“In Cooperation with Nature”
IPLOCA Environmental Award 2010 sponsored by SHELL

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1. Introduction: In Cooperation with Nature

Nowadays, the preservation and protection of our environment is a significant factor in the decision process of the pipeline industry. The STREICHER Group goes even further: We do not only see our duty in protecting the environment from damages of any kind, but also to ensure its persistence and prosperousness in a sustainable manner. Professionals of our industry often ask themselves how environmental damages can be reduced. We consider this thought as outdated and not appropriate anymore: Our employees devote themselves to permanently sustain the nature.

We are aware of this fact and therefore pay special attention to all factors that could influence the environment: Not only that our highest priorities in developing new processes and innovative technologies are the requirements of the environmental protection, we also make constant efforts to improve and optimize all present and conventional methods in use. The STREICHER Group acknowledges and confirms its responsibility towards nature and also towards next generations: Our objectives are not only to keep the environmental interferences as low as possible, but to neutralize them completely.

That’s why we would like to present you our new procedure that is consequently aiming to enforce the positive cooperation with nature, besides of its purpose to minimize negative influences.

We endeavor for your appreciation as we see our self-set principles as fulfilled. Furthermore, we perceive our innovative procedure as a vital step of our industry towards more environmental responsibility. It should become indicatory and exemplary for all companies of our industry.
2. Company Profile

The STREICHER Group is characterized by technologies and services in four business sectors: pipeline and plant construction, mechanical engineering, civil and structural engineering, raw and construction material.

The individual corporate divisions are specialized in their business fields. More than 2,800 employees work with expertise and distinctive customer orientation. The divisions work hand in hand and guarantee a smooth project execution. A tight organizational structure and high reliability concerning the execution of projects result in a cost effective calculation.

STREICHER’s success is based many years of experience, a consequent quality management and solid capital resources as well as motivated employees. All companies of the Group work on a high technological level. The basis for this is regular investment in machinery as well as the qualification of our employees.

Innovation and investments result in a continuous extension of company activities and guarantee long-term performance of the STREICHER Group.

STREICHER Group possesses extensive expertise and many years of experience. Due to the bundling of specialized business units, STREICHER is able to carry out major projects as a complete package.
3. Access roads in the pipeline industry

(Image 1: Spreading and milling machine at the sample field. The plenum is highly instable and hydrous.)

It is inevitable for the economical and safe realization of construction projects to access the site on appropriate roads. This infrastructure makes it possible to provide the construction site with pipes and materials. Moreover, the access roads within working areas are essential for the technological construction of projects and the transport of heavy machinery.

Aspects of safety play a vital role when evaluating the quality of an access road: construction projects often have to be executed on hydrous, instable and hardly passable terrain. In these cases it is of outmost importance to rely on paved access roads, as a poorly realized road could entail in jeopardizing consequences: construction vehicles tilt, resulting in personal or property damage.
In respect to nature a conflict of interest arises as appropriately paved and safe access roads require greater interference which leads to irreparable damages to the environment.

STREICHER has extensively occupied itself with this difficulty and has acknowledged the necessity of new environmentally friendly and sustainable methods as the pollution created by conventional procedures is unbearable and irresponsible.

3.1. Conventional methods in pipeline construction

The setup of conventional access roads in the pipeline industry leads to vast derogation of nature and environment. Large amounts of sand, gravel and other synthetic materials are used and later disposed worldwide. Logistically, the industry is confronted with long distances which have to be driven by heavy loaded and highly motorized vehicles. Thus, the establishment of access roads, their rebuilding and disposal are related to high energy consumption and consequently to high carbon-dioxide emissions.

The massive usage of expensive materials and high energy consumption are two factors which makes building of access roads on hydrous, instable terrain so cost-intensive.

Additionally, conventional access roads inflict irreparable damage to the soil, even after they have been rebuild. The consequences often lead to unnaturally condensed soil, resulting in high degradation. This reduces the functions of the soil’s ecological system or – worst case scenario – eliminates them completely. Without a healthy ground and their micro fauna the important functions of the ecological system cease to perform: Disintegration of dead organic material, recycling of nutrients and the cultivation of field crops are not processed any longer.
It is not necessary to mention that the energy corporations and all companies involved will suffer tremendous reputation loss in modern society that is sensitive for environmental issues. Due to the technological advantages of the information age all catastrophic consequences of incidents caused by companies of all industries are made aware and discussed in public. Hence, the preservation of soil resources is continually discussed in all aspects of our everyday life.

All these facts have encouraged STREICHER to take the necessary steps towards nature and soil protection. And with TerraBas® we have found an innovative solution to build access roads in an environmentally friendly way.

### 3.2. TerraBas® - The innovative method for building construction roads

#### 3.2.1 TerraBas® as a material

TerraBas® is not only used in the pipeline industry, but also in rail road construction, landfill construction, structural engineering and hydraulic engineering. It suits well to hydrous soil with low carrying capacity and frost resistance. TerraBas® is made of alkaline rock flour with a silicate carrier. With a ratio of 80% the alkaline rock flours embody the foundation of the binding agent. The base materials for this are extrusive rocks of volcanic origin. The primary rock flour is produced in Diabas and Basalt quarries and directly crushed and grinded at the extraction site.

The production of TerraBas® needs less energy and is environmentally friendlier than sand or gravel.
TerraBas® does not include any kind of hazardous substances, as it completely consists of natural products. Consequently, it is unrestrictedly environmentally acceptable and can even be used in sensible areas like water protection zones.

3.2.2 Building and rebuilding of access roads with TerraBas® in agricultural production land

The topsoil in the area of the construction site is removed by 0.1m to 0.4m. The underlying subsoil is as well shifted. Both are stored in a separate and sterile location and sheltered from pollution or any other negative influence.
TerraBas® is inserted in a depth of approximately 0.45m into the remaining subsoil. It dehydrates the soil and so reduces its moisture content. The surface structure is being condensed and paved in an environmentally friendly manner. TerraBas® ensures after the setting of the soil-binding agent mixture in a short period of time surface stability and weather unconditional solidness for construction works. It is even highly resistant to strong flowing sour water.

Not only does TerraBas® provide the necessary soil attributes for optimal and highly resistant access roads, it also has many other positive influences on nature: It improves the soil condition by stabilizing organic soil minerals and by conditioning of sludge. Furthermore, optimization of the carrying capacity of instable soils considerably reduces the permanent threat of erosion.

The rebuilding of TerraBas® is as simple as it can be: As no disposal of the material is necessary, the access road is split up and the soil-binding agent mixture is homogenized. The separately stored topsoil is put back on. The area used for the access road can now be used again for agricultural purposes.

Due to the following attributes TerraBas® is the solution to provide environmentally friendly and cost intensive production of access roads

- Without transportation and disposal of waste materials
- Low energy consumption and carbon-dioxide footprint
- safe access roads, independent from climate and weather
- no synthetic material that is hazardous to groundwater or nature

This is why we consider TerraBas® as one of our most innovative methods to protect our environment.
3.2.3 Processing TerraBas®

The spreader vehicle is equipped with a computer-controlled spreading regulation making it possible to precisely adjust the spreading range and angle. A silo vehicle situated beside the route fills the spreader.

After TerraBas® has been spread on the route the milling process starts. Its execution depends on the condition of the soil in order to have an optimal result.

The solid area is rolled off; it must be noted that the rolling process should be started after less than 2 ½ hours (depending on weather conditions) after TerraBas® has been induced. The finished access road should not be used for 48 hours in order to ensure an optimal binding of TerraBas®.
There is no increase in mass and volume of the soil during the whole process. The major part of the binding is finished after less than 48 hours. The complete process is finished in 28 days. If the access road is split up after this period of time, there will be no second binding process or any other biochemical reaction.

3.2.4 Environmentally friendly effects of TerraBas

Primary rock flour has been used in gardening and agriculture for many years; especially for biodynamic and organic agriculture it has become indispensable. According to German Law and European Union regulations, primary rock flour is not categorized as fertilizer, but is a soil auxiliary material. Furthermore, the usage of primary rock flour is a gentle method to improve the mineral content of the soil as confirmed and proofed by scientific studies, research and the corresponding literature.

Important minerals, particularly iron and magnesium are necessary for plant growth. Additionally, the amount of trace elements is vital. Alkaline rock flours, as contained in TerraBas®, provide all the mentioned substances in order to improve the stabilization of soil minerals, ph-value and the supply of nutrients and trace elements.
The negative impact on agricultural productivity is very low, as TerraBas® is only inserted in a proportion of 2 to 4% of the subsoil.

All mentioned facts are scientifically proofed: In 2009, scientific tests were carried out by the Dr.-Meyer Spasche Institute which analyzed TerraBas® construction purposes but also its nutrient supply and plant growth in case of a later agricultural use. The biological and chemical compatibility was also confirmed in reports of special laboratories for plant nutrition. In summary this means that there are no restrictions for further agricultural use of areas treated with TerraBas®.

4. Conclusion

Not direct factors, like its fertilizing effect or the absence of any hazardous or phytotoxics substances, have to be taken into consideration when evaluating TerraBas®: Indirect factors, like low carbon-dioxide footprint and energy consumption during production, transport and usage are playing a vital role. Thus, TerraBas® does not only score environmentally and economically, but as well in its holistic usage on all construction sites.

Expert pipeline construction shows no residuals or changes. The use of TerraBas® is a significant element of this requirement: TerraBas® is absolutely neutral in respect to hazardous influences and even provides many useful auxiliary minerals for the soil and promotes plant growth by additional minerals and trace element due to its nature as alkaline rock flour.

The usage of TerraBas® is an important innovation in the environmental protection of our industry: all in all, the usage of TerraBas® is not only environmentally friendly but also
beneficial. Furthermore, it saves energy and reduces carbon-dioxide emissions in production and transportation and ensures the safety of people and equipment on site – No matter under which soil or weather conditions.

5. Appendix: Technical Data of TerraBas®

Processing:
Stabilization and condensing technology by TerraBas®

Machinery Requirement:
Commercially available construction, cultivation and mixing machinery.

Types of Soil/Terrain:
Soil of BKI 1-5, independent of granulometric composition, road construction or asphalt waste, frost resistance, contaminated soil / ground, various ashes or slag and common construction waste

Characteristics of Process:
Mixed-in-place process (Exception: Mixed-in-plant)

Changes in Weight and Volume:
Change in weight maximally 4% to 10%
Generally no change in volume

General composition aggregates:
Compositions are made after individual examination and possible present hazard contamination. The portion of the binding agent lies between 1% to 6%.

Cure time:
The usage of the access road depends on the amount inserted but is generally possible after 16 hours

Solidness:
Can be set individually. Density of more than 180 MN/m² is possible depending on composition.
Permeability:
10^-8 m/s to maximally 10^-12 m/s, depending on requirement and composition.

Capacity:
Depending on milling and mixing capacity

Fields of application:
Application depends on size, distribution and consistency of grain used. Unrestrictedly environmentally friendly, appropriate for use in water protection area

End product:
Consolidated, stabilized material with high lateral deformation module, absolutely free of cracks

Testing process:
According to suitability and quality program, water content, organic content, pressure resistance, degree of compaction

Economic efficiency:
Significantly more cost effective than all alternative processes, minimum amount > 25 t
Binding Agent with silo vehicle, > 20 t usage of binding agent with semi-trail vehicle, delivery in BigBags

References:
TerraBas® is used worldwide.
## Conventional Method

**Production / Extraction of Material**

The rock is extracted in an open quarry by drilling or detonation. It is transported with tracked excavators (CAT face shovel excavator 385C FS). The extracted material is brought to the processing plants by dumper trucks. Then the material is crushed by cone crushers and is classified by sieves and transported in bunkers and silos by a conveyor belt.

<table>
<thead>
<tr>
<th>Transportation (For 1000m access road)</th>
<th>Conventional Method</th>
<th>TerraBas®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trucks up to 32 tons: 4-axis, payload 16 tons., 320 kW/425 PS, consumption 76.19 L/h</td>
<td></td>
<td></td>
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<tr>
<td>Approximately 15,000 tons. sand and gravel is needed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>940 transportation operations à 0,8h operation duration</td>
<td></td>
<td></td>
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<tr>
<td>750h total transportation time</td>
<td></td>
<td></td>
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<tr>
<td><strong>57,142.50 liters</strong> (76.19 L/h x 750h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Processing (For 1000m access road)</td>
<td>Conventional Method</td>
<td>TerraBas®</td>
</tr>
<tr>
<td>Bulldozer Liebherr PR 724 LGP: consumption 28.10 L/h, operation time 93h</td>
<td></td>
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<tr>
<td></td>
<td><strong>2,613.3 liters</strong> (28.10 L/h x 93h)</td>
<td></td>
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<tr>
<td>Soil compactor Bomag BW 219 DH-03 /0: consumption 31.43 L/h, operation time 7h</td>
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<tr>
<td></td>
<td><strong>220 liters</strong> (31.43 L/h x 7h)</td>
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<tr>
<td>Soil compactor Bomag BW 219 DH-03 /0: consumption 31.43 L/h, operation time 24h</td>
<td>Tractor with silo trailer, payload 25 tons., 320 kw/435 PS, consumption 76.19 L/h</td>
<td></td>
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<tr>
<td></td>
<td>Approximately 256, 5 tons. of TerraBas® is needed (1000m x 10m x 0,45m x 0,03 = 135 m³ x 1,9 to/m³)</td>
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<tr>
<td></td>
<td>11 transportation operations à 0,9h operation duration</td>
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<tr>
<td></td>
<td>10h total transportation time</td>
<td></td>
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<tr>
<td></td>
<td><strong>761,9 liters</strong> (52.62 L/h x 10h)</td>
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<tr>
<td>Category</td>
<td>Details</td>
<td>Calculation</td>
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<tr>
<td><strong>Rebuilding</strong> (For 1000m access road)</td>
<td>Rebuilding process - Tracked Excavator Komatsu PC 210 LC-7K: consumption 25.48 l/h, operation duration 130h</td>
<td>3,312.4 liters (25.48 l/h x 130h)</td>
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<td></td>
<td>Leverage process – Tractor Fendt Favorit 930 Vario TMS: consumption with binding agent stabilizing milling machine STEHR SBF 24 52.62 l/h, operation time 5h</td>
<td>262.1 liters (52.62 l/h x 5h)</td>
</tr>
<tr>
<td><strong>Transportation</strong></td>
<td>Trucks up to 32 to: 4-axis, payload 16 to., 320 kW/425 PS, consumption 76.19 l/h</td>
<td>No transportation necessary</td>
</tr>
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<tr>
<td></td>
<td><strong>57,142.50 liters</strong> (76.19 l/h x 750h)</td>
<td></td>
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<tr>
<td><strong>Disposal</strong></td>
<td>Sand/Gravel have to be recycled</td>
<td>No disposal necessary</td>
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<tr>
<td></td>
<td>Synthetic fibres (approx. 10 to.), disposal cost 135 €/to.</td>
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<tr>
<td></td>
<td><strong>1350 €</strong> (10 to. X 135 €/ton.)</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>120,430.70 liters Diesel</td>
<td>2,507.90 liters Diesel</td>
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<tr>
<td></td>
<td>+ 1350 € disposal costs</td>
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6. Appendix: Ecological Road Construction

Nowadays we are more than ever aware of the scarcity of our world’s resources and the sensibility of environment. Our mission should be to wisely reallocate these resources to have the most added value and to preserve and protect nature. Here, TerraBas® plays a vital role: We developed, tested and proofed TerraBas® for the use of heavy machinery. But why don’t use it for civilian traffic, like cars, bicycles or even pedestrians? In fact, there have been a lot of projects in Latin America, where TerraBas® is especially appreciated for its lower costs and the possibility to build roads in environmentally sensible areas.

TerraBas® does not only build save, climate resistant and environmentally sound access roads, it can also be used for any kind of road. Many people around the world consider TerraBas® as a formidable and economical material for building simple but save and ecological roads. Especially in rural areas this lack of infrastructure is conquered with the help of TerraBas®.

For the first time there is such an excellent match of economical reasoning and environmental preservation. TerraBas® provides everyone around the world, no matter which climate, region or terrain, with the possibility to build environmentally friendly roads without asphalt or cement, without any waste material or rebuilding. TerraBas® opens a new area of road construction – ecological road construction.
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(Image 6 and 7: spreading and rolling of TerraBas® access road)

(Image 8 and 9: Left before construction and right after construction)
7. Appendix: Comparison between conventional access roads and TerraBas®

7.1 Access roads in comparison on meadow
7.2 Access roads in comparison in sensible area or forest

- Less accumulated topsoil in forest
- Topsoil
- Sand and gravel
- Route
- Fleece

- Less accumulated topsoil in forest
- Topsoil
- Timber
- Route