throughout the country to consider volunteering as candidates for areas to explore the feasibility of constructing a final repository for high-level radioactive waste.

The documents contained in this solicitation are provided to help communities decide whether to volunteer as a candidate site for preliminary investigations for a repository. In this package you will find the following documents:

- Instructions for Application;
- Repository Concepts;
- Siting Factors for the Selection of Preliminary Investigation Areas;
- Outreach Scheme.

We urge all municipalities will study these documents and consider volunteering.

President Kazunao Tomon

# Resolving the HLW Disposal Issue

## Nuclear power generation produces HLW

One third of the total electricity production in Japan comes from nuclear power, which generates very small volumes of high-level radioactive waste (HLW)

As with carbon dioxide production from fossil fuel power generation, any form of electricity generation produces some form of waste.

In Japan, reprocessing of spent fuel is used to separate re-usable uranium and plutonium from the waste. The resulting liquid containing high-level radioactive waste will be vitrified in stainless steel containers. This is termed vitrified waste or HLW.

Nuclear power generation began in our country some 40 years ago. By the end of 2001, spent nuclear fuel corresponding to approximately 15,500 containers of vitrified waste had been generated.

## We need to find a safe solution

Because HLW contains high levels of radioactivity, it has to be isolated from humans and the environment.

Currently, HLW is held in secure surface storage facilities. This type of storage presents no technical or economic problems over reasonable periods of time. However, HLW requires tens of thousands of years until the radioactivity has dropped to acceptably low levels. Surface storage over such timescales is not practicable without passing a great burden of responsibility to future generations.

We are the generation benefiting from nuclear power based electricity generation and we should not leave the problems associated with HLW to future generations. Also, we share the global view that disposal of HLW should be managed within the country and by the generation benefiting from the nuclear energy.

Radioactivity decays spontaneously with time. Thus, it is possible eliminate negative consequences of HLW if the waste is isolated from humans and the environment for the time needed for the waste to decay to negligible levels.

Locations that are sufficiently isolated from humans and the environment include outer space, beneath oceans and deep underground. Of these, the deep underground environment is most appropriate because of the following factors: 1) movement of radioactive materials underground is generally slow; 2) human intrusion is difficult; 3) a subsurface facility can be implemented within an individual nation's boundaries; 4) this approach is permitted by international law; and 5) subsurface disposal is technically and financially feasible.

## The deep underground environment is naturally capable of confining materials

The deep underground environment has preserved ore deposits and fossils for millions of years. This is possible in environments where:

① Movement of deep groundwater is very slow;
② The environment is chemically stable and chemically "reducing".

The rate of deep groundwater movement can be determined from the age of deep groundwaters. In suitable locations, water may be tens of thousands of years old. Stable chemical conditions result from the interaction of small volumes of water with large volumes of rock over very long times without major disturbance.

Geological disposal represents an effective means of utilizing the natural conditions in deep geological formations to isolate radioactive materials.

## Geological disposal will not affect our living environment

Japan has frequent earthquakes, many volcanoes, no deserts and groundwater. This set of conditions makes it difficult to realize geological disposal. Caution needs to be used to prevent impact on humans and the environment of radioactive materials released from a repository where:

① Volcanic activity or fault movement disturb the repository; and
② Migration of radioactive materials within groundwater are sufficiently fast to bring significant amounts to the surface.

Previous volcanic activity and the location of active faults, as well as the current structure of tectonic plates around the islands of Japan have been extensively studied. Based on these studies, we are confident that the tectonic plate structure around Japan will not change significantly in the foreseeable future and there is small chance of volcanoes and active faults appearing in new locations. Therefore, it is possible to identify and avoid these areas.

Additionally, radioactivity can be released as waste dissolves in groundwater then moves with the water away from a repository. Engineered structures act as barriers preventing migration of radioactive materials to the human environment for tens of thousands of years. These barriers include mixing the waste in a vitrified form, encasing the vitrified waste in steel containers and surrounding the containers with layers of clay. Furthermore, as radioactive materials migrate through the subsurface they will be sorbed onto rock. Jointly these mechanism retard the rate of movement and thus nuclear material will ultimately require hundreds of thousands of years to reach the surface. After such long time periods, the level of radioactivity of any material returning the human environment would be well below radioactivity levels that occur naturally.

## Promoting community trust and safety

Existing research has shown that safe HLW disposal is clearly possible. However, the safety of a geologic repository is not yet accepted completely by our society for three reasons: 1) radioactivity cannot be detected by our senses; 2) members of society have no direct experience with repository and ; 3) few understand that the risks associated with HLW decrease through time as radioactivity decays away.

NUMO wishes to help resolve these important issues by providing extensive information about geological disposal, NUMO's overall project, and other related topics of interest to communities throughout Japan.

The HLW disposal project will be implemented in a step-by-step manner, consulting regularly with municipalities and interested parties to ensuring active exchange of information.

# Implementation of Final Disposal

NUMO's foremost priorities are insuring public safety and building public trust. To accomplish these goals we will focus on three items.

## Safety and Trust

### Stepwise Project Development

The disposal project will require more than a century to implement. NUMO will proceed in a step-by-step manner, with thorough evaluation of information, and extensive public involvement in each stage. Stages of development include: selecting a repository site, construction, operation, closure and post-closure control.

### Engaging Communities

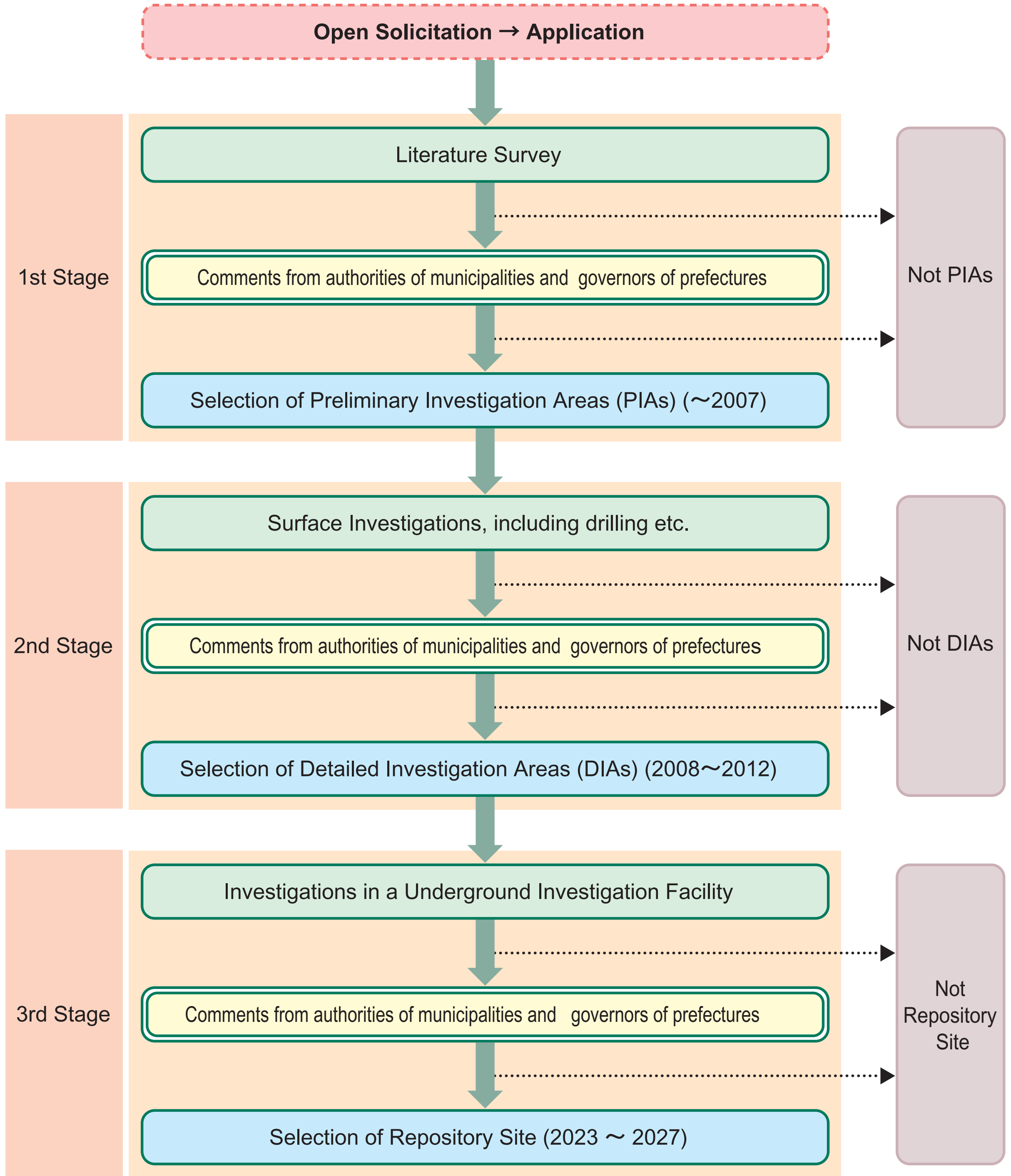
The HLW disposal project is highly-public and long-term project. NUMO will seek strong municipality involvement and provide support for broad community engagement.

### Focusing on Transparency

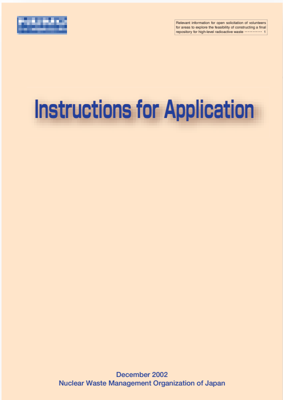
NUMO will disclose all information on this project in an accurate, timely and comprehensible manner to municipalities and others.

## Procedure for Repository Site Selection

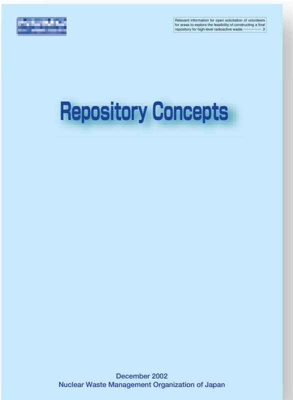
There are three stages of activity in selecting a repository site. NUMO will pursue these activities in close consultation with municipalities, providing detailed information to every interested party in the form of reports, explanatory meetings, etc.



# Information Provided in Supporting Documents

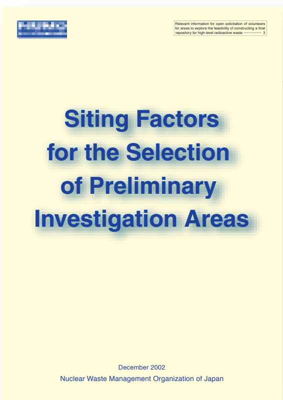



Basic guidelines and requirements for volunteering as a candidates for areas to explore the feasibility of constructing a final repository for HLW, e.g. suitable areas, application method, etc.



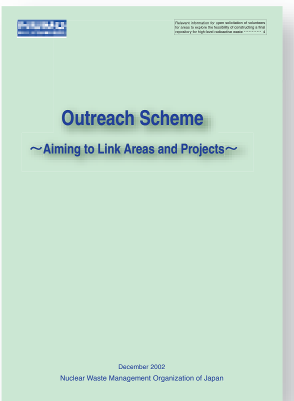

Information needed to understand the features of a repository including engineering design, construction, operation and safety

(see pages 8-10)




Siting factors that must be considered in selecting PIAs and the criteria used for their assessment based on Literature Survey.

(see page 11)




Interaction between NUMO and volunteer communities along with regional development, information exchange and so forth.

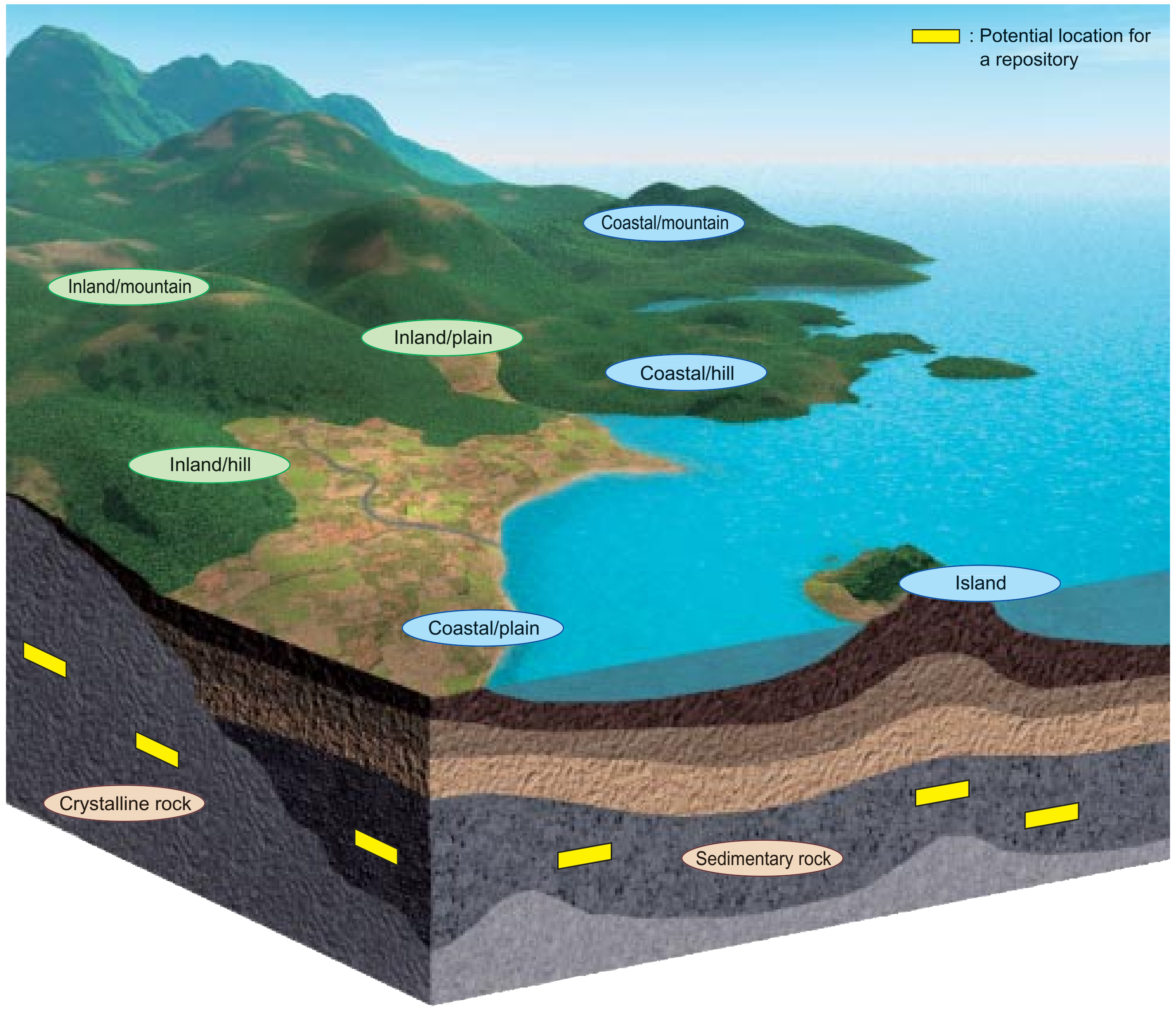
(see pages 12)

## 1 Repository Concepts

### Appropriate repository locations can be found throughout Japan

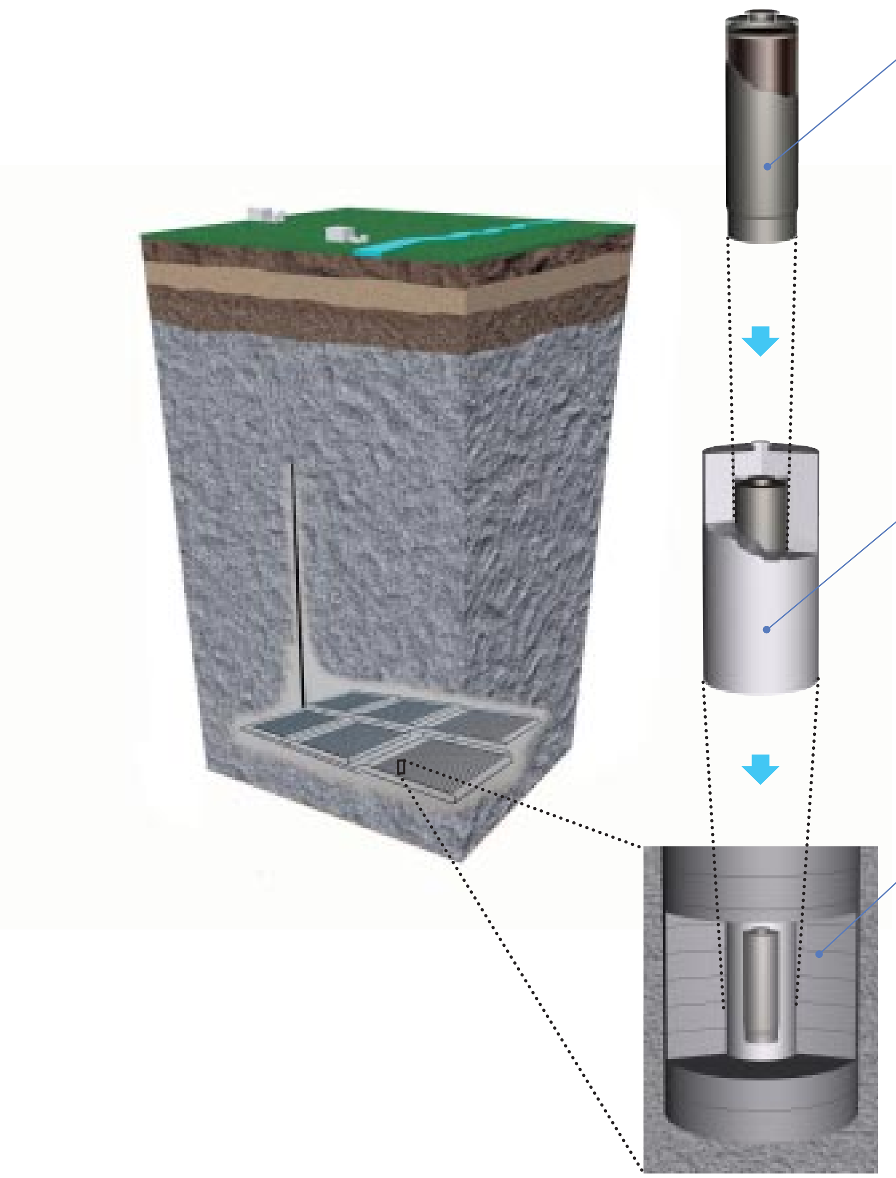
NUMO plans to dispose of at least 40,000 containers of vitrified waste in a repository consisting of surface facilities (required area: approximately $1km^2$) and underground facilities (required area: approximately $10km^2$ or less). There is a range of potential environments for repository construction in Japan. These have different characteristics, for example inland and coastal areas (geographic aspects), mountainous, hilly and plain areas (topographic aspects) and areas with crystalline or sedimentary rocks (geological aspects).

Various Potential Areas for a Repository



## Safe containment of HLW

The underground facilities will be constructed in stable rock formations at least 300m below the surface. The rock formations themselves function as a natural barrier between the waste and humans for a long time period. The waste is vitrified and encapsulated in steel containers, which are also surrounded by a compacted clay, and emplaced in tunnels in the repository as shown in the picture below. The vitrified waste, steel containers and clay buffer are termed “the engineered barrier system”.



**Vitrified Waste**

Radioactive material is immobilized in a glass matrix and is only released as the glass is dissolved.

**Overpack (Steel Container)**

The vitrified HLW is encapsulated in an overpack (steel container) to prevent contact with groundwater during the time when its radioactivity and heat generation are high.

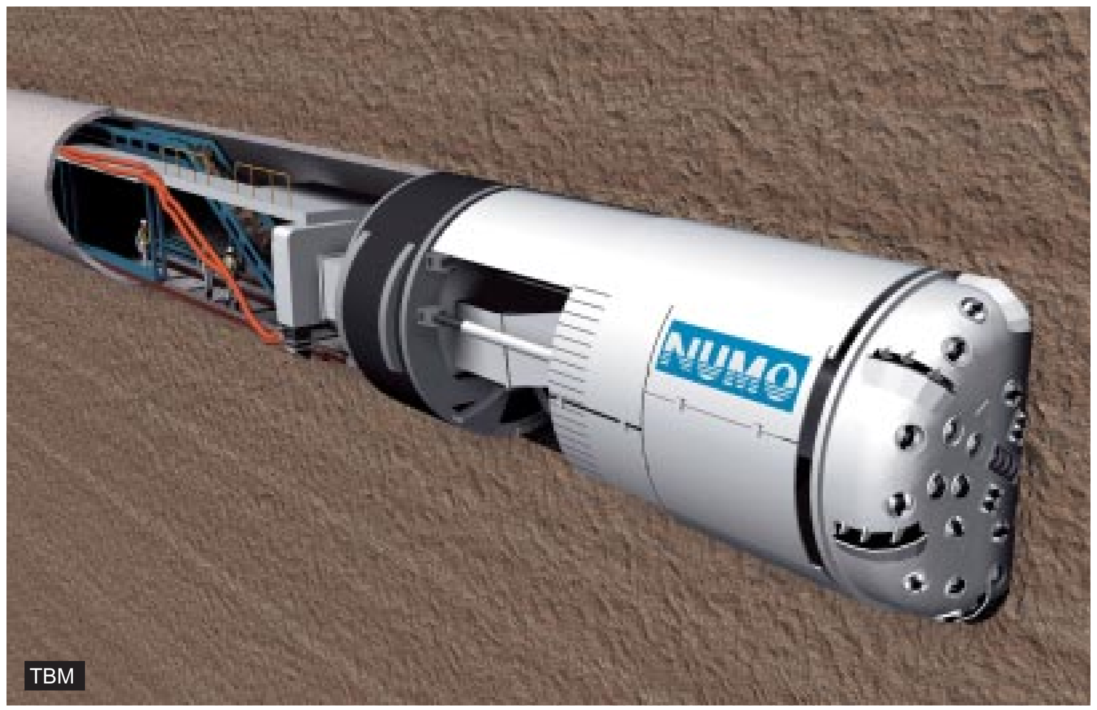
**Buffer (compacted clay)**

The buffer is mainly bentonite clay compacted to high density so as to have low permeability, which slows the movement of dissolved radioactive waste. The buffer is also designed to protect the overpack

## Construction using established technologies

Although constructing a large-scale facility deep underground may appear to be a very difficult task, Japan has extensive experience in mining and tunnel construction at depths in excess of several hundred meters.

The repository will be constructed using current technology, such as Tunnel Boring Machines (TBM) like those used to excavate the Channel Tunnel in Europe and will not require completely new technology.




TBM

# 2 Siting Factors for the Selection of PIAs

## PIA selection

NUMO will conduct literature surveys to collect and assess existing information for volunteer areas and will then select PIAs. Prior to this selection, information on volunteer sites gathered through literature survey will be used to identify areas unsuitable for repository construction. These areas will be excluded. In cases where it is difficult to make a conclusive judgement of suitability, follow-up investigations at later stages will be carried out for further clarification.

## Siting factors

There are two sets of factors or site conditions that can be used to screen volunteers and select potential PIAs. First are factors that must be met as required by act. Second are factors that would indicate more favorable sites.

### Factors relating to legal requirements

The act requires that areas with the following characteristics defined in through the literature review will be excluded from consideration as PIAs:

| | |
|---|---|
| ① Earthquakes, Fault Activity: | Areas with clearly-indentified active faults |
| ② Igneous Activity: | Areas within a 15km radius of recently active volcanoes identified Japanese Quaternary Volcano Catalogue |
| ③ Uplift / Erosion: | Areas with uplift amounting to more than 300m during the last 100,000 years |
| ④ Quaternary Unconsolidated Deposits: | Areas with geological formations in relevant depth ranges consisting of Quaternary unconsolidated deposits |
| ⑤ Mineral Resources: | Areas with geological formations bearing economically valuable mineral resources |

### Factors related to favorable characteristics

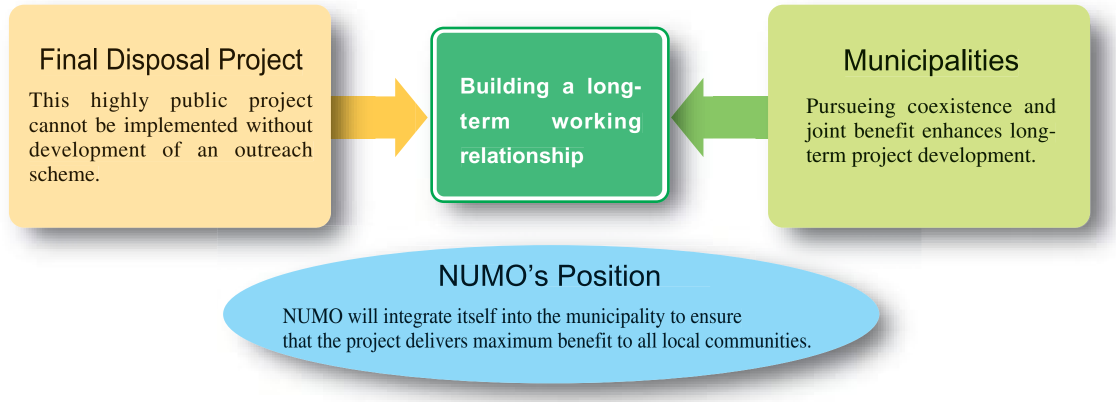
In addition to the legal requirements there are characteristics or favorable factors that if present would help ensure safety, simplify characterization and analysis, reduce project cost and implementation; such as groundwater and host rock properties, availability of land, efficiency of transportation, etc. These will be evaluated to allow comparison of potentially suitable candidate areas.



# 3 Outreach Scheme

## Outreach policy

It is important for the relationship between the waste disposal group and the municipality that has accepted the project to grow and develop through time. NUMO's outreach scheme is intended to build a relationship involving integration of NUMO activities with community needs, communicating with all interested parties and earning the community's trust.




## Approach for Outreach Scheme Planning

- Building an outreach relationship through formulation and implementation of a long-term regional vision
  → Establish a system that gives first priority to the area's wishes and thus creates a forum where local residents and NUMO can exchange opinions and hold free discussions.
- Implementation of the project to ensure sustainable regional development
  → NUMO will proceed with the implementation of the final disposal project with a view to ensuring that maximum economic benefits are achieved in the prefecture, including the municipality, over the long-term project.
- Implementation of activities aimed at promoting mutual understanding
- Enhancement of outreach plans concurrent with the full start of operations

## Aiming towards Outreach to the Municipality

- Establish a working relationship and system to facilitate joint activities to adjust various conditions, secure necessary budgets, and interact jointly with Japanese Government and electric power companies.

| | |
|---|---|
| **Expected economic benefits associated with the construction and operation of a repository** ▶ | [Production inducement effect: 1.7 trillion yen, Employment creation effect: approximately 130,000 workers, fixed property tax revenue: 160 billion yen] |
| **National Power Source Grant Program** ▶ | [Literature survey period: 0.21 billion yen/year/site; preliminary investigation period: 2 billion yen/year/site (upper limit : 7 billion yen/year/site) ; amount not fixed for detailed investigation period] |