Dossier

Candidature UNESCO World Heritage

Rhaetian Railway in the Albula/Bernina Cultural Landscape

Switzerland / Italy
21st December 2006
No. 1/14

Rhaetian Railway
Candidature UNESCO World Heritage
ALBULA/BERNINA CULTURAL LANDSCAPE
graubünden

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Preface

When the first passengers on the Albula Railway entered the Engadin a hundred years ago they must have been impressed by the bold engineering structures wrought in the wild mountain landscape. Certainly, no one regretted the exhausting and often perilous journey before the advent of the railway. When the Bernina line was opened, shortly afterwards, tourists from the lowlands could imagine being on one of those expeditions to the North Pole which were so in vogue at the time. They could travel comfortably through snow and ice in a kind of tram, past spectacular mountain scenery, only to disembark a little later in the Mediterranean atmosphere of Tirano, in Italy. Their journey combined the dream of the south with the sublime experience of the Alps.

At the same time, the Albula and Bernina lines were and continue to be an efficient means of public transport. The exceptional technical achievement of their construction can still be experienced because the structures have been preserved in their original state virtually everywhere, and even today the railway offers a full service, transporting both passengers and freight. As a technical system, it has adapted continuously to new developments and changing needs without losing its original character. The unique surrounding landscape interweaves varied evidence of an eventful past with exceptional natural phenomena in a small space. The region has achieved the remarkable feat of avoiding collisions between tradition and progress, human action and nature, by accepting them respectfully and as a matter of course. So the railway structures merged with the landmarks of the landscape to form a coherent and emblematic image of the Alps.

The candidature of the Rhaetian Railway in the Albula/Bernina cultural landscape for inscription on the UNESCO World Heritage List is an expression of a profound commitment to the protection and careful development of the landscape with all its cultural variety. I find it particularly gratifying that this candidature could be prepared jointly with Italy as a trans-national project. Our two countries have always been closely linked. With the ratification of the Convention for the Protection of the World Cultural and Natural Heritage we have undertaken to carefully look after and preserve our exceptional cultural heritage. Projects like this show how these objectives can be reached when joint efforts are made on both sides of a border. In a time of globalisation, international cooperation is an important and successful instrument to preserve our mutual heritage. UNESCO has become the embodiment of this cooperation.

I am fully convinced of the quality of this candidature and thank the World Heritage Committee for its attentive appraisal.

Micheline Calmy-Rey

Head of the Federal Department of Foreign Affairs FDFA

President of the Swiss Confederation 2007

Executive Summary

Candidature UNESCO World Heritage

Rhaetian Railway in the Albula/Bernina Cultural Landscape

State Party

Switzerland and Italy

State, Province or Region

Switzerland
Canton Graubünden
Regions: Heinzenberg/Domleschg, Mittelbünden (Central Graubünden), Upper Engadin and Poschiavo

Italy
Region Lombardy
Province Sondrio

Name of Property

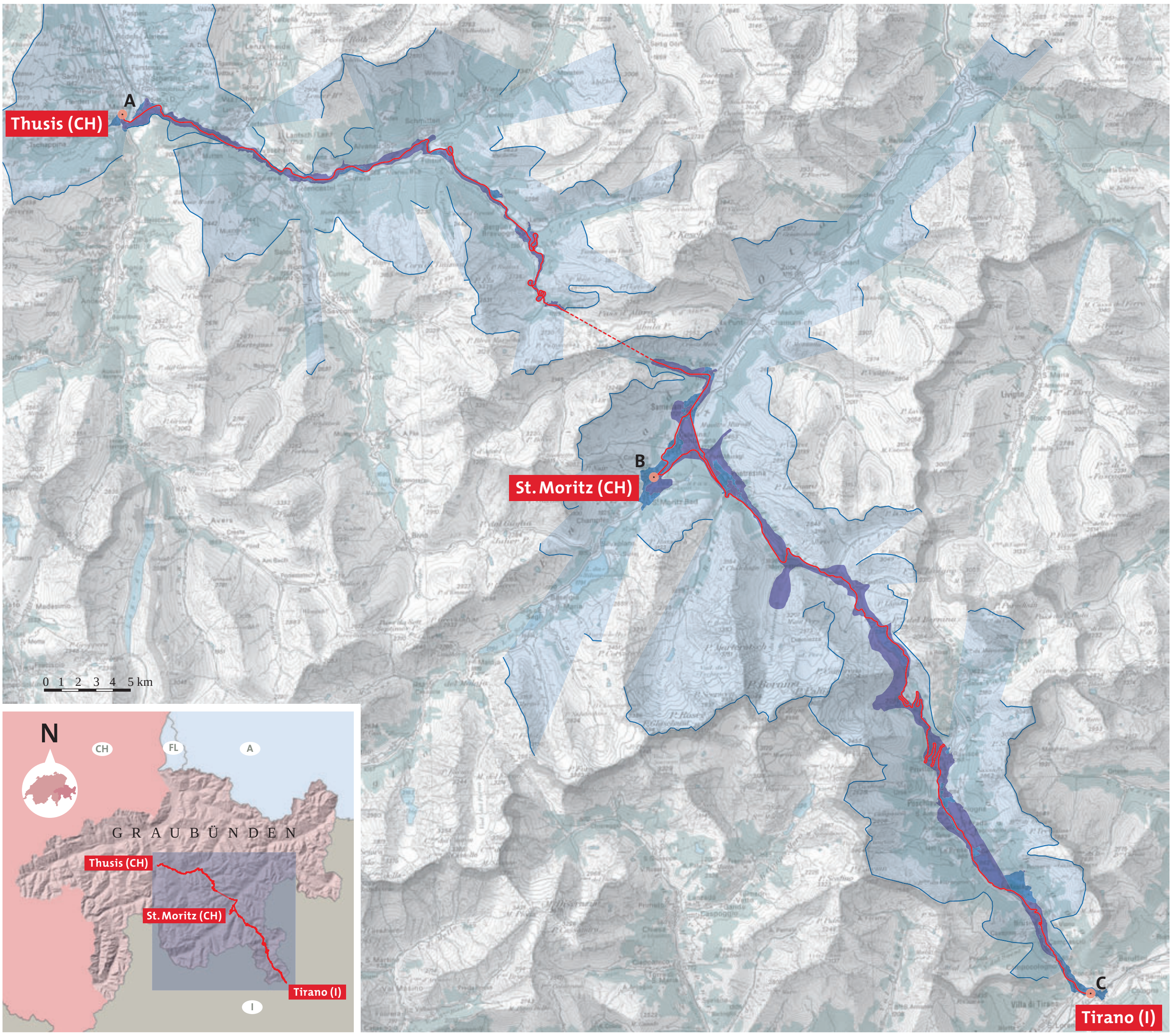
Rhaetian Railway in the Albula / Bernina Cultural Landscape

Geographical coordinates to the nearest second

The perimeter of the property comprises the stretch of railway line from Thusis to Tirano together with its buildings and installations. St. Moritz marks the approximate centre of the property.

Name	Community(ies)	State(s)	Area in ha (Core zone)	Coordinates
Thusis – Tirano	20 Communities (cf. chap. 1.e)	Switzerland / Italy	152.42	**A (Thusis Exit Signal)** N 46° 41' 50'' E 9° 26' 28'' **B (St. Moritz Station)** N 46° 29' 54'' E 9° 50' 47'' **C (Tirano Station)** N 46° 12' 57'' E 10° 10' 00''

A4 size map of the nominated property, showing boundaries and buffer zone



Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Design: Süsskind, SGD, Chur
Reproduced by permission of swisstopo (BM062220)

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

Georeferenced points

A Thusis Exit Signal: N 46° 41' 50'' E 9° 26' 28''

B St. Moritz Station: N 46° 29' 54'' E 9° 50' 47''

C Tirano Station: N 46° 12' 57'' E 10° 10' 00''

Textual description of the boundary(ies) of the nominated property

Core zone

The Albula and Bernina railway lines running from Thusis via St. Moritz to Tirano represent the "red thread" that defines the cultural landscape; the overall length is some 130 km. The railway line with its structures, installations and systems is defined as the core zone.
The perimeter of the nominated area touches 19 communities on Swiss territory: Thusis, Sils i.D., Mutten, Vaz/Obervaz, Alvaschein, Tiefencastel, Brienz/Brinzauls, Surava, Alvaneu, Schmitten, Filisur, Bergün/Bravuogn, Bever, Samedan, Celerina/Schlarigna, Pontresina, St. Moritz, Poschiavo and Brusio. The perimeter takes in only one community in Italy, namely Tirano.

Buffer zone

In places, the cultural landscape can be surveyed for miles and miles from the railway line; the traveller can overlook entire valleys. The distant silhouettes of mountain ranges and peaks are an important element of experiencing the cultural asset in the sense of a "background" or "backdrop". As specified by Article 104 of the *Operational Guidelines*, the buffer zone comprises the immediate environs of the property together with the landscape (in this case, as far as the horizon). The buffer zone is an important element of the property as regards the overall visualisation and the general functional relationships. The most wide-ranging view a traveller can experience in Switzerland is at Bever: a 27 km vista covering a large part of the Engadin and extending as far as the Swiss National Park. Many villages within this viewing distance cannot be seen due to the topographic features or their sheer remoteness, so that changes in the cultural landscape cannot be observed from the railway. In the immediate proximity of the core zones, some settlements and landscape elements can also be seen in considerable detail from the property. Changes to these are more noticeable.
Under these circumstances, the buffer zone was broken down in an initial step into a 'near' and a 'distant' area (buffer area or "backdrop"). The division into two areas resolves the problems of differentiation between "open" tributary valleys and extensive vistas, and the cultural landscape in the immediate vicinity of the core zone with its clearly visible details of settlement and elements of the cultural landscape. In a second step, in the near zone, a distinction is made between areas with a high quality of cultural history or landscape and those of lesser value. This demarcation is further reflected in the differentiated

provisions for the protection of the buffer zone (cf. chapters 5.b and 5.c). The three categories in this zone are:

> a *primary buffer zone* (in the near area)
> a *buffer zone in the 'near' area*
> a *buffer zone in the 'distant' area*

The *primary buffer zone* (in the near area) comprises important and valuable cultural assets, places of interest (of national importance) and landscape elements. The demarcation of the buffer zone in the distant area is determined either by natural features (e.g. the tree line) or by topographical criteria (contours, slopes etc.); where this is not possible or expedient, the boundaries are marked by infrastructure features (such as roads or power lines). The resulting "ribbon" is, for the most part, 500 – 1000 m wide, although this width is reduced in narrow valleys (120 – 150 m). It may, however, extend to some 5 km where there is an exceptional vista of high alpine areas and glacial valleys.
The *'near' buffer zone* essentially includes parts of settlement areas that are close to the core zone and lack the exceptional qualities of the primary buffer zone. These are recently built residential areas together with small commercial and industrial zones and their immediate surroundings.

The *buffer zone in the 'distant' area* ("backdrop") includes the entire remaining vista of the cultural landscape visible from the train as far as and including the horizon. In view of the way in which Veltlin valley opens up and the character of the railway changes in Tirano (where it runs on the road and is no longer a mountain railway with imposing scenery), the definition of a buffer zone in the distance is omitted for the approximately 3 km stretch on Italian territory.

Justification Statement of Outstanding Universal Value

In exceptional fashion, the “Rhaetian Railway in the Albula/Bernina Cultural Landscape” is an example as unique as it is typical of a mountain railway integrated into an Alpine landscape. The Albula line, with its spectacular alignment and original engineering structures that represent a most impressive technical achievement, is an outstanding ‘product’ of the golden age of high altitude railways. From the outset, it was recognised as a transport route most harmoniously embedded in the landscape. The Bernina railway, as an electric surface railway at exceptionally high altitude and with extreme upgrades, is a unique example of the application of a technology that was highly innovative about 1900, but would soon become widespread. What is more, the development of its alignment was planned with a view to the best possible integration into the surrounding landscape. The Albula/Bernina line, as a railway that traverses an entire mountain range, links three distinct linguistic and cultural regions. To this day, it remains in full service, transporting both passengers and goods.

The combination of two different kinds of mountain railway – on the one hand with crest tunnels (and the equally technically demanding spiral tunnels) and on the other a surface electric railway crossing a high altitude mountain pass in the open – make the Albula/Bernina line simultaneously unique and typical, an outstanding example of a railway in the mountains. Its major role in the history of railway construction and the quality of the achievement established the basis for the worldwide recognition it has enjoyed ever since it was first brought into service. It is essentially different from the mountain railways already figuring on the World Heritage List: the Albula line, as a masterpiece, constructed with lavish planning and excellent craftsmanship, represents the archetype of the mountain railway from the golden age of rail. With its many stone viaducts of varying heights and lengths, the complex, sometimes overlaid structures of the helical tunnels and the long crest tunnel, the meticulous and architecturally valuable design of the elevated structures, and finally the actual operation itself, it displays all the characteristics of a mainline railway, even though it was constructed with a narrow gauge. The Bernina line, on the other hand, an electric surface railway at a high altitude and with the extreme gradient of 70‰, opened up new technical territory and introduced a new type of railway which would soon become widespread. The Albula/Bernina section represents a special type of "high-altitude mountain railway": over a distance of some 130 km and with a maximum difference in altitude (1,550 to 1,700 m) it crosses a mountain range, from one side to the other. While the "Semmeringbahn" UNESCO World Heritage Site marks the beginning of accessing mountainous areas by rail, the Albula/Bernina line represents the golden age of mountain railway construction: it was only with the development of mechanical tunnelling machines in the second half of the 19th century that long tunnel constructions and special types of tunnel (such as spiral tunnels) could be erected within acceptable time and cost constraints. The construction of alpine mountain railways came to an end with the First World War. Since then, no new trans-alpine railways have been completed, while spiral tunnels no longer feature in contemporary rail construction.

The construction of the Albula/Bernina line was rendered possible by an exceptionally creative exploitation of technical, economic and socio-cultural influences. An important goal which was promoted by the construction of the railway, was to preserve the diverse cultural and linguistic areas within the canton of Graubünden. In view of the topography, the Albula line was laid out as a narrow-gauge railway, but its design and operation followed the pattern of a mainline (standard gauge) railway. The aim was to facilitate access to the Engadin, in both summer and winter. Thus the railway contributed to the development of a new branch of the economy, namely winter (sports) tourism. Indeed tourism was to become the main industry in the region. The railway line was integrated subtly into the diversified cultural landscape and continues to enrich it today. The Bernina line was a product of the hydroelectric projects, built on Italian initiative, to generate power for the Lombard metropolis of Milan, and exploited the capital released by these projects. Moreover, the concerns of tourism were taken into account by aligning the track to ensure an exceptional 'mountain experience' from the comfort of the train. To satisfy these special conditions, the latest technology was used to construct the high Alpine railway as an electrical surface operation. The "Rhaetian Railway in the Albula/ Bernina Cultural Landscape" is an exceptional example of a masterpiece created by a unique and diversified interplay between economics, politics, engineering, culture and nature.

Even at the time the railway was built, the outstanding quality of the landscape to be traversed was recognised and deemed worthy of preservation. Emphasis was put on harmonious integration of the railway infrastructure, while at the same time the alignment – particularly in the case of the Bernina line – was planned, as far as possible, to present the landscape to the traveller in all its magnificence as a landscape experience. The structurally created measures to enhance perception of the landscape during a rail journey together with the railway landscaping realised during construction are unique in the early 20th century. The experience of the exceptional views is an inherent element of the quality of the property. The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" displays emblematically this synthesis of nature, culture and technology which has exerted a powerful influence on how the Alps have been perceived over the years: a vignette of cultural history.

Criteria under which inscription is proposed (and justification for inscription under these criteria)

The property is nominated according to Criteria i, ii and iv pursuant to Article 77 of the *Operational Guidelines for the Implementation of the World Heritage Convention* on the following grounds:

Criterion i

The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" is an exceptional masterpiece of creative genius generated by the interaction of aesthetic standards, engineering acumen, technical innovation and perfect craftsmanship in a *Gesamtkunstwerk*. It is the outcome of the outstanding cooperation of wide skills with a highly innovative approach and handling of difficulties.

Criterion ii

The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" is a pioneering work of modern engineering and architectural structures that exhibits the important interchange of human values on innovative technical developments in the early 20th century. It is an excellent example of a harmonious relationship between human interaction and natural beauty, exemplary of the perception of the Alps as a sublime experience of the relationship between nature, culture and technology.

Criterion iv

The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" is an outstanding example of a technological ensemble which illustrates the zenith of the golden age of mountain railways. It has also exerted a powerful influence on how the Alps have been perceived over the years.

Name and contact information of official local institution/agency

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Rhaetian Railway in the Albula/Bernina Cultural Landscape
c/o Rhätische Bahn
Bahnhofstrasse 25
CH-7002 Chur
Tel: +41 (0)81 288 63 66
E-mail: unesco@rhb.ch
http://www.rhb-unesco.ch

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Albula line > Above the village of Sils i.D. , the train runs just below the Campi ruins.
T. Keller

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3. Justification for Inscription

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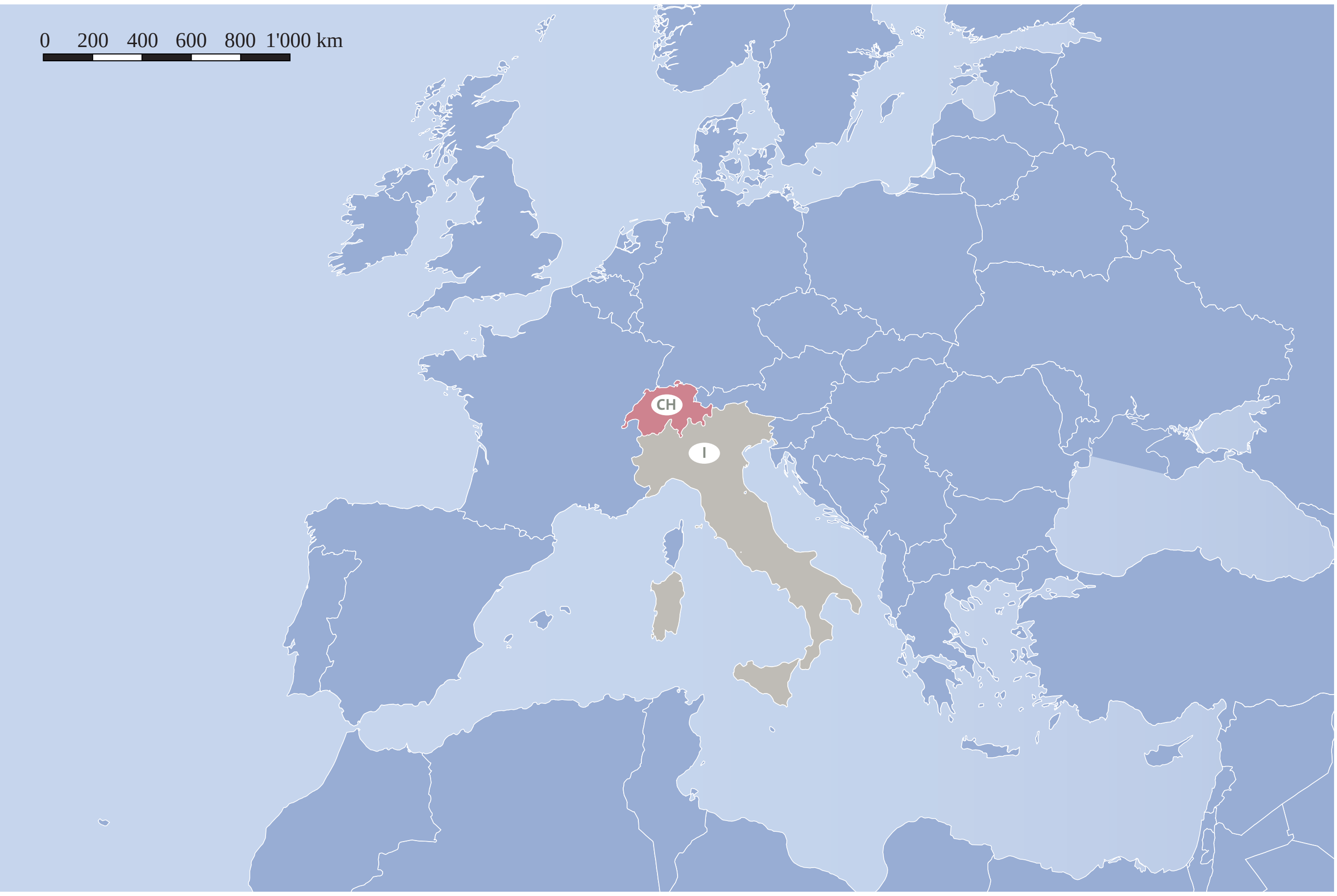
5. Protection and Management of the Property

1. Identification of the Property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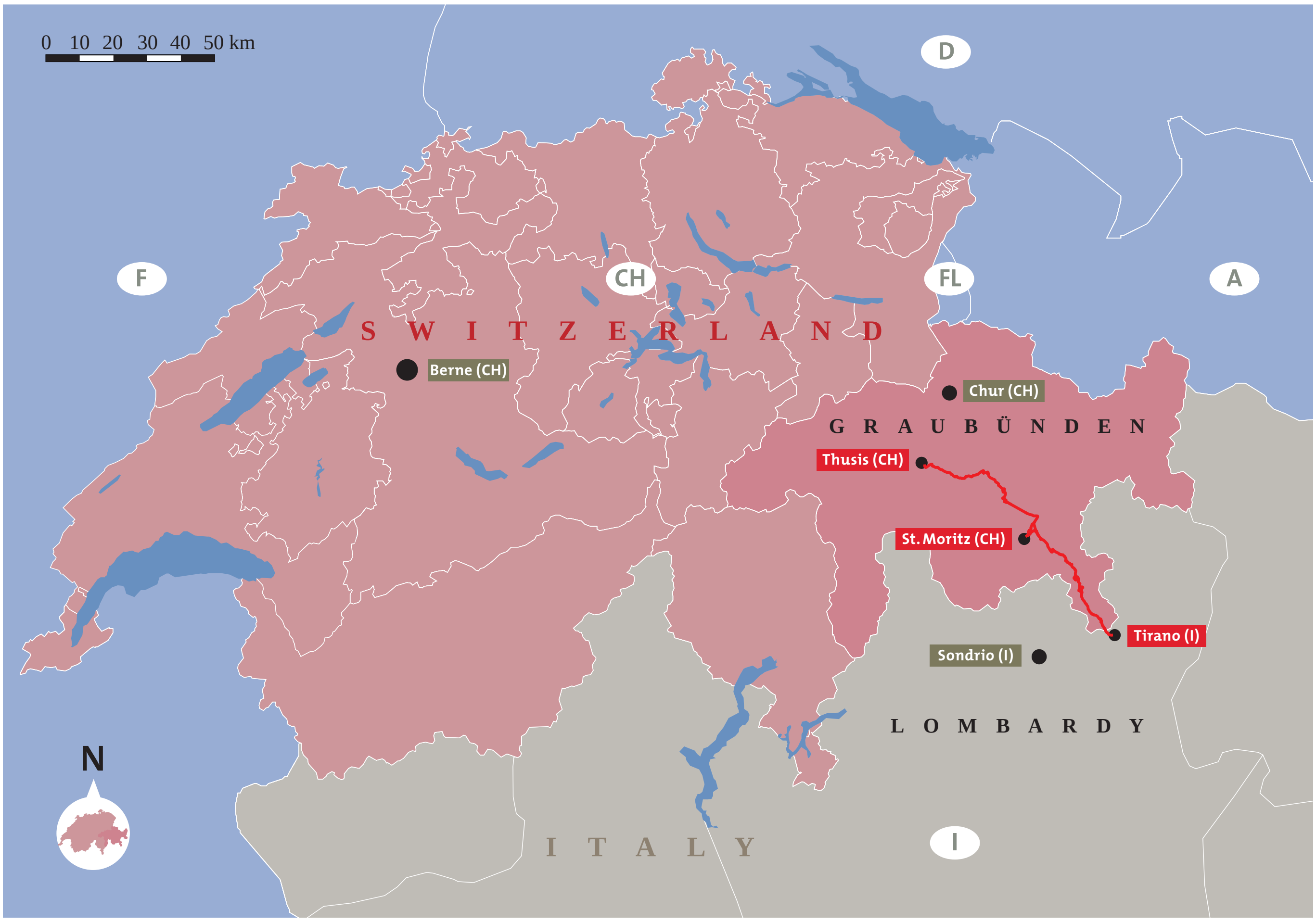
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Chur (CH)
G R A U B Ü N D E N
Thusis (CH)
St. Moritz (CH)
Tirano (I)
Sondrio (I)
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I

1.a Country (and State Party if different)

Switzerland and Italy

Switzerland is situated in the centre of Europe and covers a surface area of 41,285 km^2. The country is divided into 26 cantons.

Italy is situated in the south of Europe and covers a surface area of 301,336 km^2. The country is divided into 20 political regions.

1.b State, Province or Region

Switzerland
Canton Graubünden
Regions: Heinzenberg/Domleschg, Mittelbünden (Central Graubünden), Upper Engadin and Poschiavo

Graubünden lies at the centre of the curve of the Alps; it has some 187,000 inhabitants and, with an area of 7,106 km^2, is the largest canton in Switzerland.

Italy
Region Lombardy
Province Sondrio

Lombardy is a region in northern Italy. The province of Sondrio has some 179,000 inhabitants and covers an area of 3,212 km^2.

1.c Name of Property

Rhaetian Railway in the Albula/Bernina Cultural Landscape

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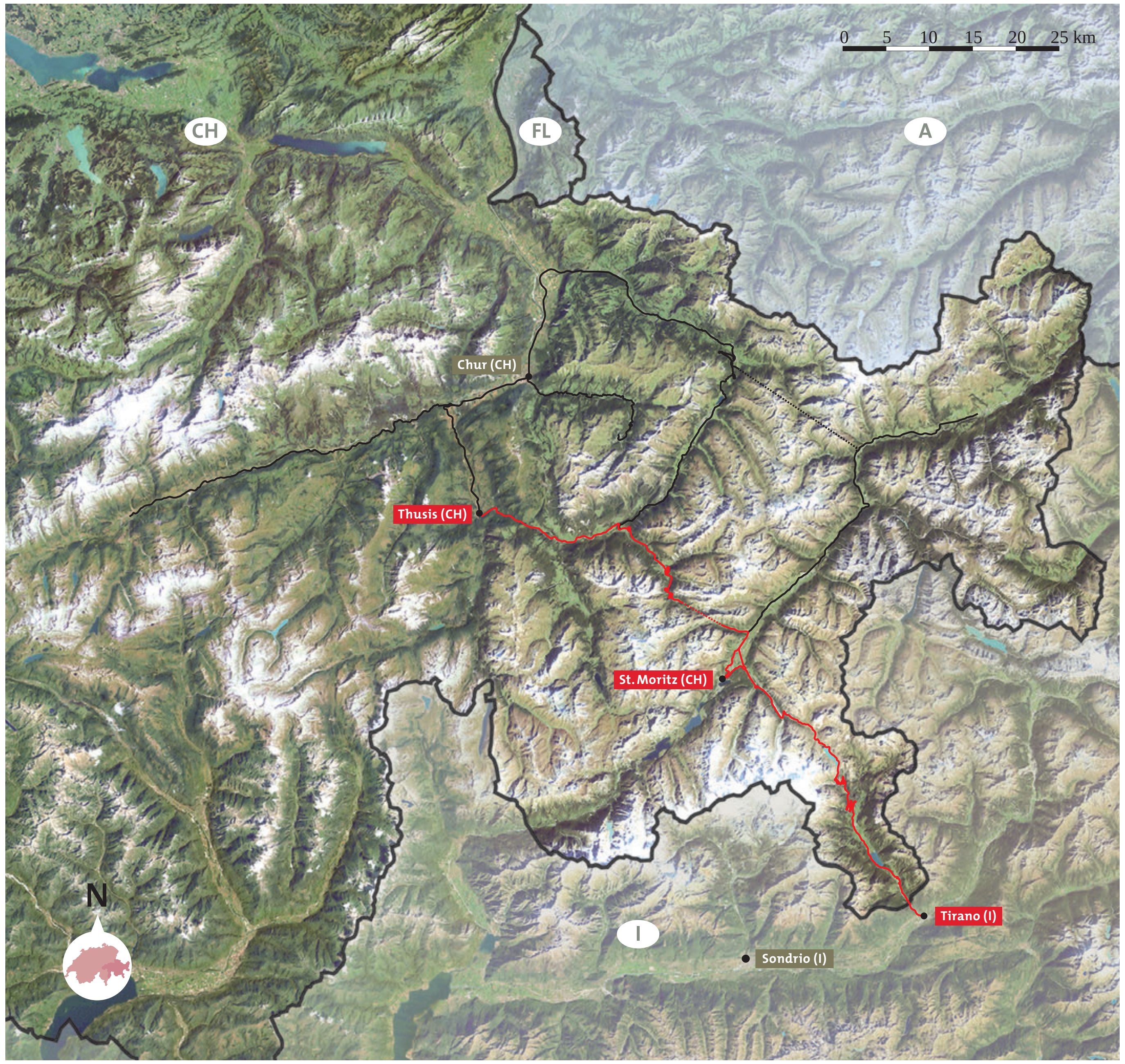
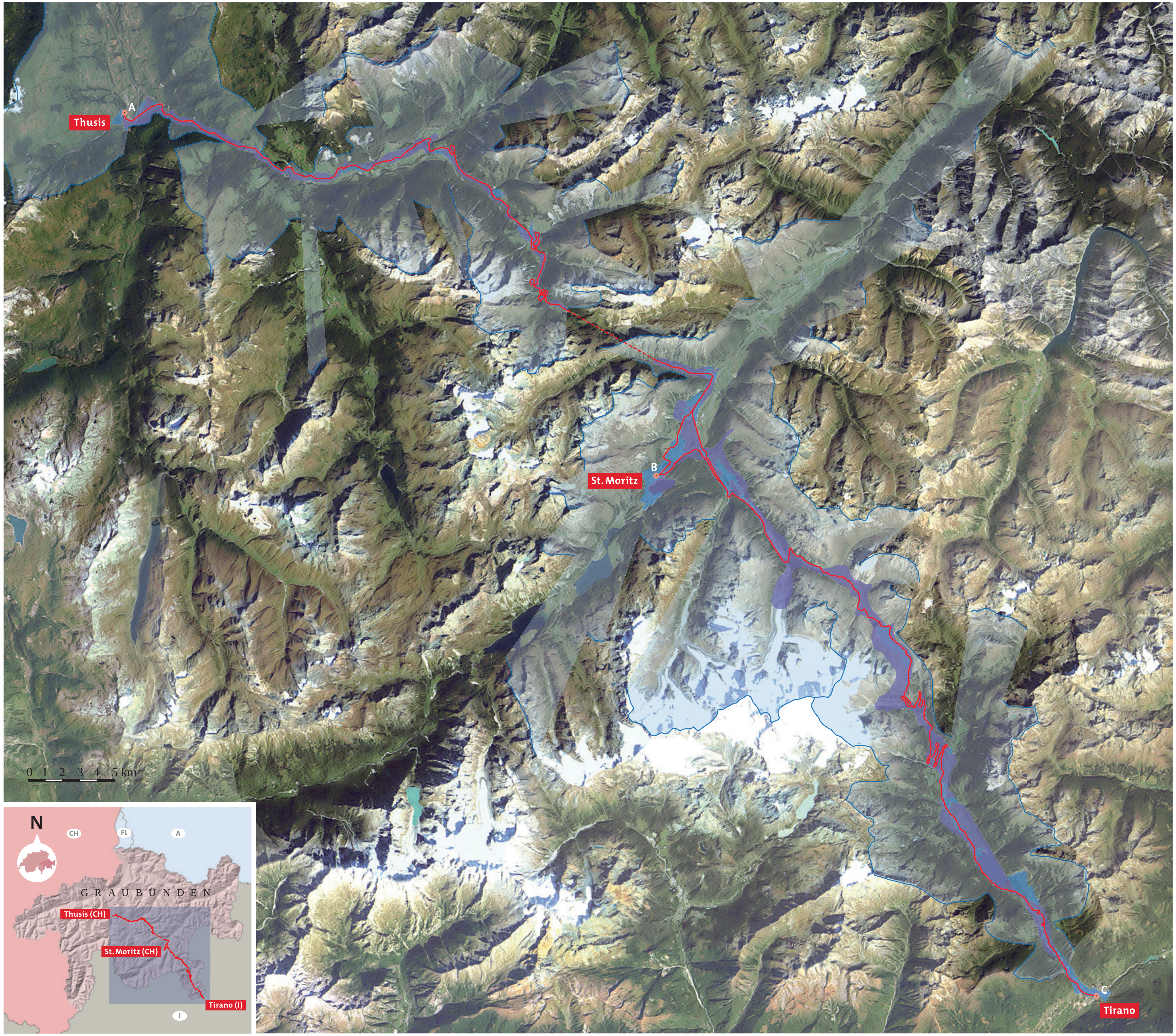


Albula/Bernina line of the Rhaetian Railway

Other stretches of the Rhaetian Railway

Sources:
Satellite Image: ESA / Eurimage / swisstopo, NPOC
Design: Süsskind, SGD, Chur
Reproduced by permission of swisstopo (BM062220)



Demarcation of the site

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

Georeferenced points

A Thusis Exit Signal:
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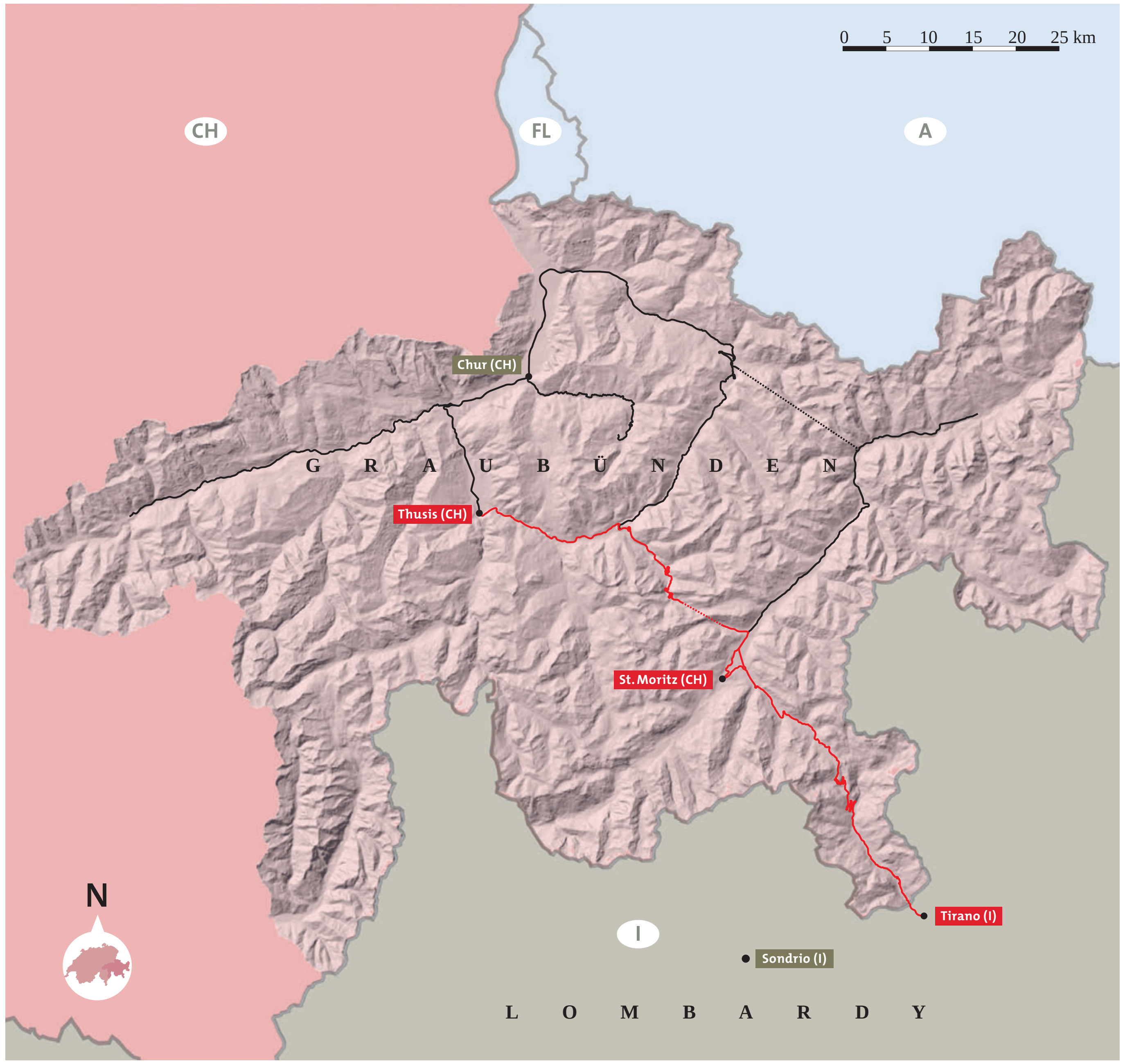

Albula/Bernina line of the Rhaetian Railway

Other stretches of the Rhaetian Railway

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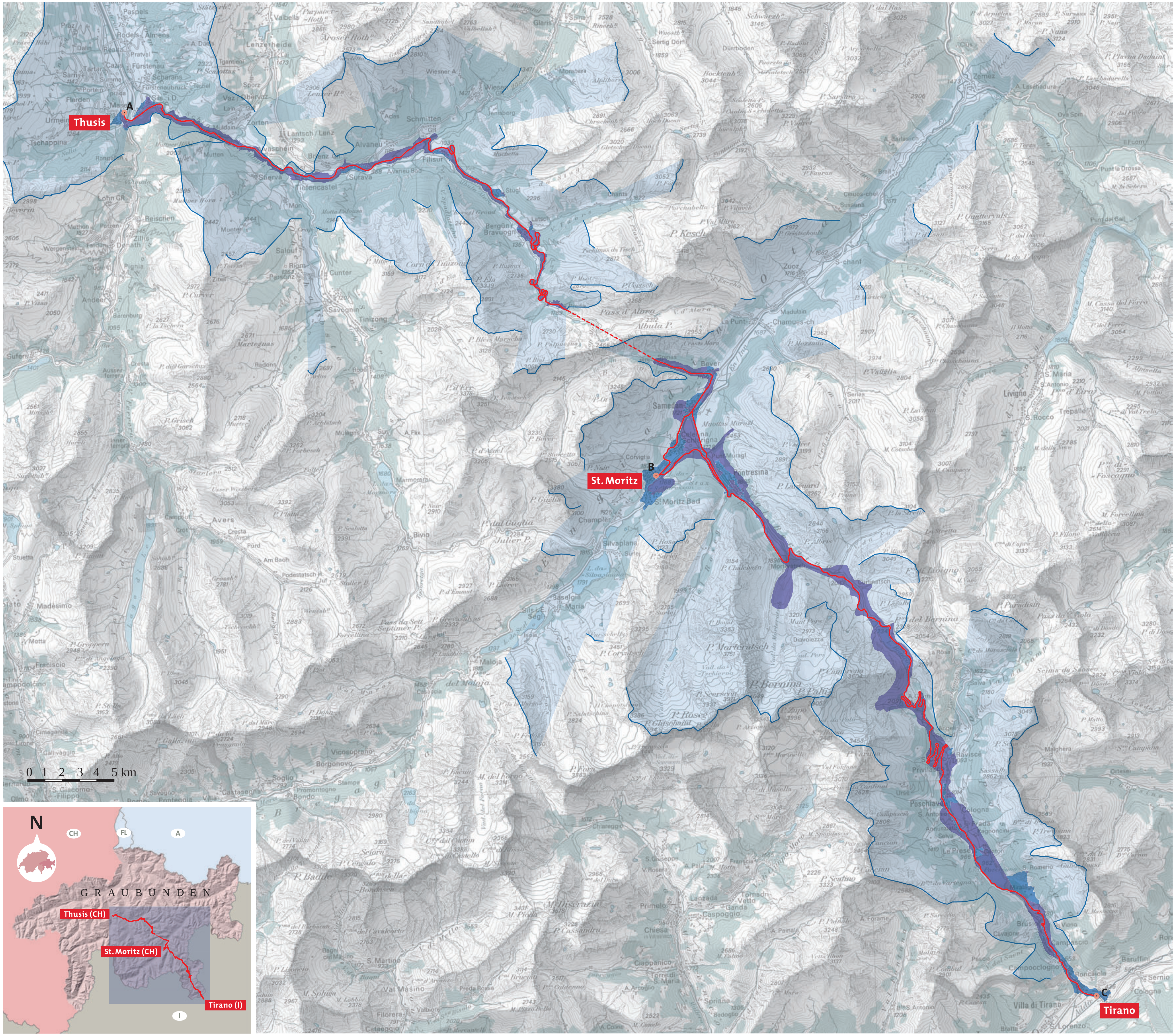

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1.e Maps and plans, showing the boundaries of the nominated property and buffer zones

The following maps and plans are appended to the candidature documentation:

> Overview plan of the entire property, scale 1:60,000
> Synthesis maps showing the current protection zones and other utilisations of the area, scale 1:25,000
> Detailed plans of the property with the core and buffer zones, scale 1:15,000 and, to visualise the degree of detailing, five selected sections on a scale of 1:2,000 showing halts and crossings (Filisur, Stugl/Stuls, Preda, Bever, Poschiavo).

These plans and maps are also included in the electronic version (CD) and in the additional GIS data (core and buffer zones etc.) of the nominated property. This data record allows the boundaries of the property to be shown clearly and outlines each plot on any scale. The file includes a hard copy of the overview plan on a scale of 1:60,000, the detailed plans on a scale of 1:15,000 as well as selected sections on a scale of 1:2,000 (Filisur, Stugl/Stuls, Preda, Bever, Poschiavo).

Core zone

The Albula and Bernina railway lines running from Thusis via St. Moritz to Tirano represent the "red thread" that defines the cultural landscape; the overall length is some 130 km. The railway line with its structures, installations and systems is defined as the core zone.

The perimeter of the nominated area touches 19 communities on Swiss territory: Thusis, Sils i.D., Mutten, Vaz/Obervaz, Alvaschein, Tiefencastel, Brienz/Brinzauls, Surava, Alvaneu, Schmitten, Filisur, Bergün/Bravuogn, Bever, Samedan, Celerina/Schlarigna, Pontresina, St. Moritz, Poschiavo and Brusio. The perimeter takes in only one community in Italy, namely Tirano.

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1.f Area of nominated property (ha) and proposed buffer zones (ha)

Core zone:	152.4 ha	(3.0 ha in Italy)
Primary buffer zone:	5,436.0 ha	(28.4 ha in Italy)
Buffer zone in the ‘near’ area:	1,140.4 ha	(76.4 ha in Italy)
Buffer zone in the ‘distant’ area:	102,809.5 ha	
Total of core and buffer zones:	109,538.3 ha	(107.8 ha in Italy)

2. Description

Bernina line > Goods and passenger train in the snowy landscape of the Bernina Pass.
R. Bösch / Rhaetian Railway

2.a Description of Property

2.a.1 Prologue

Iso Camartin

Landscapes leave their mark on people. And people leave their mark on landscapes. This give and take between natural conditions and the people working in them generates the foundations for what we call civilisation. One could say that in a way civilisation is the social and cultural moulding of the natural environment attributable to man, in brief: people's capacity to adapt to the natural conditions and to open up new habitats for themselves. Settlements and living communities arise in the course of this remodelling process with appropriate economic structures, modes of political organisation and the community practices and rituals that make living together practicable. The surprising factor is that people settle not only in regions where nature makes settling and living easy. People also settle even where the natural conditions are refractory and difficult to cope with; they brave the dangers to make the original wilderness habitable, appropriate and even benign.

The Alps are anything but inviting to settlers. One must only survey the whole alpine region from the air, on a sunny day, to discover how hostile the higher reaches of the alpine landscape really are. This has repeatedly been a source of amazement to philosophers. Friedrich Nietzsche, for example, who spent several summers in the Engadin between 1881 and 1888, was fascinated by that borderline in the Alps, behind which death and not life rules. He felt that up here the cosmos is closer than the warming earth. The rock and firn landscape hardly seems to be made for man. It lies there as if waiting for something greater than men. How can one nurse the ambition to be at home in such a hostile world?

People have always been tempted, to utilise the Alps not only for their passes and direct routes to other countries, to exchange their wares and goods and engage in trade, but also to settle permanently in the Alps, to weather the seasons and guarantee themselves and their families a life in dignity. The settlement history of the Alps is a fascinating exercise in survival, that has continued over the centuries and is still today marked by the struggle with the life threatening-aspects of nature. It is still there: the untamed, the colossal, the measure of what man apparently cannot change. Railways, hotels and aids to comfort have been installed on the peaks of the most beautiful mountains. Technical achievements have made so much accessible to our lust for adventure. Scintillating achievements of homo faber! But the august majesty of a landscape, its sheer force and radicality; we can only realise how immutable and impassive nature is with respect to the wishes and concerns of man by discovering it ourselves. Nature's disregard for our cares contains a strange guarantee that, with all his persistence and rashness, man cannot entirely change the prerequisites of human life.

During the Christian Middle Ages, the conviction arose that not only is man a faulty and defective being, who has born the blemish of original

Albula line > Between Bergün/Bravuogn and Preda.
R. Bösch / Rhaetian Railway

sin since the expulsion from paradise, but that nature in its entirety suffers from the imperfection and corruption inherent, since the Fall, to all that is earthly, to all that is created. Alone by Christ's act of salvation, could man and nature be freed from this blemish and achieve his original, unsullied condition. The theologians called this construction error in nature the "natura lapsa", defective and damaged nature, and were apt to consider this life on earth as a repair shop for the damage incurred.

Today, these theological constructs appear rather unworldly; we assume that nature is fundamentally free of values and that it is man alone who, by his interventions, changes it to the good or bad. But anyone who travels on the Rhaetian Railway through the Albula valley into the Engadin and then over the Bernina Pass to the south, could easily entertain the idea that this glorious landscape was imperfect and lacking something until clever people decided to lay a railway through the precipitous terrain enhancing the beauty of the region, perfecting it. It is hard to imagine that what the surveyors, the line plotters, the bridge and tunnel builders have achieved could have been better and more beautiful than what we see today. They mastered the art of building without over-building. The short-lived wounds to nature have long since healed. The supple, delicate lines of the railway as it curves ever higher across the slopes have a rhythm and elegance that is almost musical. With a sense of beauty and daring, with empathy and the acme of technical expertise, the pioneers of railway building have realised a masterpiece that must be taken as a text book example of what man can achieve to enhance the "natura lapsa". Only so can the traveller experience the beauty of nature, in its surprising wildness and roughness, its delicacy and suppleness, its diversity of form and richness of expression. Nature is defective and imperfect, that is certain! Then man comes with his imaginative perception and his skills and makes its beauties accessible to the seeing and wondering eye.

There is no doubt: this stretch of railway is a masterpiece with respect to engineering and constructional solutions and to the harmony of nature with formative intervention. From bridge to bridge one experiences the challenges of nature and what man can achieve by harnessing them to his purpose. One discovers the interplay of form generated by landscape, railway and road; during the climb one experiences all imaginable forms of giving way and tunnelling through, of daring bridging and piercing, determined advance and playful detour. The lasting impression of a felicitous reconciliation between nature and man is a fundamental experience. The force of nature is neither broken nor denied, nor is man's determination to achieve his own objectives and fulfil his own interests. The felicitous approach to the wild and taming it with daring technical visions leaves an indelible stamp on our perception. He who is seeking what is special in the landscape, also perceives the unrealisable process where nature and man attempt to harmonise their forces in a balancing act.

Of all the bridges, viaducts, galleries and supporting walls along this stretch, so full of impediments, there is one that outshines the others, that has become the most photographed structure in Graubünden thanks to its majesty, elegance and daring: the Landwasser Viaduct. Once the train has passed Surava and is dashing on, up through gorges and past rock faces as it approaches Filisur, a ripple runs through the carriages: the travellers move to the right side, to get a good window seat for what is to come. First one catches a glimpse ahead of piers and arches leading

Albula line > The 65 m high Landwasser Viaduct, the most spectacular engineering structure between Thusis and St. Moritz.
A. Badrutt/Rhaetian Railway

to a vertical rock face. These disappear again, but as soon as the train begins to veer right in a prolonged curve, the wonder suddenly comes into sight. It is true one does not see all of the six great curving arches immediately, but once the train is on the viaduct and one looks down, even the least prone to vertigo tends to shudder at the audacity of the engineers who planned this work of art. In the amazement at so much courage and daring, it is only in the tunnel that one begins to consider what that must have meant in 1898, to place such a breathtaking structure in this wild landscape of ravines and gorges.
Anyone who is familiar with the Alps, cannot forget that every step towards capturing the terrain for man's objectives was fraught with risks, dangers and sacrifices. A wide range of safety and security measures were essential to guard against the unpredictable moods of nature. The history of this stretch of railway is also one of defence measures to guard against floods, rockfall, landslides, avalanches and other unpredictable natural phenomena which, from one moment to another, could change the glorious landscape into a living hell. Safety has always had to take priority; from the outset. Today the technical possibilities of making the railway safe, and controlling the safety measures, all the year round and independent of the weather, are incomparably more sophisticated. However, a quantum of risk remains – here like anywhere else. The passengers feel this instinctively as they pass over viaducts and bridges when, for a moment, their glance plumbs the terrifying depths of a ravine.
When the train leaves the long Albula tunnel, and runs alongside the Beverin stream towards Bever, where it curves to the right into the elongated valley that is one of the most remarkable areas in the whole of the Alps, which we call the Engadin, we feel: here down in the valley, we are already up on high. Naturally, it is again bordered by lofty mountains and white peaks, but we can leave them to those who aspire to the heights. Here the generous expanse of the valley floor, the bed of the Inn, permits an enhanced perception of reality. The fundamental mood is quite special; everything is different, light has another quality, another dimension, another life. Why is this so?
The special characteristics of air and light in this region have always been a cause for wonder. Eye specialists have claimed that here, in the heights of the mountains, the pupils dilate in a unique fashion. Reality appears to the eye in a clarity and transparency nowhere else to be found. Many visitors to the Engadin tell of a strange light headedness that they feel here, already at an altitude of only 1,800 m. Since the early days of tourism, the mid 19th century, artists and eccentrics, from all nations and countries have made the pilgrimage up here in summer and winter to experience this landscape, that is not only externally present but quickly and irresistibly becomes a landscape of the soul.
Anyone who climbs up to Muottas Muragl on a light-drenched morning, to look down on the mirror of the Upper Engadin lakes basking in the morning sunshine, will be aware of the singular character of this region. It is hardly surprising that so many artists have sought their inspiration here. Giovanni Segantini, who painted his famous triptych – which can be seen at the Segantini Museum in St. Moritz, not far from here – spoke of the "chords of an Alpine composition of tone and colour" that must reverberate together to give the true impression of beauty. Or he invokes an "all pervasive aura of light, generating the eternal harmony of the alpine world". These lines show a representative artist struggling for the words to invoke a magical light that only the eye can

Muottas Muragl > Upper Engadin lake landscape.
P. Mathis / ENGADIN Bergbahnen

perceive adequately. Many followed him, native and foreign, in the attempt to capture a borderline visual and imaginative experience on canvas. And yet, to understand the works of these artists it is essential to experience this pervasive reality of light oneself, here in the Engadin. Unmistakable beauty is not purely fantasy and imagination. It exists, because there is something present in reality that arouses and accentuates our quest for beauty.

But the most famous word on the light experience in this region was spoken by someone else; genial, sick, philosophising, writing and reflecting on the world in the most modest conditions: Friedrich Nietzsche. “Transparent, glowing in all colours, all contrasts, encompassing everything between forbidding ice and the South” – that is how he saw the Engadin.

After crossing the Bernina Pass, when Val Poschiavo suddenly opens up before us, bringing us to the Veltlin and Italy, we suddenly feel: this must be the watershed between North and South. We are right in the middle, where two points of the compass, two world philosophies and two ways of life meet. Although surrounded by the highest mountains, in close proximity to snow and ice, a completely different world greets us from afar; the South, the Mediterranean, the absolute opposite and contrast to the world of the Alps. The verses from Nietzsche’s poem “New Seas” come to mind: “The sea spreads out / My Genoese boat drifts into the blue.”

The Albula/Bernina region is that special interface in the Alps, that is not only the watershed between north, south and east, but at the same time the place of encounter, the contact region for divergent linguistic cultures and ways of life. Graubünden is the only canton in Switzerland where three languages are spoken. Today the original languages are complemented by a plethora of turns of phrase introduced by immigrants, guest workers and tourists. There are no barriers to mark the linguistic borders. Words, ideas and habits cross the border undeclared. The more closely one considers the history and culture of Graubünden, the more palpable the experience that here south and north, Latin and Germanic cultures interact and enrich one another. Some may think that the survival of such a small language as Rhaeto Romansh is solely due to the remoteness and isolation from the world. Since time immemorial, Graubünden has been a pass and transit land. The local people were never isolated for long. Besides, they were often anxious to try their luck in foreign countries. The fascinating history of the emigration of the people of Graubünden, from their valleys to the most farflung corners of Europe and abroad, documents that the people were neither so unworldly nor so uninformed as simplistic interpretations of the ‘homeland’ sometimes make out.

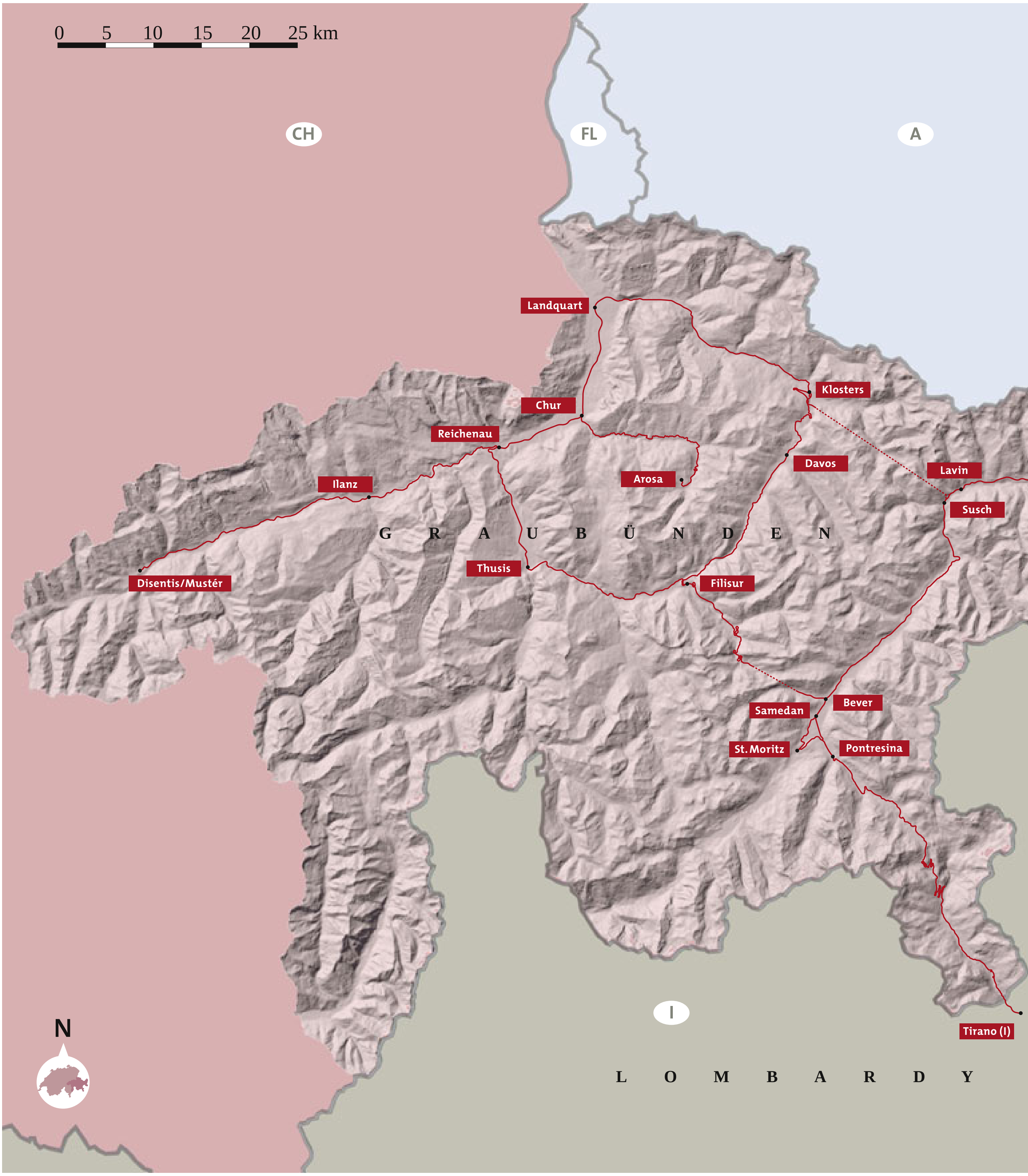
So the cultural barriers in our minds must come down, like the other barriers that have long been removed from the countryside. The contact with the neighbouring regions – the Italian, Austrian and German – was the impetus not to remain rooted in their own penury but to serve others to their own profit and advantage. It took a great deal of strong will to change the universally accepted, to give it a form and manner appropriate to the own circumstances. The cultural added value of a linguistically complex region is precisely inherent to this exchange of ways of life and customs so unmistakably reflected in the languages The culture of Graubünden is inconceivable without all that it has absorbed from the Germanic and Italian civilisations. However, it is by no means a conglomerate of mere copies of foreign patterns. The people of Graubünden have always had so much strong will and imagination

Bernina line > The Bernina railway on the circular viaduct at Brusio.
R. Pedetti

that they would never make do with insipid duplicates. Cultural exchange is a vital process. Own needs blend surprisingly with the impulses streaming in from other sources. The languages situation, like the day-to-day culture, has documented this to the present day.

One of the most attractive proofs of the open-mindedness, courage and pioneering spirit that was needed, already over a hundred years ago, to recast the approaches to one another and improve the accessibility of the centre and region was and is the building of the Albula and Bernina Railway. Here far-sighted local people and specialists from Switzerland and other countries came together to realise an incomparable oeuvre, the masterpiece of the century. We contemporaries have every reason to admire the entrepreneurial daring, the engineering achievements and the sense of beauty of those pioneers who ensured that not only were the inhabitants of the north and south, east and west able to reach out to one another but that they could also rediscover a landscape, in the heart of the Alps, that is virtually without par on our planet.

Albula line > The Rhaetian Railway Bernina Express on the Landwasser Viaduct near Filisur.
P. Donatsch / Rhaetian Railway



0 5 10 15 20 25 km
CH
FL
A
Landquart
Klosters
Chur
Reichenau
Davos
Lavin
Arosa
Ilanz
Susch
G R A U B Ü N D E N
Thusis
Disentis/Mustér
Filisur
Bever
Samedan
St. Moritz
Pontresina
N
I
Tirano (I)
L O M B A R D Y

Rhaetian Railway network

Length of the entire network 384 km

Sections of railway lines	Building started	Operation started
Landquart – Klosters	1888	1889
Klosters – Davos	1888	1890
Landquart – Thusis	1894	1896
Thusis – St. Moritz	1898	1904
Reichenau-Tamins – Ilanz	1898	1903
Davos – Filisur	1906	1909
Samedan – Pontresina	1906	1908
St. Moritz – Tirano	1906	1908 – 1910
Bever – Scuol-Tarasp	1909	1913
Ilanz – Disentis/Mustér	1910	1912
Chur – Arosa	1912	1914
Klosters – Susch – Lavin	1991	1999

Number of rail vehicles 1,449

Position 31.12.2005

Sources:
Relief: Swisstopo, Wabern
Design: Süsskind, SGD, Chur
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2.a.2 Facts & figures of the Rhaetian Railway and the nominated railway lines

Legal form and shareholders

Limited share company and breakdown of shareholders:

Canton Graubünden	51.3 %
Swiss government	43.1 %
Communities in Graubünden	1.0 %
Private / companies	4.6 %

Profit and loss account

Total expenditure	*CHF*	*255.4*	*million*
Personnel expenditure	CHF	131.3	million
Other operating expenditure	CHF	66.3	million
Amortisation	CHF	48.4	million
Financing expenditure, miscellaneous	CHF	8.5	million
Annual profit	CHF	0.9	million
Total income	*CHF*	*255.4*	*million*
Passenger traffic	CHF	83.2	million
Goods traffic	CHF	15.8	million
Compensation	CHF	116.2	million
Financial yield	CHF	2.2	million
Other operating income, miscellaneous	CHF	37.8	million

Rail account

Acquisition value	*CHF*	*2,456.3*	*million*
Installations, equipment	CHF	1,784.1	million
Vehicles	CHF	626.7	million
Movables	CHF	45.5	million

Personnel – average over the year

Permanent staff and auxiliaries	1,337
Personnel in apprenticeship	122

Passenger traffic

Passenger trips	9,226,000
Passenger kilometres	316.6 million
Distance per person	34.3 km

Goods traffic

Total tonnes	*699,000*
Beverages, food	133,000
Building materials	225,000
Timber, oil products	183,000
Post	34,000
Other traffic	124,000

Position 31.12.2005

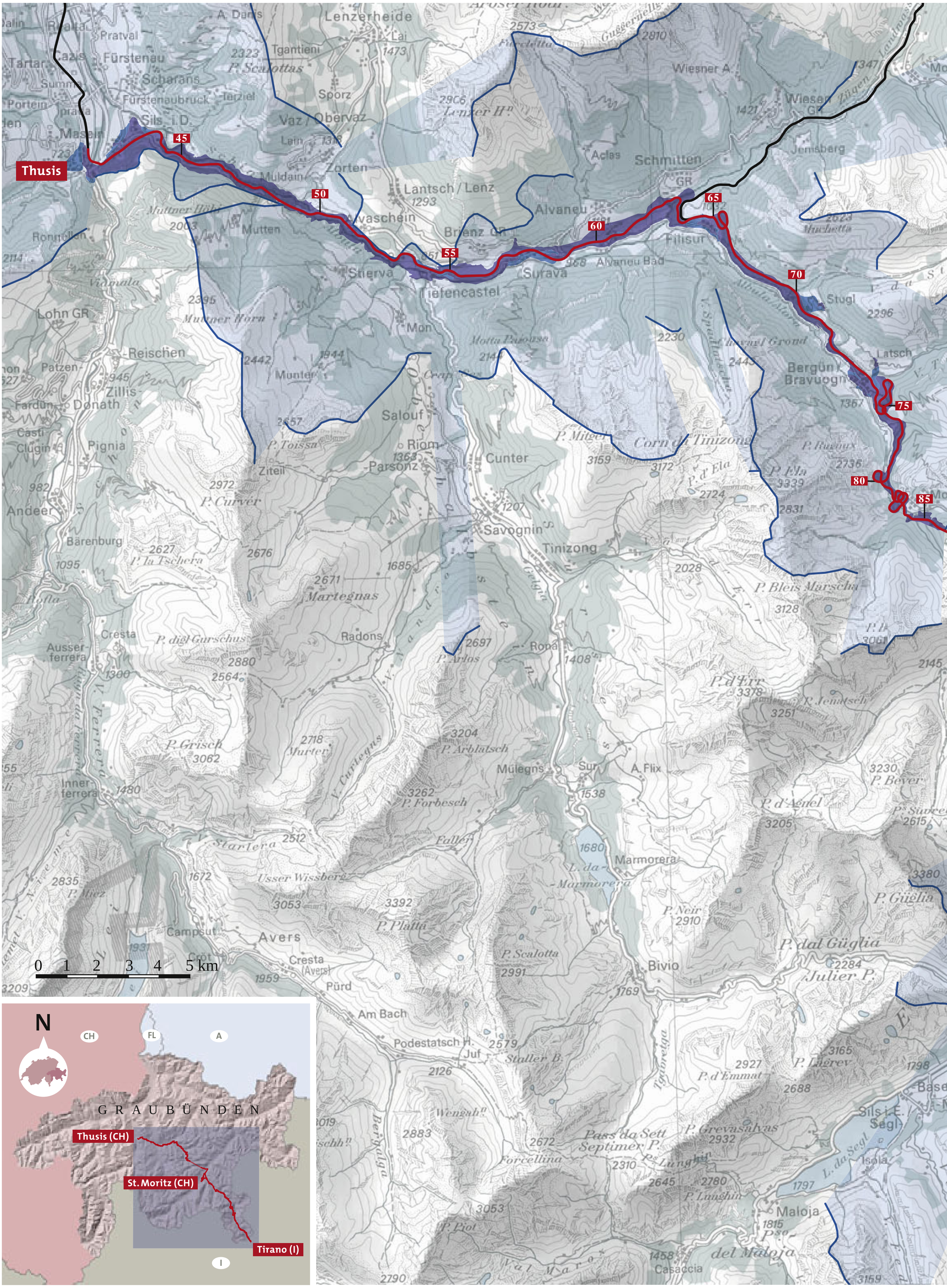
Albula line Thusis – St. Moritz (incl. Samedan – Pontresina)

Building started	October 1898
Operation started	
Thusis – Celerina	1st July 1903
Celerina – St. Moritz	1st July 1904
Samedan – Pontresina	1st July 1908
Initial building costs	CHF 25,112,000
Building costs per kilometre	CHF 388,450 Thusis – St. Moritz CHF 218,210 Samedan – Pontresina
Electrification	
St. Moritz – Bever, Samedan – Pontresina	1st July 1913
Bever – Filisur	20th April 1919
Filisur – Thusis	15th October 1919
Voltage system	Single-phase alternating current 16.7 Hz, 11 kV
Line distance	66,967 m (61,674 m + 5,293 m)
Altitude min/max	697.2 m (Thusis) 1,819.9 m (Albulatunnel)
Maximum gradient	35 ‰
Minimal curve radius	120 m, Landwasser Viaduct 100 m
Tunnels and galleries	42
Total length	16,545 m
Longest tunnel	5,865 m
Proportion of stretch	26.7 %
Bridges	144 (span ≥ 2 m)
Total lenght	2,901 m
Longest bridge	215.50 m
Original rail type	25 kg/m (Filisur – St. Moritz); 27 kg/m (Samedan – Pontresina)
Original rail length	12 m

Bernina line St. Moritz – Tirano

Building started	July 1906
Operation started	
Pontresina – Morteratsch, Poschiavo – Tirano	1st July 1908
Celerina Staz – Pontresina, Morteratsch – Bernina Suot	18th August 1908
St. Moritz – Celerina Staz, Bernina Suot – Ospizio Bernina	1st July 1909
Ospizio Bernina – Poschiavo (total stretch Bernina line)	5th July 1910
Initial building costs	CHF 11,698,000
Building costs per kilometre	CHF 192,760
Voltage system	Direct current 1,000 V
Line distance	60,688 m
Altitude min/max	429.3 m (Tirano) 2,253 m (Ospizio Bernina)
Maximum gradient	70 ‰
Minimal curve radius	45 m
Tunnels and galleries	13
Total length	4,072 m
Longest tunnel	839 m
Proportion of stretch	6.7 %
Bridges	52 (span ≥ 2 m)
Total span width	722 m
Longest bridge	116 m
Original rail type	24.3 kg/m
Original rail length	12 m

Albula line > The Albula Viaduct III between Bergün/Bravuogn and Preda in the inner Albula Valley.
R. Bösch / Rhaetian Railway


Thusis
45
50
55
60
65
70
75
80
85
Lenzerheide
Fürstenau
Sils i.D.
Vaz / Obervaz
Zorten
Lantsch / Lenz
Alvaneu
Schmitten
Wiesen
Filisur
Stugl
Bergün / Bravuogn
Latsch
Alvaschein
Mutten
Stierva
Tiefencastel
Surava
Alvaneu Bad
Brienz GR
Mon
Salouf
Riom
Parsonz
Cunter
Savognin
Tinizong
Rona
Mulegns
Sur
Marmorera
Bivio
Avers
Cresta (Avers)
Juf
Maloja
Casaccia
Sils i.E. / Segl
Andeer
Zillis
Donath
Pignia
Reischen
Lohn GR
Ausserferrera
Innerferrera
Julier P.
Pass da Sett Septimer P.
0 1 2 3 4 5 km
N
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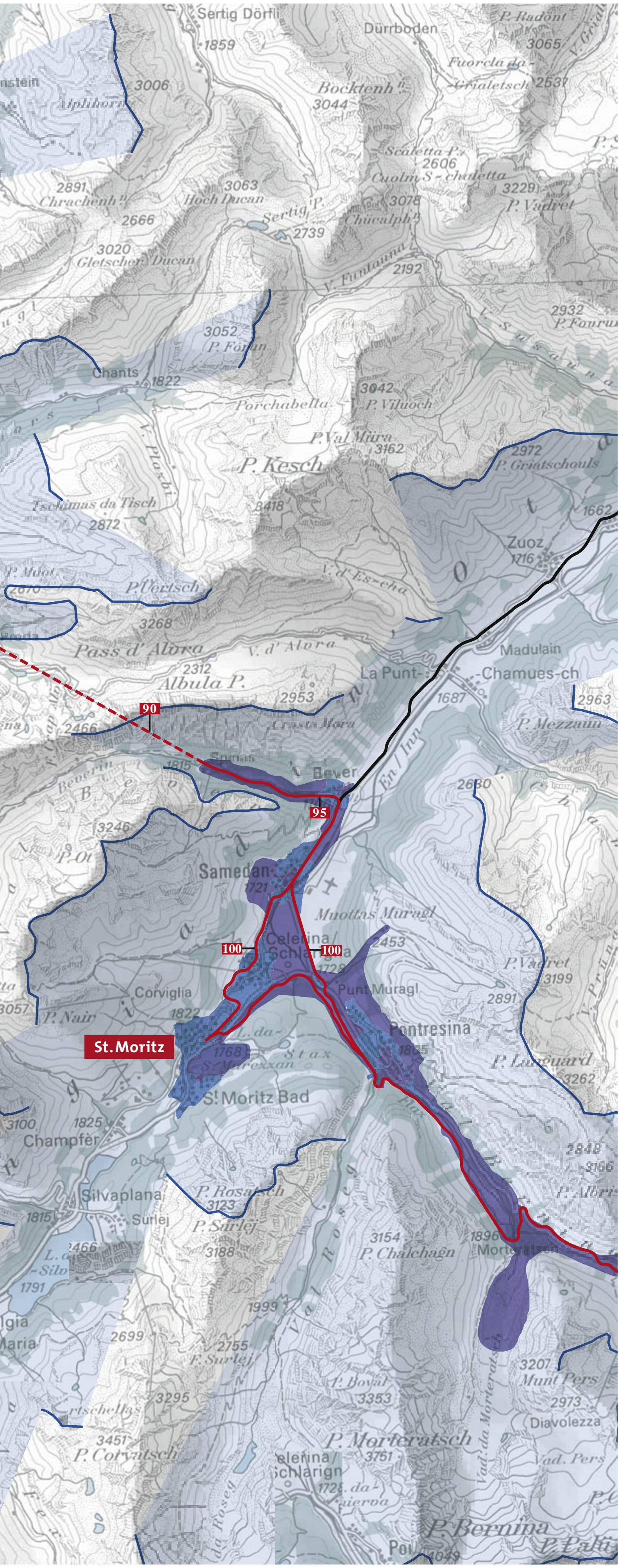
I
GRAUBÜNDEN
Thusis (CH)
St. Moritz (CH)
Tirano (I)



Albula line (Thusis – St. Moritz)

65 Kilometre markings

Station	Altitude
Thusis	697.2
Sils i.D.	735.2
Solis	850.7
Tiefencastel	883.7
Surava	939.1
Alvaneu	999.3
Filisur	1,080.2
Stugl/Stuls	1,276.5
Bergün	1,372.3
Muot	1,575.1
Preda	1,788.7
Spinas	1,814.7
Bever	1,710.2
Samedan	1,705.4
Celerina	1,729.7
St. Moritz	1,774.7
Pontresina	1,773.7

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Gion Rudolf Caprez
Design: Süsskind, SGD, Chur
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2.a.3 Descriptions of sections

Albula line (Thusis – St. Moritz, built 1899 – 1904)

The Albula line, which connects the towns of Thusis and St. Moritz, was built between 1899 and 1904. It was planned primarily to meet the needs of the rapid growth in tourism in the Upper Engadin, which began in the middle of the 19th century (cf. 2.b.9). In terms of its functions it can be described as a branch terminal line; in contrast to a through line it did not connect two outlying conurbations but linked the population of a valley (in this case an inner-Alpine valley) to an inter-regional railway network and did not itself have any continuing connection. However, as far as the alignment is concerned the Albula line can be classed as a trans-Alpine mountain railway in the same tradition as the Semmering and Gotthard railways. In terms of operational management and rolling stock the Albula line was based on the major through-lines, although the Albula line differed from these as it was narrow-gauge and not standard-gauge, had tighter curve radii, and a maximum gradient of 35‰ as opposed to a mere 25‰.

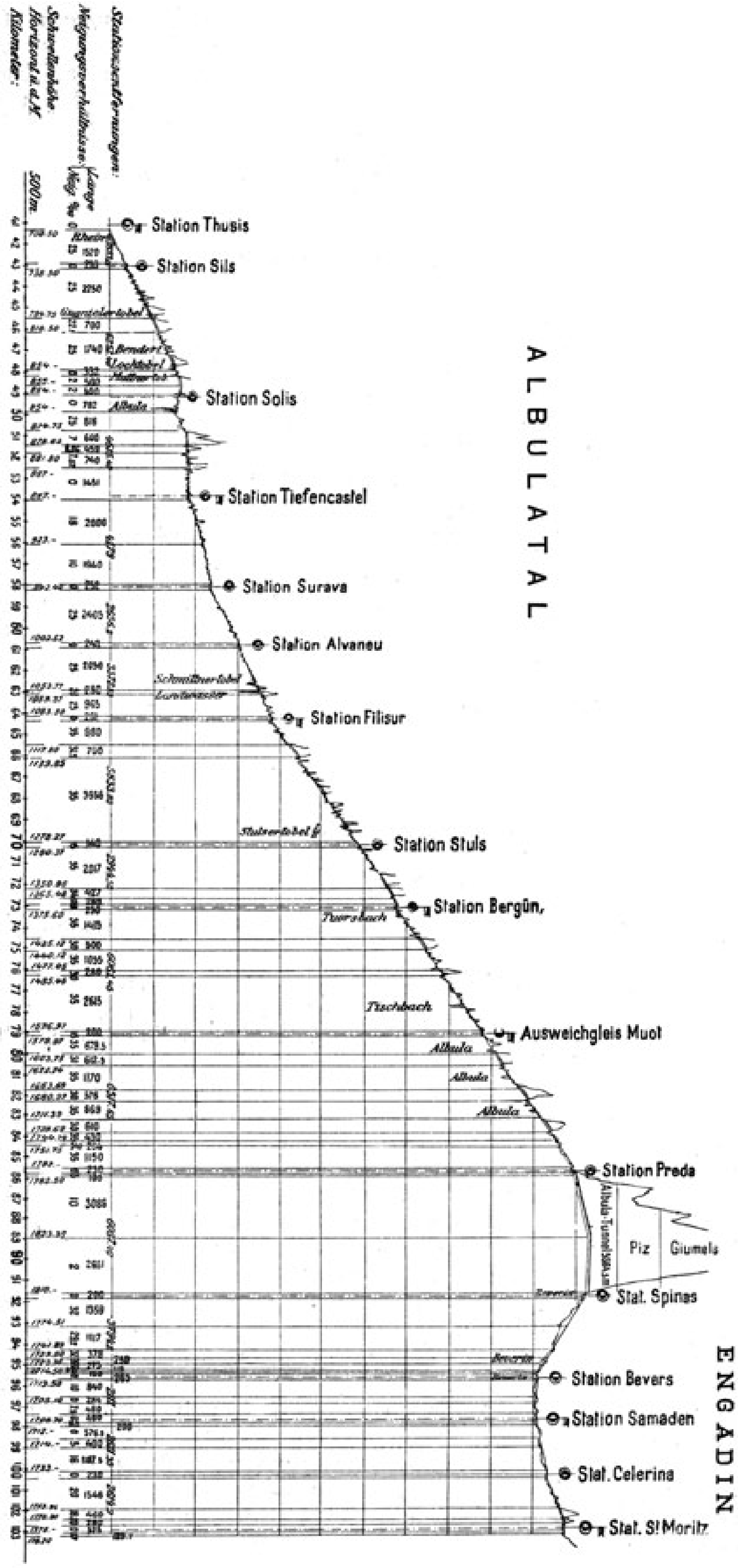
Standards

The Albula line was part of a larger Rhaetian Railway construction programme (cf. 2.b.5), which also included the line through the Rhine gorge, from Reichenau to Ilanz; the design standards and execution of the two lines are identical. The determination of specific set values was necessary so that the alignment of the line could be plotted and the costs calculated. Such values included maximum gradient, minimum curve radius, track gauge, formation width and the loading gauge. Standards and types for other features were also defined for the Albula line with respect to station buildings (cf. 2.a.5), stone arch bridges and walls, the angle of slope of embankments and cuttings, and details such as the design of fences. Norms were also prepared and developed for the quality of construction of the buildings. Documents defining staff responsibilities for the railway personnel were published before the line was commissioned. From section engineer to tunnel guard, every employee was required to comply with a personalised set of rules. All this shows the determination of those responsible to construct a railway line which would be exemplary in every detail.

> Track gauge 1,000 mm
> Curve radius minimum 120 m, in exceptional cases 100 m
> Maximum gradient Thusis – Filisur and Bever – St. Moritz 25‰
> Maximum gradient Filisur – Bever 35‰
> Width of formation 3.8 m – 4.1 m
> Passing length 120 m, after 1904 gradually increased to 200 m, today minimum 270 m
> Railway loading gauge 3.55 m width, 3.9 m height
> Angle of slope of embankments and cuttings 2:3
> Taper of mortar masonry: 1:5
> Taper of dry masonry: 1:3

Longitudinal profile, route planning

The original alignment of the line – still largely followed by the Albula line today – was developed based on the specific principles for a main line: as such a line should arrive at its destination as efficiently as possible, a balanced longitudinal profile was to be aimed for. “Lost” upgrades, for example to bring a station closer to a village or to avoid obstacles, were avoided. The overall line can be roughly divided into



Albula line > Profile of the line.
***Enzyklopädie des Eisenbahnwesens*, ed. by [Victor] von Röll, vol. 1, Berlin and Vienna 1912.**

three sections: a long northern ramp, the summit tunnel, and a short southern ramp with a following valley section. The northern ramp for its part consists of two ramps, each with an upgrade of 25‰ (Thusis – Lochtobel and Surava – Filisur) and a third (main) ramp with a 35‰ downgrade (Filisur – Preda). This division of the northern ramp into a section with a low gradient and a section with a higher gradient points to the efforts which were made to design the railway line with the aim of keeping operational management as economic as possible: up to Filisur the line could be operated with a less powerful steam locomotive. It was only for the second section that it was necessary to involve the use of a more powerful or a second locomotive; for technical reasons the journey had to be divided into stages when the services were steam-operated.
With a mountain railway, keeping to a balanced longitudinal profile necessarily involves the building of many civil engineering structures. In this respect, four sections of the Albula line can be identified which have a high density of engineering structures:

> Thusis – Tiefencastel (Schin gorge)
> Surava – Preda (Albula valley)
> Spinas – Bever (Bever valley)
> Celerina – St. Moritz (Charnadüra valley stage)

With the exception of the section Sils i. D. (Sils im Domleschg) – Solis the line runs along the sunny side of the valley; this is an advantage in terms of snow clearance and drainage. With regard to snow clearance the formation width along revetment walls was widened in order to provide space for the cleared snow on the mountain side of the line. Where accumulations of snow were to be expected the line was either set on an embankment or snow trenches were excavated.
Special elements of the layout are the forced alignments between Alvaneu and Preda; these include exits from side valleys and loops with turning tunnels und spiral tunnels. A typical aspect of the alignment as a main line is that all the crossings with main roads (with the exception of those in Surava and Samedan) were built as overpasses or underpasses. There are still many level crossings with farm tracks.

Organisation of the intermediate stations

A number of intermediate stations have been constructed along the Albula section between the two termini in Thusis and St. Moritz, and these too have a standardised configuration. At the smaller stations the main track, which is used by the through trains, has a straight and level length of 230 m. The passing track which branches off from the main track allows trains to pass and also provides access to the loading ramp, which has a useable length of 200 m and at one end (mostly against the downgrade) extends into a dead-end track. The typical intermediate station therefore has a total of three points. The station building is situated close to the passing track, and always where the dead-end track branches off. This track is paralleled on one side by the loading ramp. A station forecourt was constructed at the other end of the building (which contains the waiting room); the forecourt was also the start of the station access road. Grouped around this forecourt were a station toilet, a well and the station master’s garden.
The larger intermediate stations – Tiefencastel, Filisur, Bergün/Bravuogn, Bever and Samedan – were equipped with more extensive track systems, such as sidings, and tracks leading to the water tank, the engine shed and the turntable. For technical reasons a longer intermediate halt was constructed in Filisur, which is about the middle of the section. Here there was also a station buffet which offered travellers light refreshments. There

Albula line > Alignment below the ruins at Campi near Sils i.D.
R. Bösch / Rhaetian Railway

was no freight traffic at any of the intermediate stations on a scale that merited the construction of special facilities.

Short description of the individual sections of the route.

The description of the individual sections of the line and the various structures associated with them is based on the kilometerage specified at the time the Rhaetian Railway was built and which is still in use today. Kilometre 0.0 of the Rhaetian Railway's network is in Landquart.

km 41 – 64: Thusis – Filisur

The starting point of the Albula line is the station in Thusis. This was built as the terminus of the line between Chur and Thusis, opened in 1896. The station facility was completely rebuilt between 1990 – 1993.
Directly following the station in Thusis the line crosses the Hinterrhein (Upper Rhine) over a wide-spanned concrete bridge (km 41.7). The original crossing – an iron lozenge lattice girder with a span of ca. 80 m – had to be replaced when the motorway was constructed. Even in its original form as an iron structure the Rhine bridge formed an untypical element among the otherwise "stone-built" engineering structures of the Albula line; here formal reference to the river bridges over the Rhine was made for the last time, before the line enters the mountains (cf. 2.a.4). The former Rhätischen Werke's Viamala power station can be seen from the bridge. It is from this power station that the Rhaetian Railway drew the electricity needed for the operation of the railway, beginning with the electrification of the line in 1919 and on up to the middle of the 20th century (cf. 2.b.7).
Starting as far up the line as Thusis the alignment is determined by compliance with the maximum slope of 25 ‰ and by the requirement for a balanced longitudinal profile. At km 42.6, close to Ehrenfels castle, the line crosses the historic Viamala bridleway over a small, three-arched underpass. The first of the smaller intermediate stations is reached at the station in Sils i.D. (km 43.1). From here a connecting road roughly 100 m long leads down to the cantonal highway; the village at the foot of the slope which gives the station its name can be reached by means of small path. A branch line on the Thusis side serves to load the broken stone from the gravel plant on the Albula. The track scales in the dead-end track – untypical for a small railway station – recall the significant volume of freight traffic once dealt with in Sils i.D., here, and not in Thusis, was where the freight handling for the industrial factories along the Albula took place.
At the end of the Sils i.D. railway station the road, which ran along below the line to this point, crosses the tracks on a bridge; from here it now continues to run above the line. After this underpass the line of the railway was blasted out of the rock. The railway line enters the Schin gorge along a sharp curve. At the entrance to the gorge, stand the ruins of Campi castle; given its unplastered rubble masonry the question involuntarily comes to mind of to what extent did the builders of the railway line base the design of the engineering structures on the medieval military architecture typical of Graubünden. The next section, as far as the station in Solis, is distinguished by a continuing series of tunnels, inclined viaducts, bridges and walls. The total of twelve tunnels on this section have altogether a length of 4,270 m, which corresponds to half the length of the Schin section of the line; structures which have significant lengths include the Runplanas (km 44.8), Versasca (km 45.5) Passmal (km 47.1) and Solis (km 48.2) tunnels. The bridge structures

Albula line > The Solis Viaduct, the bridge with the greatest span on the Albula line.
P. Donatsch

Albula line > The 27 m Mistail Viaduct is located immediately below the Carolingian church of St. Peter in Mistail at the upper end of the Schin gorge.
B. Studer

which should be mentioned include the Bändertobel viaduct (km 47.0), the Lochtobel viaduct (km 47.8), which used to be very popular as a subject for photographs, but is overgrown today, and the Muttnertobel viaduct (km 48.2). The first, 25 ‰ steep section of the northern ramp ends at the Lochtobel viaduct; a horizontal section commences directly after the bridge and extends as far as the Solis viaduct. Apart from the Solis viaduct, the Muttnertobel viaduct has the widest spanned single arch of all the bridge structures on the Albula section. It leads directly into the Solis tunnel; at the southern portal a switch house dating from the time when the line was electrified (1919) has been preserved. Immediately after the tunnel the line runs directly into the station in Solis (km 49.3), which approximately marks the midpoint between Sils i.D. and Tiefencastel. The reason for the construction of this station was less to serve a village but rather the opportunity to provide the essential facility of a passing track – due to the very difficult topography in the Schin – at the first feasible location after Sils i.D. The restricted space available is the reason why Solis is the only station on the Albula line which was not built to a straight alignment but along a reverse curve.

Shortly after the station at Solis the railway line crosses over the Solis viaduct (km 49.8), the bridge has the greatest arch span of any structure on the Albula section. The crossing of the valley at a right angle called for curved approaches; these lie partly on approach bridges and allow travellers a view of the imposing viaduct. The exceptionally well-maintained Solis viaduct can be easily accessed and, thanks to the good view of it from the bridge of the old cantonal highway running parallel, is a popular motif for photographs. With the Solis viaduct the railway switches from the shady side to the sunny side of the Albula valley. For topographical reasons it was only possible to cross the valley at this specific point; thus the Solis viaduct is a defining element which influenced the entire the alignment between Thusis and Tiefencastel.

After the Solis viaduct the second section of the northern ramp begins, with an upgrade of 25 ‰. The section as far as Tiefencastel has a high density of engineering structures, above all of tunnels passing behind rock faces. Between the Alvaschein and the Nisellas tunnels (km 50.8 and 51.5) there is an improvised worker's accommodation building, located under the arch of a bridge (km 51.5); the accommodation is linked to the maintenance of the railway. The address, "At the Golden Ox 1963", provides an indication of when it was constructed. At km 51.8 there are footings of a linesman's house; this point, which later saw the construction of the Nisella block post, was where the original plans proposed the construction of a railway station (Alvaschein). The remains of a cable railway have also been preserved here. This served the construction and maintenance of the former storage dam for the Albula power station (1910). The 27 m long Mistail viaduct at km 52.7 lies directly below the Carolingian church of Mistail; here the rock was cut into to allow its construction. The Tiefencastel railway station (km 54) was built – against the will of the local community – on the opposite side of the valley to the village of the same name, where it lay close to the main road; this was a result of crossing the valley at Solis and the more important function given to the railway as providing a connecting link for the Engadin valley. One interesting feature is the express buffet dating from 1958, the interior of which is furnished in the style of an American "diner" with bar and booths. The following section of the line as far as the Tiefencastel tunnel (km 55) runs through geologically very difficult

Albula line > Alignment in the Albula Valley.
D. Enz

Albula line > Zalaint Tunnel and Landwasser Viaduct.
Foto Geiger

terrain. As an exception, in order to avoid constructing tunnels here, the normal curve radius of 120 m was reduced to 100 m, so that the railway line, with inclined viaducts and cuttings, could match the terrain more closely. In this area, which is subject to landslides between the Tiefencastel tunnel – the only mountain tunnel between Mistail and the Landwasser viaduct – and the station in Surava (km 58.1), the railway line runs through open terrain, through meadows and bush-covered countryside. Surava railway station lies above the village of the same name. At the edge of the station the line crosses the valley road over a level crossing; the barriers could therefore be operated by the station master himself, so that there was no need to construct a special guard's cottage. At km 59 the railway line leaves the valley floor and begins to climb steadily up the side of the valley as far as Filisur (km 64.4) at a gradient of 25 ‰. This section along the hillside is distinguished by a large number of engineering structures. Typical here is the location of the line on an earth fill embankment which is supported by a dry stone wall. This arrangement avoids the need for high retaining walls in steep terrain, which could only have been constructed in mortar masonry. Between km 60.1 – 60.3 a protective rockfall walling separates the line on the mountain side from a quarry dating from the time when the line was constructed. The formation level of the station for the next station, in Alveneu (km 60.8), could be set up by means of an embankment, without any walls. The link road between Alvaneu Bad and Alvaneu Dorf was built at the same time as the railway; this road crosses the railway line at the railway station.

The section in the Landwasser valley (km 61.1 – 63.4) is the most famous section on the Albula line; it is distinguished by an ensemble of forced alignments. Engineering structures here include the Schmittentobel viaduct (km 62.6), the Zalaint tunnel (km 62.8), the Landwasser viaduct (km 63.0), the Landwasser tunnel (km 63.1) and a sparing arch viaduct (km 63.4). Travellers have three opportunities to admire the view of the imposing Landwasser viaduct. The Filisur – Schmitten footpath crosses below the Schmittentobel viaduct. At km 62.8 the line passes a former railway quarry (on the mountain side). The overgrown piles of stone accumulated here consist of rail track ballast. During the 1920's the rock was excavated above this point and then moved down to the railway line by chutes. The Zalaint tunnel is not lined on the inside, although the portal is marked by a vault arch. Signs of a construction site access can still be recognised around the top of the crag. A site was selected for the crossing of the gorge at the exit of the Landwasser valley where a protruding outcrop allowed the construction of a bridge with a relatively small span. The construction of the Landwasser viaduct (km 63.0) is subject to the demands set by the alignment, whereby the viaduct sets off tangentially from the north slope and then swings in sharp curves – the curve radius here is reduced to 100 m for the second time since leaving Thusis – frontally towards the opposing vertical rock face. The Landwasser viaduct is actually a turning viaduct similar to the "Kalte Rinne" of the Semmering line. The surrounding terrain has preserved traces of the extraction of material for the viaduct and of the engineering installations. The mine chambers integrated in the foot of the column, so it could be demolished quickly in the event of a military emergency, have since been walled up but they are still recognisable. Since it was opened, this valley crossing has provided an instantly recognisable image of the Albula line. Early standard motifs were the view of the viaduct with the

Albula line > Landwasser Viaduct. The Landwasser Valley is crossed at the narrowest point with a radius of only 100 m.
P. Donatsch

Albula line > The Stulsertobel Viaduct is one of the most striking viaducts between Filisur and the Bergünerstein.
T. Keller

Albula line > The remote Stuls/Stugl crossing station is built on an outcrop high above the valley.
T. Keller

Schmittentobel viaduct in the foreground, or the view from the outer side of the arch. Today perhaps only the view from the former quarry looking down onto the viaduct is well-known.

Km 64 – 86: Filisur – Albula Tunnel

The decision to gain height as quickly as possible and to leave the valley floor after Surava resulted in the Filisur railway station location high above the village. The station lies on an impressive level area; on the mountain side it is terminated partly by a revetment wall, partly by an earth slope and partly by in-situ rock. Filisur was a stage between Chur and St. Moritz, where the railway engines were checked, and where a buffet was available for the travellers. The station square was planted with a line of trees to underscore the importance of the facility. Access was provided by a new road leading off the cantonal road, and by a new, direct footpath.

The branch line to Davos was opened in 1909, and it is thanks to this line that Filisur is still today a railway station used by fast trains. The conversion of the railway station in 2004 left the depot with its turntable, shed and water crane untouched.

The third section of the northern ramp begins after Filisur; the design of the alignment was based entirely on the desire to gain height and used the maximum gradient, which here is now 35 ‰ rather than 25 ‰. This approach led to the need for several engineering structures. Above Filisur railway station the line passes through the 698 m long Greifenstein tunnel (km 65.4) and the short, 55 m Schlossberg tunnel (km 66.2) which form a first reverse loop designed to gain height. The names of these two tunnels are taken from Greifenstein castle which lies above them. This Greifenstein loop is inset in the karst countryside and offers fascinating views back towards the Albula valley. The line then runs along the wooded slope around 150 m above the valley floor. Here screes alternate with steep rock faces. The section runs continuously along slope sections or in tunnels and on bridges, and may be compared with the part of the Semmering line which runs through the Weinzettelwand. Moving on up to the Bergünerstein the line crosses over eight viaducts (total length 316 m) and through eleven tunnels with a total length of 1,806 m. Where the line runs in the open it is supported almost everywhere by dry stone walling on both the valley and the mountain sides, the walls having an average height of 4 m. The entire section as far as the Bergünerstein is endangered by rock falls. This made it necessary to construct an unusually large number of protective structures; in some parts these extend several hundred metres up the slope and need constant extension and maintenance. The lower portal to the small Cruschetta tunnel (km 67.2) has a rockfall gallery with rockfall catch areas. The abutment on the valley side is structured as a buttress, which is connected to a domed passage. The upper portal is extended by the addition of a rockfall gallery in reinforced concrete. Two notable viaducts are the Surmin (km 68.5) and the Stulsertobel (km 69.7). The latter is joined directly by a vertical retaining wall. With the exception of the cantilevers on the edging the great area of walling is not subdivided.

The passing station in Stugl/Stuls (km 70.2) lies on a natural plateau which was extended by means of rock blasting. With station building, guard house, workers' huts and smaller buildings, a group of buildings has been preserved here that reflect the living conditions along the line.

A road constructed by the railway leads up to Stugl/Stuls village; this road largely retains its original form. One minor feature is the overbridge over Stugl/Stuls railway station, which is in the form of a "flying arch" – the only bridge along the Albula line which was built to this principle. The

Albula line > The first elongation to overcome the natural step in the terrain between Bergün/Bravuogn and Preda is set in gently sloping meadows.
T. Keller

Albula line > A Rhaetian Railway train in the centre loop above Bergün/Bravuogn.
P. Donatsch

Albula line > After passing the revetment wall at Fuegna, the train has come down almost to the valley floor and must start climbing again.
Foto Geiger

transverse profile of the section from km 70.5 – 71.4 is typical for the Albula line: on the valley side a covered dry stone wall and on the mountain side dry stone retaining walls. The line pierces the rock wall of the Bergünerstein, in almost a straight line, through the 409.5 m long tunnel of the same name (km 71.7). Thereafter the line once more runs close to the bottom of the valley, beside the road (km 72.2), which it had turned away from near Surava. Only 124 m after the Bergünerstein tunnel the railway enters the 333 m long Glatscheras tunnel. This is followed by the Bergün/Bravuogn railway station (km 73.1). Bergün/Bravuogn is the only village between Filisur and the Engadin. Here it was hoped – vainly, as it turned out – that the construction of the railway would provide an impulse for the economic development of the locality; structures which give evidence of this are the arsenal near the station building (the arsenal building is to be converted into a railway museum in the near future) and the Kurhaus Hotel. The railway station is situated somewhat above the village. Access was provided by the construction of a new, tree-lined road linking the Albula road with the station forecourt.

The valley floor between Bergün/Bravuogn and Preda has an average gradient of 77 ‰; overcoming this 'step' in the terrain required a complicated longitudinal alignment. The first element is located in the gentle meadow slopes above Bergün/Bravuogn; it consists of a double reverse curve which brings to mind the alignment of the Gotthard railway near Wassen. It was so skilfully integrated into the terrain that only two shorter turning tunnels were needed here. A marble memorial tablet was built into the exterior wall of the church in Bergün/Bravuogn in honour of an engineer named Perbs, who designed the open loops of Bergün/Bravuogn and who lost his life in the Greifenstein tunnel in 1901; the tablet itself can be seen from the railway (km 73.8). At Val Tuors loop curve (km 75.8) the cutting was constructed using the "English" method with a tunnel and vertical shafts; together with the associated embankment, which is protected by four large drainage trenches, this is one of the most imposing earth structures on the Albula line.

Following a section along the slope and the crossing of Val Tisch, the line arrives at the Muot service station. The Val Tisch viaduct (km 77.9) has an uneven face walling. The arches consist of different types of stone; above Bergün it was difficult to find enough suitable stone material for the bridge structures. Near km 78.3 stands a walled workmen's hut. This was used as accommodation during the construction of the avalanche barrier, and later as a kitchen and canteen for track workers; the open fireplace in the interior of the building is still preserved. Today the hut is used as a private cottage. Between km 78.8 – 79.1 the line passes the Chanaletta avalanche track, from which it had to be protected by extensive avalanche barriers; the dry stone walling reaches up to a height of 2,300 m above sea level. Because of its steepness the mainstream of the avalanche could not be blocked, and therefore the Chanaletta gallery had to be tunnelled through it (km 79.0).

The Muot railway station (km 79.2) is a "signal station" and is not open to the public. For this reason the gradient was not reduced to 0 ‰, as was the case for stations where marshalling manoeuvres were expected, but only down to 15 ‰. The station building stands with its axis at right angles to the track. Despite the shady location it was decided to build a garden here as well; this – together with a well – can be found on the side toward the mountain.

Soon after Muot the railway line has almost reached the floor of the valley and now it has to climb again. The selected gradient and minimum

Albula line > The stretch between Bergün/Bravuogn and Preda. The impressive alignment can be best appreciated from the air.
T. Keller

Albula line > In the foreground the 11 m high and 59 m long Albula Viaduct I. In the background left, the Rugnux inclined viaduct.
A. Badrutt

Albula line > Shortly before Preda station there is a spectacular view back to the mountains flanking the inner Albula Valley.
Foto Geiger

radius meant that, in the narrow valley, there was no opportunity to construct an open loop or to swing out into a side valley. The few open valley slopes also had to be avoided, in this case because of the risk of avalanches. For this reason use had to be made – three times – of the most costly artificial alignment feature: the spiral tunnel. 500 m above Muot the line crosses the valley river for the first time, traversing the 59 m long and 11 m high Albula Viaduct I (km 79.8). Directly beyond this it winds its way upwards along the left bank, through the 661 m long Rugnux spiral tunnel (km 79.9). The upper portal of this tunnel is connected to a gallery composed of steel and revetment walls with six cast concrete sparing arches. From the upper portal a view can be obtained backwards towards Muot and the adjoining rock section. With the 95 m long and 29 m high Albula Viaduct II (km 81.2) the railway line once again returns to the right bank, in order to avoid the avalanche endangered slope of Val Rots. There now follow the 677 m long Toua spiral tunnel (km 81.6 – 82.3) and then the Albula Viaduct III (km 82.5). At km 82.8 the line passes through the Maliera avalanche gallery. On the left bank of the river it describes an open semicircular arc, crosses the river Albula for the last time by the Albula Viaduct IV (km 83.0) and then winds its way upwards through the 535 m long Zuondra spiral tunnel (km 83.2 – 83.7) to the height needed to be able to pass in a straight line through the open valley of Preda towards the Albula tunnel. The latter two spiral tunnels are located almost one above the other, vertically separated by about 50 m.
At km 84.4 the cantonal road is crossed at a sharp angle by means of a straight bridge. The railway crosses the Preda basin over an embankment which was constructed using material obtained from the excavation of the Albula tunnel.
Besides the railway structures themselves the density of accommodation buildings along the section just described is also worthy of note; these were used to provide housing for the railway maintenance workers. Between Bergün/Bravuogn and Preda traces can be found of no fewer than four, permanently occupied houses and five huts – for example the guards' huts at the lower portal of the Rugnux spiral tunnel. These were available to the workers whose job was to remove ice from the tunnel in winter.

km 86–92: Albula tunnel

This section consists of the Albula tunnel and the two adjoining stations. The 5,864.5 m long summit tunnel connects the high Preda valley, in a straight line, with Val Bever, a side valley of the Upper Engadin. The tunnel passes below the western peak of the Dschimel; the highest overburden of mountain is around 950 m. From the entry portal the tunnel tube first rises for 100 m at a slope of 5 ‰, with the next 3,070 m rising at 10 ‰; the crest horizontal section then follows; it is 100 m long and at a height of 1,819.9 m. Finally a 2,596 m long downgrade of 2 ‰ drops down towards the exit portal in Spinas. The clear height is 5 m, the clear width 4.5 m; these dimensions exceed those of the smaller tunnel by 0.3 and 0.2 m. The total clearance is 19.91 m^2, which is around 86 % of the 23.2 m^2 of the Simplon tunnel. The vault is designed as a semicircle; the abutments have a taper of $1/20$. The design of the well-preserved southern portal of the Albula tunnel is a particularly representative feature.
Preda railway station (km 85.7) at the entrance to the tunnel lies in an area which formerly was only used for brief periods; before the construction of the railway the only feature here was the Kulm Hotel on the Albula road. When the railway was constructed Preda became a settlement which was used all year round. It never quite attained the

Albula line > The railway reaches the Engadin at Bever.
A. Badrutt

Albula line > Between Samedan and Celerina the River Inn forces the railway and the road to run along the foot of the rocks.
T. Keller

status of a railway village, since railway operations required the presence of only a few families in Preda. The station is built on material which became available with the excavation of the Albula tunnel. Today Preda is the starting point for the railway history education trail towards Bergün/Bravuogn.

Spinas, at the other end of the Albula tunnel, like Preda, used to be just a summer settlement. Following the construction of the railway only railway workers and their families lived here all year round. The station (km 91.8), probably the best preserved station ensemble on the Albula line, lies partly in the advance cutting and partly on material excavated from the Albula tunnel. Between the Albula tunnel and the Spina railway station the line crosses the Beverin river over a two-track steel bridge.

km 92 – 103: Spinas – St. Moritz

The last section of the Albula railway line, from Spinas to St. Moritz, runs through quite a different type of countryside to that of the northern ramp. The only engineering structures that had to be built here were two tunnels – the Charnadüra I tunnel (449 m) and the Argentieri tunnel (114 m) – which were needed to take the railway over the gorge of the Inn shortly before St. Moritz, and three small bridges over the river Beverin. There is a risk of avalanches along both flanks of the Bever valley. For this reason the railway line up to Bever was relocated and built on a high embankment along the centre of the valley, parallel to the river Beverin; material excavated from the tunnel was used as the fill material for the embankment. A mortar masonry wall, 150 m long, was built to protect the railway line from the avalanche “da la Resgia” (km 94.2) which, coming from as far as the Crasta Mora on the left flank of the valley, even crosses the Beverin in some places. Shortly before this wall there is an overbridge with a concrete, skewed segmental arch (km 94.1). At km 94.8 the line crosses the river at a oblique angle by means of a flat stone vault in a curve with open stone masonry. Beyond the bridge the railway line runs along a meadow with abandoned irrigation ditches. The entrance to Bever railway station (km 96.6) is on a curve, the narrow radius is explained by the effort on the one hand to construct the station close to the village, and on the other to be able to construct a branch line towards the Lower Engadin. The road between Bever and Samedan runs parallel to Bever railway station, so that only a short access road had to be built. Despite its closeness to Samedan, Bever railway station had all the facilities to be found in a medium-sized station: station buildings, goods depot, post office (later the station buffet) and two guard’s houses. After 1913 the Lower Engadin line to Scuol branched off here and Bever was for a long time used as a transfer station. From 1913 the power supply for the electrical operation was located in Bever; the former transformer building is today a substation.

From Bever to Samedan the line is almost straight, although with some light downgrades. The most impressive structure is the embankment in the valley (km 95.9 – 96.7), also constructed using material excavated from the Albula tunnel.

Samedan railway station (km 97.7) occupies the space between the former high bank of the river Inn and the dyke along the Inn; when the railway was built this area appeared as an stretch of exposed gravel. The station road (today the Via Retica) branches off the road towards Pontresina in front of the railway station and then rises to reach the road towards Bever just after the Hotel Bernina. In addition there are two footpaths which lead from the station into the village. In Samedan the line, opened 1908, branches off towards

St. Moritz > The terminus of the Albula line.
A. Henkel / Rhaetian Railway

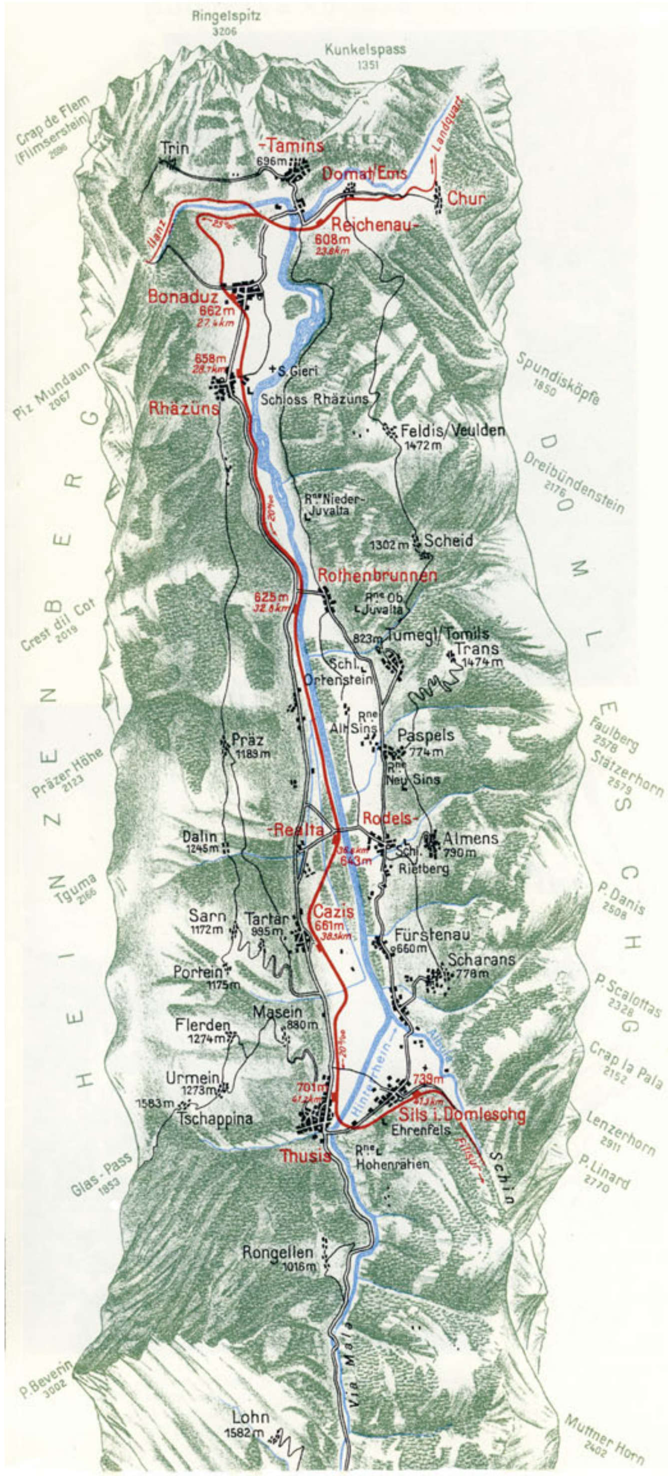
Between Samedan and Pontresina > A train with a load of timber on its way south through the autumnal splendour of the Engadin.
A. Henkel / Rhaetian Railway

Pontresina. The depot facility dates from 1985 and stands on the site of the original depot and workshops. The station building and the railway settlement are also new facilities, constructed on the site of the original buildings. Many railway workers moved to the Samedan area after the railway opened.
Between Samedan and St. Moritz the line has to cross a valley; in the section from Ochsenbrücke (km 99.3) to St. Moritz the line therefore rises along the side of the valley at a gradient of 25‰. At km 98 the line crosses the Samedan-Pontresina road. From km 98.6 to km 99 the line then runs on an embankment over the former loop of the river Inn, whilst the old valley road runs to the right, at the foot of the slope. At km 99.2 – 99.6 there is what used to be a convex bank of the river, where the Inn directly washed against a rock groin. Here, railway line and road squeeze in close to the foot of the rock. On the mountain side the railway is protected against falling stones by rockfall catch areas and barriers.
Celerina railway station is located at km 100.3. The Crasta road overbridge (km 101.4) is a skewed crossing with segmental arches in in-situ concrete. A watchman's hut stands at the lower portal of the Charnadüra tunnel (km 101.9 – 102.4); it may have served as accommodation for workers who had to remove ice from the tunnel in wintertime.
At km 102.9 the line reaches St. Moritz railway station, the end of the Albula railway. The selection of the location for the St. Moritz railway station was the subject of some controversy (cf. 2.b.4 and 2.b.6), and was the reason why it was only possible to open the Celerina – St. Moritz section in 1904 and not in 1903 as planned. The selected – peripheral – location eventually turned out not to be the ideal site. The station formation was achieved on the mountain side by the construction of a high revetment wall with sparing arches, and on the lake side by the construction of an embankment. A road ran along the side of the lake towards St. Moritz Bad, and another, today's Via Serlas, into the village.
The track system consists of the two separate railway stations for the Rhaetian Railway and the Bernina Railway. The original facilities of the Rhaetian Railway – largely preserved in the existing railway station today – were those of a through station, with ramp track, three marshalling tracks and a siding. The station was equipped appropriately with a view to an extension of the line to Chiavenna, then planned.

km 98 – 103: Samedan – Pontresina, opened 1908

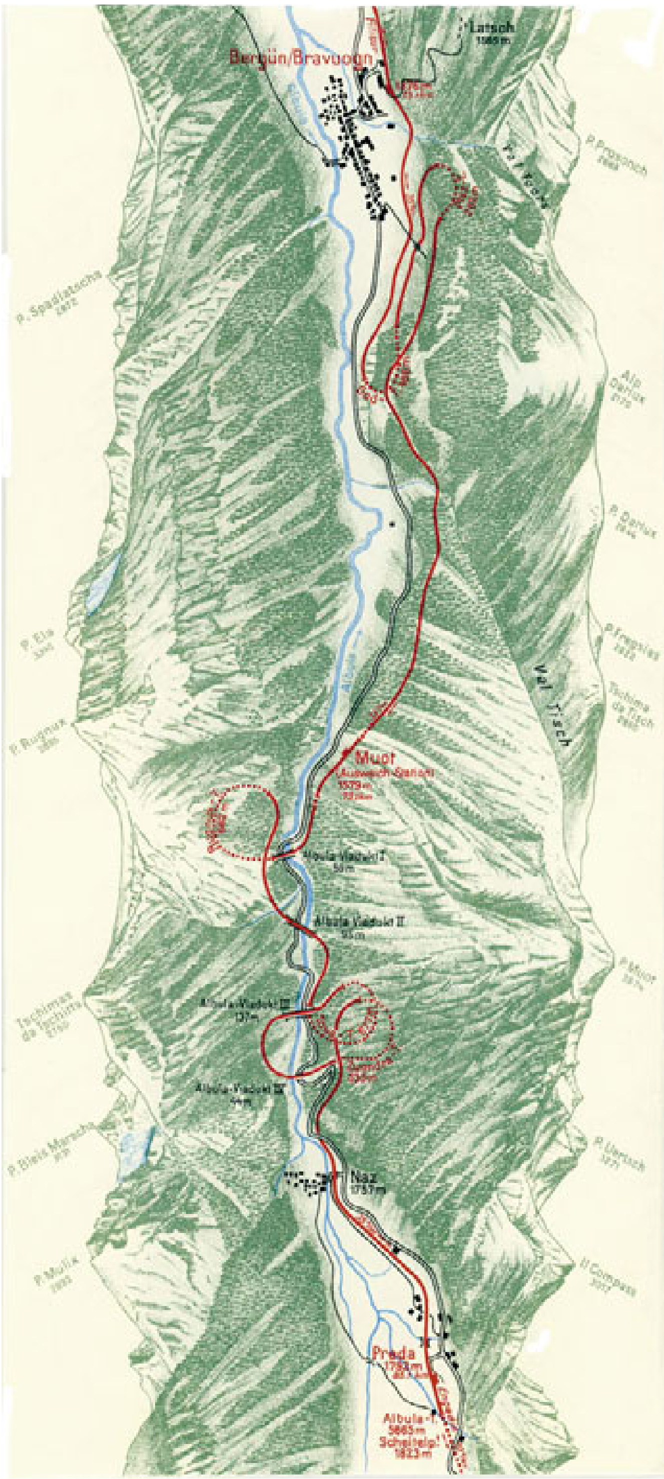
The connecting line to Pontresina branches off at the exit from Samedan railway station and following a left-hand curve crosses the river Inn by means of a steel bridge. The Champagna plateau is then crossed in a straight line which continues as far as today's railway halt in Punt Muragl (km 100.5), from where a footpath leads to the cable railway to Muottas Muragl, which was opened 1907. Punt Muragl was originally a full passing station with linesman's hut. The alignment of the section from Punt Muragl to Pontresina was designed with an upgrade of 20‰. Following the halt the line displays a large number of engineering structures: an underpass below the main road, a steel bridge over the Flazbach, a paved foot embankment above the level of the plateau, hillside alignment with cut into the rock, all in a reverse curve loop.
Pontresina railway station (km 103.0) lies opposite the village and is connected to it by means of a link road. The station building is the largest on the Rhaetian Railway.

The Rhaetian Railway has been marketing a brochure with artistic panorama photographs of the narrow-gauge network in Graubünden since the 1930s. The following illustrations are taken from a new edition issued in the 1950s.
Collection: G. Brüngger



Chur >
Sils i.D.

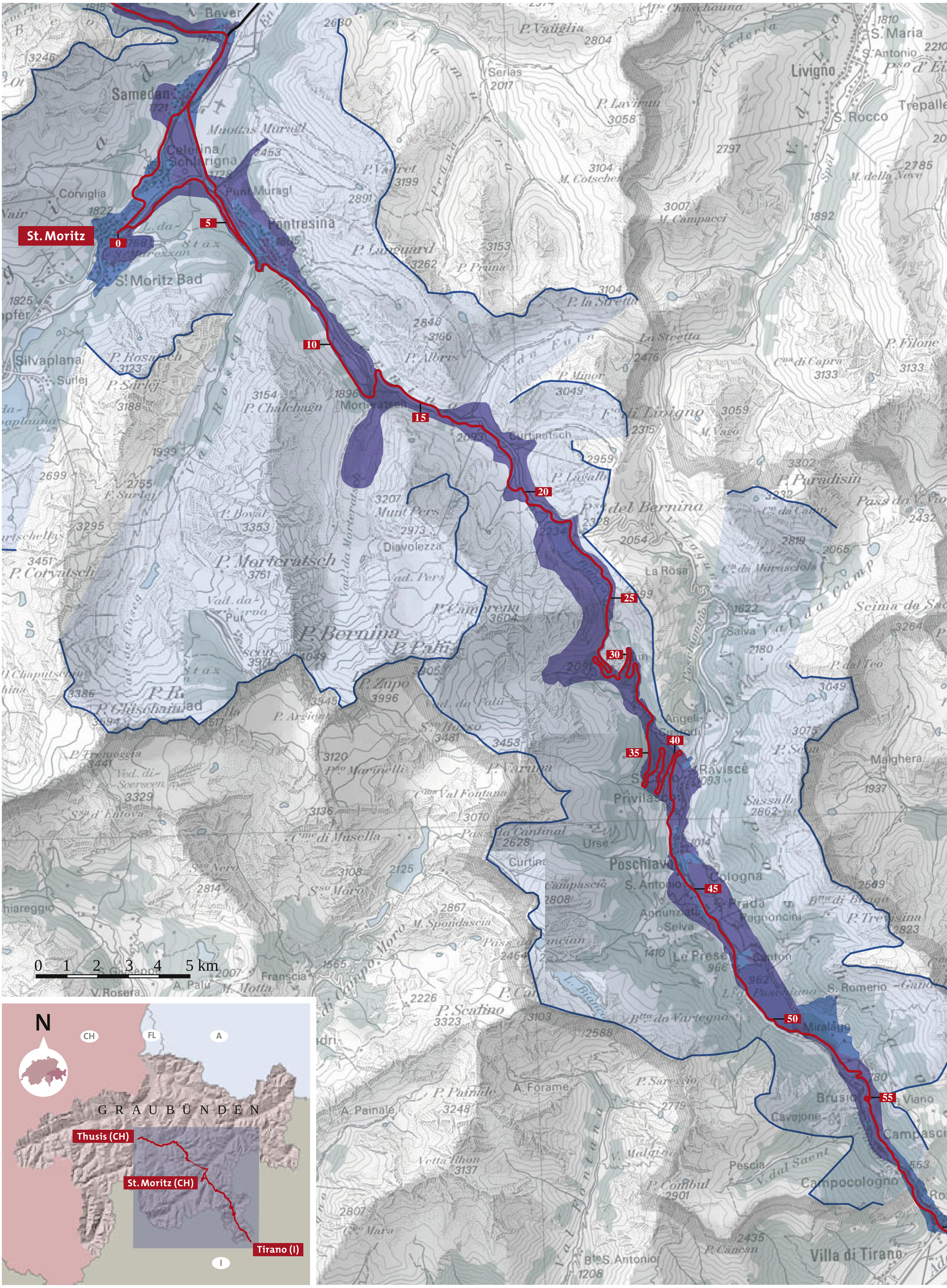
Sils i.D. >
Bergün/Bravuogn



Bergün/Bravuogn >
Preda (Albula Tunnel)

Spinas >
Bernina Pass

Bernina Ospizio >
Tirano (I)


St. Moritz
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Samedan
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Pontresina
S. Moritz Bad
Silvaplana
Surlej
Corviglia
Bever
Morteratsch
P. Bernina
P. Morteratsch
P. Palü
Diavolezza
La Rösa
P.ss del Bernina
Poschiavo
Privilasco
Cologna
S. Antonio
Prada
Annunziata
Selva
Le Prese
Miralago
Brusio
Campocologno
Viano
Cavajone
Villa di Tirano
Livigno
S. Maria
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GRAUBÜNDEN
Thusis (CH)
St. Moritz (CH)
Tirano (I)

Bernina line (St. Moritz – Tirano)

55 Kilometre markings

Station	**m**
St. Moritz	1,774.7
Celerina Staz	1,716.1
Punt Muragl Staz	1,736.4
Pontresina	1,773.7
Surovas	1,822.1
Morteratsch	1,896.0
Bernina Suot	2,046.2
Bernina Diavolezza	2,082.2
Bernina Lagalb	2,099.4
Ospizio Bernina	2,253.2
Alp Grüm	2,090.8
Cavaglia	1,692.1
Cadera	1,383.1
Privilasco	1,118.6
Poschiavo	1,014.3
Li Curt	988.1
Le Prese	972.9
Miralago	965.1
Brusio	780.2
Campascio	636.6
Campocologno	553.0
Tirano	429.3

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Gion Rudolf Caprez
Design: Süsskind, SGD, Chur
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Bernina line (St. Moritz – Tirano, built 1906 – 1910)

The Bernina railway runs from St. Moritz in the Upper Engadin through the Poschiavo valley to Tirano (Italy). Built between 1906 and 1910 it was incorporated into the Rhaetian Railway in 1944 (cf. 2.b.5). Two factors were decisive for its construction: the necessity to provide access for construction and maintenance traffic to the planned hydroelectric stations on the south side of the Bernina Pass (cf. 2.b.7), and the need to provide day trippers with convenient access to the renowned tourist attractions in the high mountain area. Cantonal subsidies were declined. Financing was secured by the same stockholders who were involved in the Kraftwerke Brusio AG (KWB, today Rätia Energie AG).

The construction of a costly, steam-powered mountain railway based on the example of the Albula line was, in the case of the Bernina line, for financial reasons, not taken into consideration. The new technology offered by the electrified, surface railways gave an opportunity for constructing the desired railway link over the Bernina within the limits of the resources available. Electrically powered railcars could manage much greater upgrades and much tighter curves than steam-powered locomotives, permitting a flexible alignment. In this specific case, this led to the option of using the road built over the Bernina Pass around the middle of the 19th century (cf. 2.b.3) as the trackway for the new railway line, thus saving considerable costs in the construction of the track. It was originally intended to run the whole of this section of the line alongside the road, but eventually it proved necessary to construct a special railway corridor for more than 75 % of the section; the selection of the route for the railway through Cavaglia, Alp Grüm and the top of the Bernina Pass had to take the needs both of the power stations and of tourism into consideration.

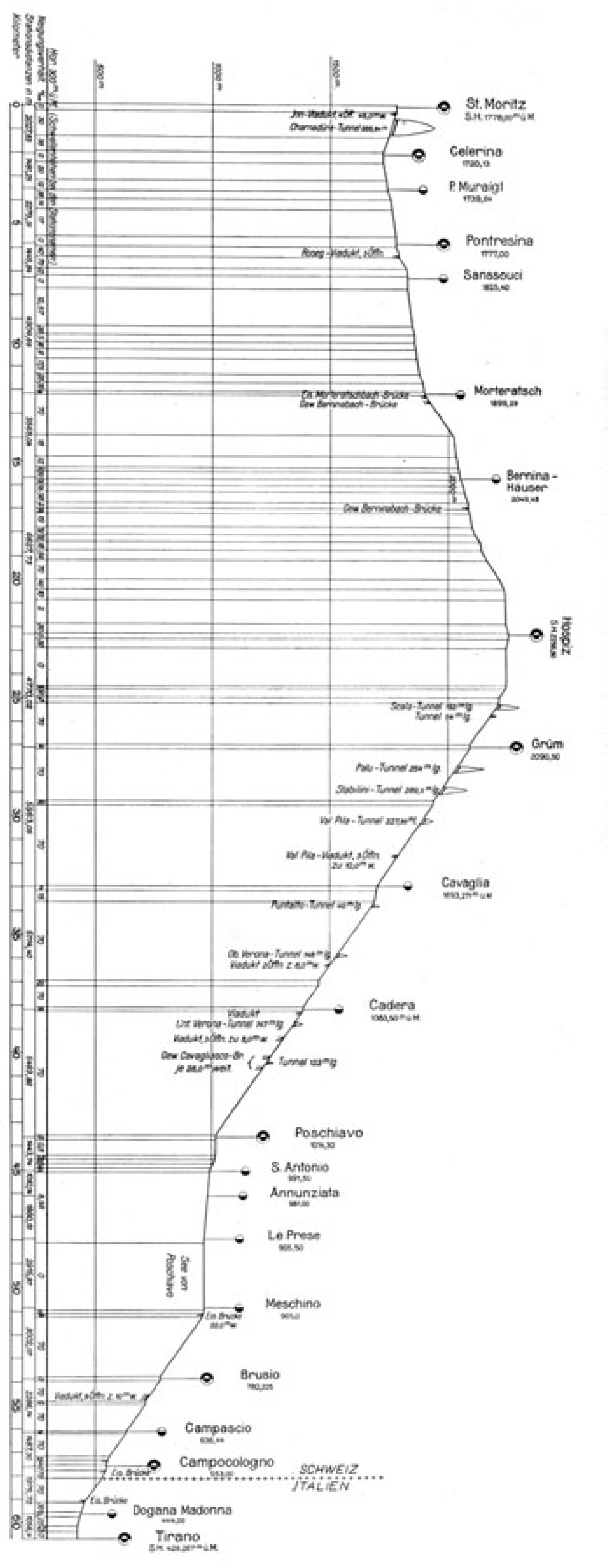
In order to keep the line operating during the winter months, the financial contribution from public funds, which had been turned down at the time the line was constructed, had to be accepted soon after 1914. The year-round usability of the Bernina railway could only be achieved with subsequent, localised improvements and constant snow-clearing work – with the Albula line, the large amount of capital invested made it possible to plan in all the (construction) measures required to permit all-the-year-round operation from the very beginning.

Standards

The standards for curves and upgrades on the Bernina line were set with regard to the need to keep the volume of earth movement as low as possible. Where earth movement was unavoidable a smaller cross-section was used compared to that of the Albula line. In the Albula line, a 2 m deep cutting led to an excavation cross-section area of 24 m^2; with the Bernina line a cutting of this size only required an excavation area of 17 m^2.

The standards for dry masonry, mortar masonry and for walled vaults correspond to those of the Albula railway, although because of the lighter weight of the motor units compared to that of steam locomotives it was possible to construct the vault some 5 cm thinner.

- Track gauge 1,000 mm
- Curve radius minimum 45 m, normally 60 m
- Upgrade maximum 70 ‰ (46 % of the length of the section has an upgrade of 50 – 70 ‰).
- Width of formation 3.60 m
- Catenary voltage 750 V= (direct current), from 1923 1,000 V=
- Passing length in the stations originally 90 m, today minimum 150 m



Bernina line > Profile of the stretch (reduced in size). Bosshard E., *Die Berninabahn*, Zurich 1912 ("Schweizerische Bauzeitung", offprint).

> Railway loading gauge 3.00 – 3.35 m width
> Slope angle of embankments 2:3
> Slope angle of cuttings 4:5 (steeper than the Albula railway)
> Width of cutting at sleeper height 5.95 m, with side walls 4.6 m (Albula railway 6.65 m).
> Taper of mortar masonry 1:5
> Taper of dry masonry 1:3

Longitudinal profile, route planning

In terms of the longitudinal profile, the Bernina railway can be divided into a St. Moritz – Morteratsch subsection, which can also be described as the "Engadin excursion railway", the northern ramp between Morteratsch – Ospizio Bernina-Scala with its passage through the mountain pass scenery, and the southern ramp, which is only interrupted by a section on the valley floor between Poschiavo and Miralago. The line may also be subdivided into sections where the line has its own corridor and sections with a corridor beside the mountain pass road and the valley road (railway line positioned alongside the road). With the exception of the unavoidable turning tunnels and short tunnels behind rock spurs the original design did not provide for any tunnelling activity at all. The only long tunnel, in the Charnadüras Gorge, only became necessary as a consequence of a design change which arose during the construction approval phase of the project. The long tunnel sections in the area of the mountain pass came into being when the railway was already in operation; these are the result of tunnel extensions and of connections between a number of tunnels made by means of galleries. The construction of new, large-span bridges was also avoided where possible in the construction of surface railways, either through the shared use of an existing road bridge or by avoiding discontinuities in the terrain.
The simple alignment needed for operation by electrical motor units meant that extensions and corrections to sections of the line could be made within an acceptable level of expenditure. Corrections to the alignment of the Bernina railway fall into the following categories:

> changes made shortly before or during construction
> section relocations for winter operation
> track relocations for winter operation or to allow for larger curves
> track relocations to separate road and railway

Organisation of the stations

With the exception of the terminal stations and the railway stations in Poschiavo and Pontresina all the intermediate stations on the Bernina railway were given only very modest facilities. Initially the station buildings between St. Moritz and Poschiavo were just simple timber pavilions. For winter operation the Bernina railway constructed a series of better-quality stone structures both for the station buildings and for other buildings needed to serve operational requirements (cf. 2.a.5).
Several times, new passing stations were constructed whilst others were removed or downgraded to halts without passing facilities. The track systems on the intermediate stations consisted simply of a passing track. Where possible, track slopes were reduced in the area of the stations and the stations constructed along a flat alignment. Where necessary the station facilities were extended, for example by the addition of a turntable for the steam-powered snow blowers, or by dead-end tracks where additional coaches could be positioned at stations used by high numbers of tourists.

Pontresina > The two lines St. Moritz-Pontresina (right) and Samedan-Pontresina (left) stand out clearly on the aerial view.
A. Badrutt

Pontresina > The Rhaetian Railway's Bernina Express on an embankment shortly before Pontresina.
Foto Geiger

Power supply and rolling stock

The Bernina railway was originally provided with AC current from the Campocologno power station, which belonged to the KWB the current was fed to four transformer substations (Pontresina, Ospizio Bernina, Poschiavo, Campocologno) by means of a high voltage line which ran parallel to the railway but in its own corridor. The high voltage line and the transformer buildings are still in existence, although the number and the technology of the rectifiers continued to be modified over the course of time.
Services on the Bernina railway had always been operated using four-axle motor units; other rolling stock included locomotives for freight traffic and service trips, and special vehicles used for snow clearance.

Short description of the individual sections of the route

The kilometre distances used in the following notes are based on those in use when the line was constructed; kilometre 0.0 is in St. Moritz. Where sections of the line were relocated, what were known as 'error profiles' were added, which provided a local correction for the difference in length.

km 0 – 12: St. Moritz – Morteratsch

The Bernina railway's station in St. Moritz (km 0.0) had to be integrated into the facilities of the Rhaetian Railway, constructed in 1904. The only site available for the covered platform and for a pedestrian underpass was a short area, skewed to the line of the Rhaetian Railway, which lay between the Hotel Bristol (today Bellaval Hotel) and the place where the bridge over the river Inn was to be sited. Apart from dead-end tracks for passenger coaches the Bernina railway did not have any technical facilities in St. Moritz. After the station the railway line crosses the Inn by means of the Charnadüra viaduct (km 0.2). In the first years after the opening of the line the view of this bridge became one of the well-known picturesque images of the Bernina railway; today the main road passes below it. The line passes behind the Charnadüra Gorge by means of the 689 m long Charnadüra tunnel (km 0.5) which has a downgrade of 30 ‰. A panel on the keystone of the upper portal shows the year of construction, "1908". After the tunnel there are no other large engineering structures on this section of the line; its alignment is able to adapt to the terrain, the line running in its own corridor in continuous curves and counter curves. Today the former Celerina railway station at km 2.0 is only used as a halt. A road constructed by the railway connects the station to the village on the opposite side of the valley. Following the takeover of the Bernina railway by the Rhaetian Railway this station was renamed Celerina Staz to distinguish it from the Rhaetian Railway's Celerina station. The station marks the lowest point on the northern section of the railway line – it is 58 m lower than the railway station in St. Moritz. The station building was constructed as a chalet and dates from 1922. The line continues on, running partly at the foot of the slope and partly along an embankment constructed across the marshy floor of the valley (km 2.3). Travellers on this section of the line have a pleasant view of the San Gian church. The railway then begins to rise at a rate of 20 ‰ and turns southward, into the valley of the Flazbach. A link road runs from the Punt Muragl Staz halt (km 3.5) along a steel bridge over the Flazbach to the valley station of the Muottas Muragl cable car. The section continues to climb towards Pontresina. There are almost no engineering structures along it apart from drainage ditches

Bernina line > From Pontresina to Morteratsch the track runs through forests of Swiss stone pines and larches.
A. Badrutt

Bernina line > Morteratsch station and the steel bridge across the Ova da Morteratsch.
A. Henkel

Bernina line > The stone arched bridge across the Ova da Bernina is still impressive today.
A. Henkel

and some smaller earthworks. The Samedan – Pontresina line approaches from the left; this line belongs to the Rhaetian Railway, and was designed separately.

Pontresina railway station (km 5.8) was important for the Bernina Railway as transit station for the Rhaetian Railway because the stretch from Bever ended here. The station building and tracks 1 – 3 which run in front of it belonged to the Rhaetian Railway. The Bernina Railway, as tenant of the Rhaetian Railway, used tracks 3 – 7. Originally the covered platform (track 1) was used by the Bernina Railway as well. After electrification of the Rhaetian Railway (alternating current) in 1913 the tracks had to be separated; the underpass and central platform, which are still in use today, were built at the same time. Track 3 can be switched to either of the two different electrical systems of the Rhaetian Railway and the Bernina Railway; the Bernina Railway was been powered by direct current from the outset. Today, Pontresina station is still the technical basis for the northern section of the Bernina line. The technical installations consist of the depot workshops with the original three-track parking shed and the updated rectifier equipment, still sited in the transformer building from 1907. Other station facilities include the three “Cuntschett” staff houses dating from 1911.

In deviation from the original plan, which had the Pontresina-Morteratsch section of the railway line follow the line of the mountain pass road, the section in this part of the line was run along the left side of the river up to the Morteratsch Hotel. This change was probably mainly due to the idea of providing tourist access to the imposing Morteratsch glacier; projects to build a tramway from the upper Engadin as far as Morteratsch had existed even before the construction of the railway. The hotel existed before the Bernina railway was built. When constructed the hotel was very close to the tongue of the glacier; in the decades since then this has receded significantly, due to global warming.

Immediately after Pontresina railway station the line moves out of the side valley, Val Roseg, along a short loop; the stone arch Val Roseg bridge (km 6.3) is located at the apex of the loop. A 500 m long ramp with an upgrade of 70 ‰ brings the line up to the level of the fluvial plain of the Ova da Bernina. The site where Surovas railway station is located (km 7.2) was originally occupied by the Sanssouci halt. A passing track and the existing station building were constructed here in 1929; adoption of the present-day name of the station seems to be linked to this. The track system was renewed in 2005. From Surovas to Morteratsch the line follows a polygonal route which involves minimum working of the terrain. The favourable terrain here also allows higher running speeds. In view of the risk of avalanches a concrete observation post with lookout slits was erected at km 9.6. Massive walled and concreted dykes (km 10.5 – 11.8) protect sections of the line from the floodwaters of the Flazbach; the closeness of the line to the river here led to the need for a large number of barriers. Shortly before Morteratsch the line runs through an Alpine pasture landscape with stone pines and larches. The St. Moritz – Morteratsch section was intended for year-round use from the time the line was opened. For this reason Morteratsch railway station (km 12.1) was given a passing track and a siding for additional coaches. The length of the station was initially limited by the entry curve, the level crossing and the break in slope before the bridge. Today’s facility is the result of an extension and a larger radius curve which swings out on the side towards Surovas.

Bernina line > The views of the Morteratsch glacier from the Montebello open loop are fascinating.
P. Donatsch

Bernina line > Even today the train still runs on the track of the old roadway which was widened when the train was built.
A. Henkel

Bernina line > The upper bridge over the Bernina stream with stonework abutments, simple girders and hinged columns.
T. Keller

km 12–24: Morteratsch – Scala

Above Morteratsch the line negotiates a section of terrain rising 120 m by means of a 1,720 m long ramp with an upgrade of 70 ‰. With this steep ramp the Bernina railway line shows its spectacular side for the first time. The views of the Morteratsch glacier – which can be enjoyed from both sides of the railway carriages, thanks to the open Montebello loop – have been standard motif choices for tourists and postcard photographers since the line was opened. The bridges over the Ova da Morteratsch (km 12.2) and the Ova da Bernina (km 12.4) are the most noteworthy structures on the north ramp. The former – which has already been replaced twice since it was first constructed – is a steel structure and was much criticised in conservationist circles because of the material selected for its construction; the latter is a stone arch bridge which is still much admired today. Its positioning in front of the Berninabach waterfalls, already known as a beauty spot before the railway was constructed, has created an impressive setting uniting engineering structure, railway and nature harmoniously. Here the line also crosses the pressure line of the Morteratsch power station which was constructed in 1891 (today the pressure line runs underground). The open Montebello loop (km 13.0) uses the terrain in a most skilful manner. The line, rising constantly at 70 ‰, describes a 180° turn with a curve with a minimum radius of 45 m. Two engineering structures were built here: a retaining wall on the valley side to allow the railway line to swing out and a cut into the mountain to allow it to swing back in. The mountain pass road crosses the railway line at the point of contact between the two structures.

The Montebello battery station (km 13.9), built in 1914, provided the electricity supply for the railway until 1927. The “tomato house”, the name given it today, comes from its later use as a warehouse, primarily for storing canned tomato puree. The steep ramp ends at km 14. Up to Arlas (km 20) the Bernina railway originally ran alongside the mountain pass road – its alignment was an adoption of the original design which had proposed that the Bernina railway would also have an integrated road; this design had been altered in favour of the alignment over the Alp Grüm. Today only the section from km 14 to 15.2 runs alongside the road. At km 14.5 the line passes a military barrier dating from the time of the First World War (concrete tunnel with the text “IV/6 1915”, a building at the foot of the slope with a plaque “Albrishütte 1915 IV/6”); higher up the slope there are several bunkers which are part of a barrier dating from the time of the Second World War. The railway and the road switch to the other side of the valley before reaching Bernina Suot railway station (km 15.7), originally known as the “Berninahäuser” railway station. The road, railway line and the station building in this section were all reconstructed in 1993. The open turntable built in 1910 for the steam-powered snow blowers was replaced as early as 1915 by an avalanche-proof shed with a covered turntable. In the section between Bernina Suot and Bernina Lagalb (km 17.9) the train still runs today along the road corridor which was widened when the line was constructed; the road itself was set deeper. Road bridges and tunnels were also widened by 2 m for the railway, where construction joints still provide an indication of this measure today; the tunnel at km 16.5 has a keystone which shows the year “1907”. The Bernina Diavolezza halt (km 16.8) was constructed in 1956 as a passing station to serve the cableway which was built at that time. The construction of the Bernina Lagalb railway station (km 17.9) is

Bernina line > Crossing the ridge of the Bernina alongside the Lago Bianco (white lake).
T. Keller

Bernina line > In the foreground the Lago Bianco, behind it the darker Lago Nero (black lake).
T. Keller

Bernina line > The Bernina Railway reaches its highest point – 2,253 m – at the Ospizio Bernina station.
A. Henkel

linked to the Lagalb cableway which started operation in 1962. The latter station replaced the passing points of Diavolezza and Alp Bondo. In 1934 the railway corridor between Bernina Lagalb and Arlas was relocated from the right to the left slope with a view to protecting the line from avalanches. Of the original 1.8 km long section which ran alongside the road, signs can still be seen of the road edge on the valley side with shoulders and conduits; at km 18.7 (old) a memorial stands to honour the eight railway employees who lost their lives in an avalanche on the 16th March 1920. The new section on the western slope is safe for use in winter; it is 400 m longer and also has more curves than the old section. The alignment was also built with many changes in slope as the Ova da Bernina had to be crossed twice. Four steel bridges with walled abutments, simple girders and hinged columns give this section a uniform appearance.

The Arlas gallery (km 20) dating from 1909/10 is the oldest avalanche gallery on the Bernina railway.

The steep ramp which began after the Bernina Lagalb railway station, ends shortly after the gallery. A stone building stands on the site of Arlas station, the former coaling and watering station, (km 20.4), which was in use between 1923 and 1957.

From km 20 to km 24 the line crosses the wide, almost level crest of the Bernina pass; here the alignment has to take into account the need for protection against the forces of nature. This is achieved more as a result of experience than through design, explaining why the section is marked by a large number of smaller corrections to the alignment, which remain visible in the Alpine landscape for a long time. The panoramic curve of Val Bügliet (km 21.6), where the line crosses a side valley by means of an embankment with a vaulted tunnel, has long been a popular subject for photographs; the scene with the train in the foreground, Lago Bianco in the centre ground and the Piz Cambrena in the background could not be more spectacular. The section along the lake is particularly popular as a subject for winter photographs; photo reports from the 1910's showing snow clearance operations and the transfer of the passengers to sleighs remind one of the Polar expeditions which were then in the news.

The Ospizio Bernina railway station is at km 22.3, and here the railway reaches its highest point, at 2,253 m above sea level. The tower-like station building dates from 1909; it was added to in 1925 by the architect Nicolaus Hartmann the younger, creating the building which exists today (cf. 2.a.5). A 550 m long road links the railway station to the top of the pass. A group of buildings stands at the southern end of the station. The group consists of a transformer station (1910), a covered turntable (1926) and a dwelling house (1912).

The next section of the line, along the reservoir, has a maximum downgrade of 30 ‰. At km 23 there was originally a curve with a snow gallery; in 1949 the railway line here was moved from the bank of the lake into the arm of the lake, which it now crosses by means of a steel bridge.

km 24 – 44: Scala – Poschiavo

At km 24 the crossing of the peak of the Bernina pass, where the line runs more or less horizontally, now turns down into the southern ramp. From Scala to Poschiavo the line had to deal with a change in height of some 1,200 m, which it accomplished at an almost continuous maximum downgrade; here the alignment had to avoid any natural hazards and yet at the same time provide access to popular tourist attractions. Engineering features on the alignment of this section

Bernina line > The spectacular layout of the line at Alp Grüm seen from the helicopter.
A. Badrutt

Bernina line > The most striking feature of the Alp Grüm station is the reception building, built by Nicolaus Hartmann the Younger, in 1923. In the background left the Palü glacier.
Rhaetian Railway

Bernina line > The much admired panorama of the base turn at Alp Grüm extends from the loop at Stablini, over the Cavaglia plain, the Lago di Poschiavo and the Aprica pass to the Alps at Bergamo.
Foto Geiger

include the triple crossing of the steep slope of Alp Grüm, by means of one open loop and a second running in a tunnel, the loops of Scala and Stablini, La Dota and Val Pila, and the five crossings of the slope of Cadera. The type of alignment and the occasionally inadequate protection against storms and avalanches were sometimes seen as evidence that the Bernina railway was originally designed only as a summer railway for tourists. However, statements made by those involved in the construction together with findings made on site lead to different conclusions. According to the resident engineer Eugen Bosshard for example, the loop near Scala was determined by the location of the dam on Lago Bianco; only the s-shaped alignment and the position of the curve at the edge of the terrain made it possible to gain the necessary height without involving large-scale earthmoving works. The picturesque situation with the view to the south is therefore the result, not the cause of the Scala curve. The correction made in 1924 did indeed call for the construction of a high embankment; the cost of constructing such a feature at the time the line was built would have exceeded the financial resources available. An analogy can be drawn here to the pioneering railways in America; these too initially had as low-cost an alignment as possible. The alignments were only improved later on, using income from the operations and bearing in mind the lessons gained from practical experience. The traverses of the slopes below Sassal Masone and Alp Grüm also initially ran in the open – with the clear knowledge of the risk of avalanches in these locations – and were only protected by galleries later on. The alignment of the Bernina railway was not made in ignorance of the inherent dangers, but rather based on the acceptance of a calculated risk. In designing the alignment between Stablini and Cacaglia use was made of the indentation of Val Pila to allow the section to be lengthened without having to cross the avalanche tracks in the upper part.

The Scala gallery (km 24.4) is made from steel sections with concrete sidewalls and corrugated iron roofing and dates from the year 1911; it protects the railway line from storms and snowdrifts. At the subsection between km 24.7 and km 25.2 the old trackway of the loop which swings out to the left is still clearly visible, and is still ballasted. The corrected alignment runs along an embankment and was constructed in 1924. The old line was connected to the new by means of points, and so could be used in summer as a passing track; points and track were removed in 1941. The still existing stone built guard’s hut at this point is associated with the former passing lines. The outermost edge of the old trackway offered a spectacular view – although this had to be “purchased” at the expense of risking the trains by exposing them to sharp gusts of wind and snowdrifts.

The large southern ramp begins at the bridge over the Acqua da Pila (km 25.3), where it has a 70 ‰ downgrade. The adjoining 631 m long Galleria Lunga comprises the Scala and Pozzo del Drago tunnels, the Sassal Masone gallery which links them, and the galleries built in advance of the two tunnel portals. Beyond the gallery the railway line crosses over an embankment to the left of the Pru dal Vent valley (km 26.1); from here travellers have their first view of the Palü glacier. Also to be seen from this section are the southern dam on Lago Bianco and the KWB (today Rätia Energie AG) pressure line.

The first of the three traverses of the Alp Grüm slope commences at km 26.7. In terms of alignment it calls to mind the serpentine curves of a mountain road rather than the typical alignment of a railway line. All attempts to stabilise this

Bernina line > The layout of the line as it climbs Alp Grüm is more reminiscent of the zigzags of a pass road than a railway track.
T. Keller

Bernina line > Rhaetian Railway train at Stablini.
Foto Geiger

slope by means of afforestation failed, so that all three of the traverses are now protected by galleries.

The Alp Grüm railway station (km 27) was constructed at a (relatively) safe location. On the mountain side, the station is bordered by cuttings into the rock and by revetment walls. Originally there was only a passing track about the length occupied by the upper half of the present station, and a timber station cabin. The large volumes of passenger traffic and the need to staff the railway station in winter led to track system and buildings being extended a number of times. The station building by Nicolaus Hartmann dating from 1923 is quite striking (cf. 2.a.5).

The station is followed by a turning curve constructed on an earth embankment (km 27.2). The much admired panorama offered to the traveller at this point extends from the loop near Stablini, over the Cavaglia plateau, the Lago di Poschiavo and the Aprica pass and on as far as the Bergamo Alps.

The 839 m long Palü gallery (km 27.6 – 28.5) consists of a 254 m long turning tunnel and the avalanche galleries which adjoin the two tunnel portals; the avalanche galleries were constructed in stages between 1911 and 1949. At km 27.8 a memorial stands in memory of an accident caused by an avalanche in 1937; at that time this point on the line was still without any protection. The transverse profile of the railway line in this section along the steep slope consists of a dry jointed, covered retaining wall, the track with lined drainage ditches on the mountain side, and the mortared revetment wall. The latter was heightened and backfilled when the galleries were constructed.

The Palü power station situated below the railway line was built in 1927 (cf. 2.b.7) and can be clearly seen from the train; a materials platform along the track (km 28.5) and traces of a cable landing, date from the time the power station was constructed. In the 334 m long Stablini tunnel (km 28.7) the rail runs behind an exposed rock wall; following the tunnel the line describes an open curve around a promontory. Km 29.2 is a popular point from which to take photographs of frontal views of the train with the Palü glacier in the background. The Stablini passing station (km 29.4) was reconstructed in 2001; there was certainly a passing track here between 1913 and 1960. The construction of a railway station on this natural terrace had been planned from the very beginning; for this reason the gradient here was reduced to 20 ‰ over a length of 186 m. Stablini railway station and the adjoining section of line are protected against avalanches by slope stabilisation measures built between 1913 and 1915; these take the form of dry stone walls and afforestation. The terrain between Stablini and Cavaglia falls steeply by about 250 m. The forced alignment of the railway line made use of the projecting ridge of La Dota and the Val Pila side valley. Thanks to skilful use of the lie of the land only one of the turning curves required on this section had to be run through a tunnel. This Val da Pila turning tunnel (km 29.9) dates from the time when the line was constructed, as probably does the footpath that links the two tunnel portals. Galleries were constructed in advance of the portals in 1913 and 1941. The railway line then runs along a slope and curves round the hill of La Dota. Timber traction poles dating from the 1940’s still stood here until quite recently. The dry walled protective piers indicate the original position of the masts. The Val da Pila turning viaduct (km 31.8) lies on a 50 m radius curve. In 2005 it had to be renovated, since the left abutment was threatening to crush the vault as the result of slope movements. The construction of

Bernina line > View of the high altitude plain at Cavaglia.
P. Donatsch

Bernina line > The train passes through the Cadera Maiensäss countryside between Cavaglia and the valley plain of Poschiavo.
A. Henkel

Bernina line > The two original bridges over the Cavagliasco river had to be replaced by steel bridges due to terrain movements.
A. Badrutt

a trackway slab means that following the renovation work there is no longer any thrust against the vault. The loop into Val Pila belongs to the category of "track extension by swinging out into side valleys"; this method was used to gain height in the early days of mountain railway construction, as for example with the Pennsylvania, Semmering and Brenner railways.
On entering the Cavaglia plateau a drainage trench running from the Acqua da Pila passes under the railway line and then continues using the line's own drainage ditches, finally connecting to the field irrigation system. Four spillways in lined trenches lead back to the railway line's drainage ditches and are carried through under the track. At km 32.9 the crown of the railway's revetment wall has a concave shape in order to carry a watercourse. In Cavaglia the sophisticated field irrigation system must have been in full use around 1910, since the design of the railway line had to take it into consideration. At km 32.8 two milk cellars with dry stone walling have been built into the railway embankment.
In Cavaglia (km 33.1) the almost continuous upgrade of 70 ‰ which the line has been rising at since km 25 is briefly interrupted. Originally only a passing track existed here. In 1911, when for a short period a sleigh service operated between Cavaglia and Alp Grüm during the 6 winter months of the year, the station – as the terminal station of the southern part of the network – was given a dead-end track. A turntable with a watering station was added to this in 1912/13, and the foundations of these facilities can still be seen today. A private hotel was constructed on the railway station in 1912; in 1925 it was acquired by the Bernina railway, which added a station office and a waiting room. At the northern end of the station stands the building containing the buffer battery; the battery was in use between 1910 and 1931 and was intended to improve the power supply in the middle of the ascent from Poschiavo to Ospizio.
Traces of the one meter gauge connecting track built in 1927 between Cavaglia station and the hydroelectric command station of the same name are still visible in the terrain. Cavaglia railway station offers views of the outer curves of Stablini and Alp Grüm.
Between Cavaglia and the throat of the valley at Puntalto, the railway line follows the left side of the valley. Rockfall boulders have been underpinned here by dry walls. The River Cavagliasc runs parallel to the railway; the river disappears into a water catchment belonging to the KWB (today Rätia Energie AG). The railway crosses the deep gorge over a stone arch bridge which lies on a curve, although little of the bridge or of the nearby glacier moulins can be seen from the train.
Of the 10 km section between Cavaglia and Poschiavo, following the "passage obligé" of Puntalto it was actually only possible to select the turning points of the alignments freely. The southern turning point near Campello (today, Campel) west of Poschiavo still lay within the concession project. In this variant the construction of a simple, long loop would have been sufficient, although Val Varuna would have had to be crossed twice. In order to avoid this double traverse a design was developed with a double loop development in the Cadera area, with loops on the north slope of Val Varuna; in order to obtain the length required, a turning loop had to be swung out into the Cavaglia Gorge, and this called for the construction of additional engineering structures.
After Puntalto the railway runs along the slope on dry jointed stone pitch slopes with concrete extensions; there are drainage ditches, in part

Bernina line > The operational and technical centre for the south ramp is located in Poschiavo.
T. Keller

Bernina line > An imposing view of the landscape as far as the Bernina Pass from Miralago station at the outlet of the Lago di Poschiavo.
Foto Geiger

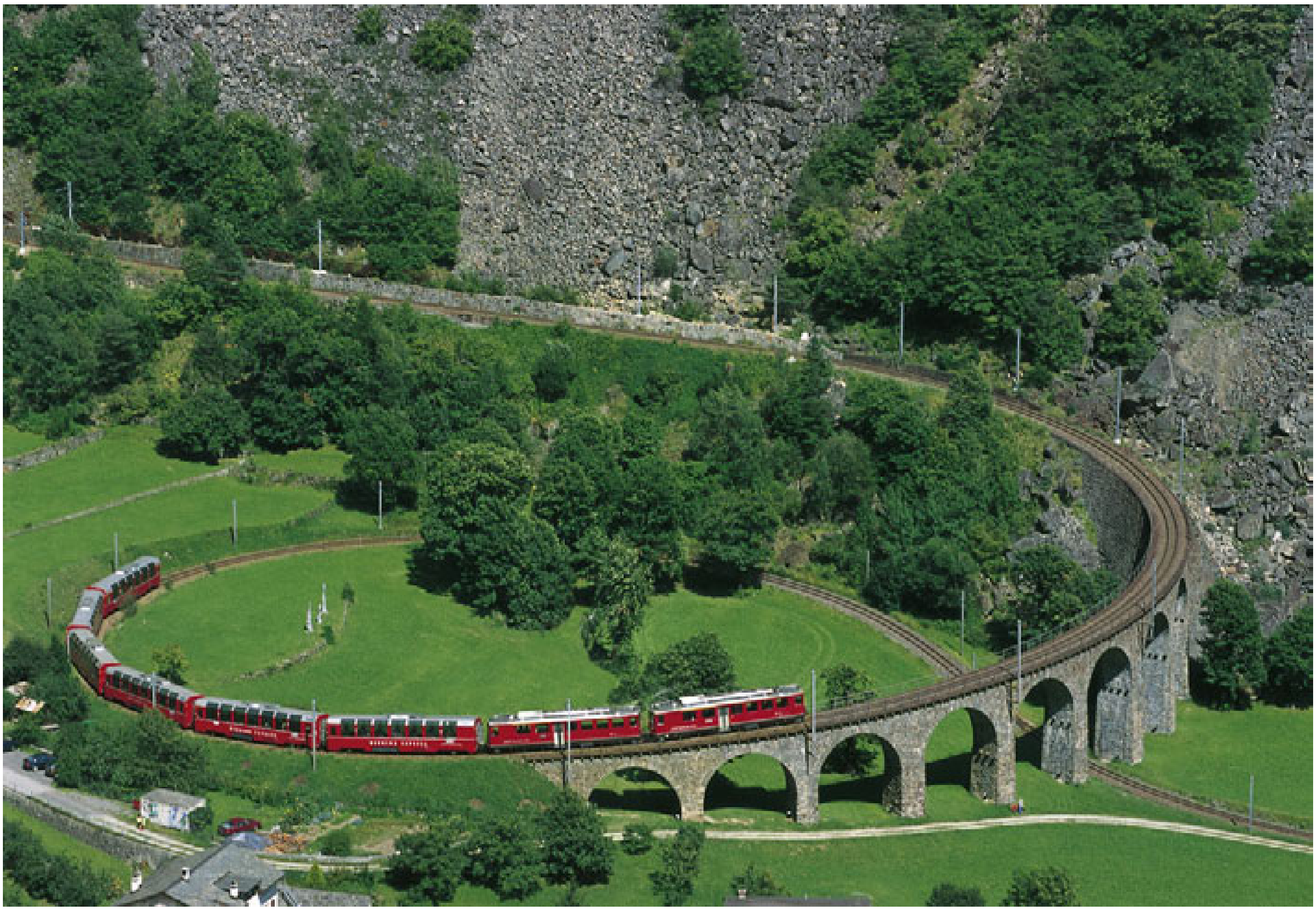
made with placed mortared slabs, in part with small stone paving on the mountain side; the side walls in the rock cuttings are well preserved. The railway line uses curves and counter curves to adapt to the lie of the terrain. The Upper Cadera viaduct (km 35.6) is the first of a total of five bridges over Val da Cadera. A passageway with a simple beam (km 35.7) and simple walled abutments runs over a former timber chute. At km 35.8 an outer curve offers a view of the valley floor and of the Lago di Poschiavo. The Val Varuna 1 tunnel (km 35.9) is the turning point of the upper loop. The upper and lower portals are connected by a footpath, which today is overgrown. The lower portal is carefully jointed, abutment and arch stones consist of bossed ashlers with beaten edges. The keystone bears the inscription “1908”. The line then leaves the forest to enter the Maiensäss landscape of Cadera; much photographed during the initial years it gradually lost much of its attraction after the line entered continuous operation as all attention was now drawn to the spectacular scenery of the high mountains.

The next loop is in open alignment in the rockfall area of Foppi da Cadera (km 37.2). The Cadera passing station at km 38.2 was constructed to subdivide the long section between Cavaglia and Poschiavo. The timber station building has remained unchanged since it was first constructed; the passing track was recently extended as far as km 37.9. A tower-like rectifier station dating from 1931 stands on the side towards the mountain.

The Val Varuna tunnel 2 (km 38.8) contains the turning curve of the lower loop of Cadera. The view from the lower portal in the flank of Val Varuna out into the valley is a popular motif for postcards; it was used in an advertising poster for the Rhaetian Railway. At km 36.6, 38.7 and 39.1 the railway crosses the surfaced bridleway to Cavaglia, which was still much in use at the time the railway was constructed. The turning curve in the Cavagliasco gorge (km 40.2) had to be constructed in difficult terrain. Earth movements since then have caused the destruction of one tunnel and two bridges. At km 40.4 there is a loading ramp for offloading material onto a runway to the delivery line to the Robbia power station, built in 1910, which also supplied power to the Bernina railway. At km 41.1 the railway line leaves the difficult terrain of the gorge and enters a stretch of common land where it crosses an intensively cultivated lynchet field system. The dry bed of Val da Cadera is crossed for a last time by a steel girder bridge (km 41.4). The Privilasco halt (km 42) was constructed as recently as 1954. For this reason it lies along the uninterrupted slope of 70 ‰. It is linked to the road by a 20 m long footpath. After Privilasco and as far as Poschiavo the alignment of the railway runs at ground level in the taper of Val Varuna.

Poschiavo (km 43.6) is where the operation and engineering centre for the southern ramp is located. The station facilities lie at the foot of the western slope, parallel to the river and to the valley road, outside the centre of the village. An avenue branching off at right angles connects the railway station with the settlement. The present station building dates from 1962. Opposite it, on the other side of the tracks, stands the building with workshops and sheds, for the most part dating back to 1908. The transformer unit is located 100 m to the north of the station.

Poschiavo, the main village in the valley, is the most important focal point for cultural and social interactions between the Bernina railway and the region it provides access to.



Bernina line > The Brusio circular Viaduct is the "trademark" of the Bernina Railway.
P. Donatsch

Bernina line > The Brusio circular Viaduct describes a quarter circle and has nine openings each with a diameter of 10 m in a curve of 70 m radius with a gradient of 70 ‰.
P. Donatsch

km 42 – 58: Poschiavo – Campocologno

Between Poschiavo and S. Antonio followed the constant succession of curves, straights and changes in slope typical of a simply aligned surface railway. The bottleneck by the S. Antonio church (km 45) was eased somewhat later, the tramway character was however preserved. From S. Antonio to Le Prese the railway – with few exceptions – once again runs alongside the road. Until 1975 the Le Prese halt (km 48) was a station with a passing track. Originally the railway services halted directly in front of the entrance to the hotel.

The main road along the Lago di Poschiavo was quite recently relocated to the slope; the old trackway was preserved and is used today as a pedestrian and cycle route. Thus the structure of a surface railway with a gravelled trackway can be experienced for quite a long stretch.

This stretch along the Lago di Poschiavo is not spectacular, in contrast to the stretch near the top of the pass, but it is picturesque. Along the rocky bank of the lake the railway line runs on a trackway cut into the rock, the projecting trackway is supported on walled columns. A bottleneck is guarded by a decommissioned military facility (km 49.6).

Until 1938 the Miralago railway station (km 50.8) bore the name Meschino. The facilities for damming the lake and the water catchments belonging to Rätia Energie AG are located here. The railway runs along a right-hand curve and between a group of houses, after which a longer ramp begins. The railway overcomes an almost continuous 70 ‰ downgrade from the outflow of Lago di Poschiavo down to the valley floor of the Veltlin. In this section it is closely integrated with the use of the surrounding arable land, either by means of protective structures against rockfalls which also serve to protect the road and the farming area, or by integration in irrigation systems or agricultural terraces.

The road and the railway cross the Poschiavino river separately. The road describes a tight reverse curve towards the bridge which is set at right-angles to the river. The railway line also follows a reverse curve – although not so tight – but crosses the river at a skew angle by means of a steel truss bridge (km 51.1). Between km 51.2 and km 51.4 a well-preserved section of the railway line runs alongside the road. The following slope traverse is greatly at risk of rockfalls, and has dry jointed shelter walls which have been built to a very high quality of construction. The large pitch slope at km 52.1 reminds one of similar engineering structures on the Brenner and the Gotthard lines. The Brusio aqueduct is integrated into the structure. Above Brusio it was necessary to route the alignment through the cultivated land: the open double loop constructed here (km 53.4) is a masterpiece in terms of adaptation of the railway line to the terrain. The first chestnut trees are now visible, within the open turn. In 2001, Brusio railway station (km 53.9) was given an extension on the valley side; the original length of the station corresponded to that of the flatter track section. The station building dates from 1976.

Shortly after the line opened it was found necessary to construct rockfall barriers in the section after Brusio (km 54.2 and 54.4). They date from 1913 and consist of mortar masonry with a top fixture made of old rails. The worn-out main rails of which the posts are made bear the rolling mill codes “HB&HV 1875” and “GHHUETTE 1875 VII”.

Below Brusio another forced alignment was needed in order to bring the railway line back to the valley floor. To realise this an open spiral was constructed consisting of a rockfill embankment,

Bernina line > Alignment along the orchards below Campascio.
A. Badrutt

arch viaduct, earth embankment, and a cutting. The Brusio circular viaduct (km 54.7) describes a quarter circle and has nine 10 m openings along a curve with a 70 m radius and a downgrade of 70 ‰. The lower track level of the spiral runs under the fourth opening of the viaduct. The Brusio circular viaduct, together with the spectacular mountain landscape, has become the acknowledged symbol of the Bernina railway. The reasons for this are perhaps its impressive size and clearly recognisable function, its integration into a special cultural landscape and the aesthetics of the standard components which are used appropriately and in just the right place.

The line continues between two rockfall areas through a well-tended terraced landscape (km 55.8). The line below the Campascio halt (km 56.2) which has a passenger shelter dating from 1960, runs through orchards. The change of valley side shortly before Campocologno is made using the road bridge which was widened to carry the line. During the construction of the line, Campocologno (km 57.6) was upgraded from a simple halt to a border station with its own station forecourt. This was also the point where connection was made to the power supply from the nearby KWB power station. The present station and customs building is a new structure, built in 1947.

The – largely original – length of the track system, with its three through tracks and sidings, is limited by the changes in slope. Room for the station was created by cutting back the slope, which is stabilised by a revetment wall. The building at the southern end of the station originally housed a transformer; in the 1960s it was made over to take animals waiting for export and used for this purpose for 20 years.

After the station the railway line runs over a steel bridge (km 57.8) which crosses Rätia Energie AG's renovated penstock. At km 58.1 the train reaches the Italian border. Today only a short, horizontal section gives an indication of the halt for the border control which once stood here.

km 58-61: Campocologno-Tirano

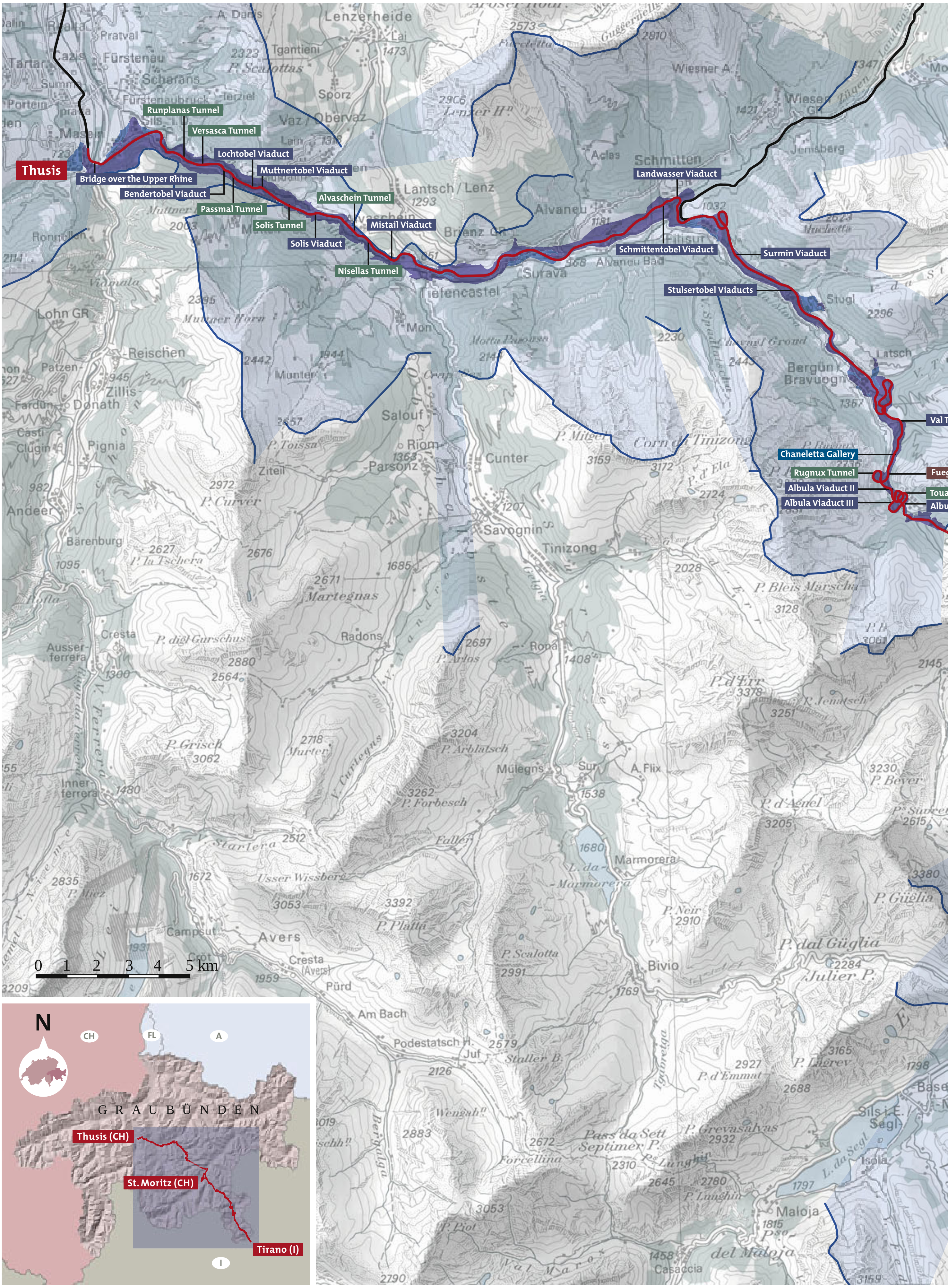
After crossing the border, the train climbs a gradient of 70 ‰ along the steep right hand flank of the valley, adapting to the lie of the terrain in a series of loops. The revetment walls, drainage ditches and walls designed to protect against rockfall are identical to the comparable structures on the Swiss part of the line. The former Piattamala transformer works, owned by the Brusio AG power station but now in disuse, can be seen from the train on the left flank of the valley.

At km 59, in the immediate vicinity of a striking wayside shrine, the railway reaches almost the same altitude as the Viale Italia, the Italian arterial road; from this point railway and road run parallel separated only by a low revetment wall. At La Rasica (km 59.2) they cross the Poschiavino river on separate ridges. Between La Rasica and Madonna di Tirano the road straightens and is also used by the train.

Surrounded closely by buildings, the track runs as far as the square in front of the Madonna di Tirano pilgrimage church, which it crosses in a sweeping curve (km 59.8). The train originally ran along the road from here to Tirano station; the current separate trackway was built in 1938.

The end, or beginning, of the Bernina line is reached at km 60.7 in Tirano station. The tracks run parallel to the Ferrovia Alta Valtellina Sondrio-Tirano, opened in 1902 and now integrated in the Italian state railway (FS). The track installation on the station square was originally open to the skies. Since 1927 it has been covered over by a structure that is also used for border controls. The track system in Tirano is currently being renewed.

Albula line > The Landwasser Viaduct near Filisur, the "trademark" of the Albula line.
A. Badrutt


Thusis
Runplanas Tunnel
Versasca Tunnel
Lochtobel Viaduct
Muttnertobel Viaduct
Bridge over the Upper Rhine
Bendertobel Viaduct
Alvaschein Tunnel
Passmal Tunnel
Solis Tunnel
Mistail Viaduct
Solis Viaduct
Nisellas Tunnel
Landwasser Viaduct
Schmittentobel Viaduct
Surmin Viaduct
Stulsertobel Viaducts
Chaneletta Gallery
Rugnux Tunnel
Albula Viaduct II
Albula Viaduct III
0 1 2 3 4 5 km
N
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Tirano (I)
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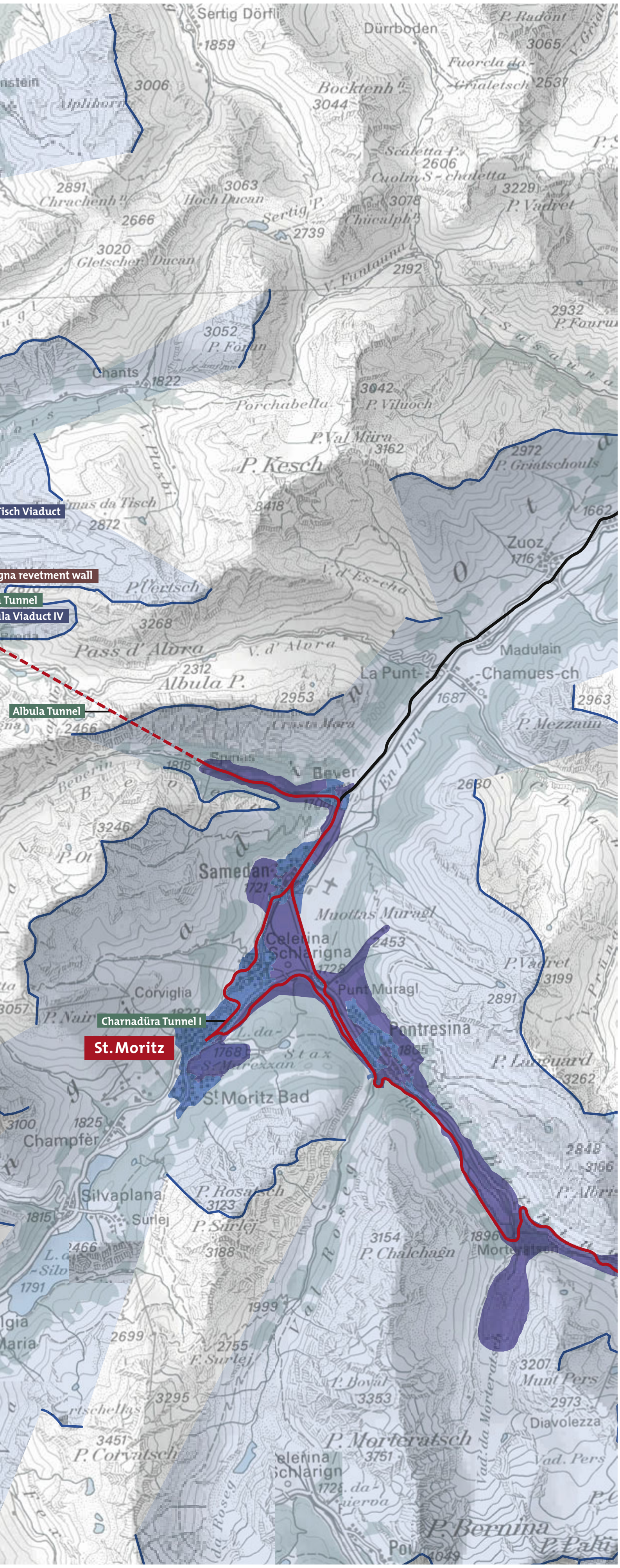


Selected engineering structures on the Albula line

- Viaducts and bridges
- Tunnels
- Galleries
- Revetment walls

Core zone

- Core zone with railway and cultural landscape

Buffer zone

- Buffer zone in the near area
- Buffer zone in the distant area (backdrop)
- Horizon line

Other contents

- Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200’000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Jürg Conzett
Design: Süsskind, SGD, Chur

2.a.4 Engineering structures on the Albula and Bernina line

The engineering structures on the Albula and Bernina railway routes are less important as individual examples, than within the scope of their mutual interplay and their relationship to a more general pattern. The decision to build these railway constructions in stone wherever possible was based on technical as well as economic and architectural factors. The successful synthesis of apparently contrary elements in opening a landscape of particular significance to tourism up to traffic was new and led to a fundamentally changed attitude to transport installations among a public that was basically critical of technical progress. The enthusiastic reception given to the railway structures discussed here by the national heritage conservation movement was quite exceptional, and its impact on other installations before the First World War was also remarkable. Another confirmation of the high quality of the engineering structures discussed here is that most of them still continue to be used for railway operation in practically unchanged form.

A statistical look at the engineering structures on the Albula and Bernina routes already shows their importance for each of these lines: the 135 bridges of the Albula railway together extend over more than 3 km, corresponding to 6.6 % of the open part of the line. A railway line is already considered to be "rich in bridges" when this proportion is a mere 1.6 %, so the density of bridges on the Albula route is exceptionally high. The tunnels on this line also make up a high proportion of its length: excluding the almost 6 km long Albula tunnel, the total length of the tunnels on this route – there are 39 of them – amounts to over 10 km, or 18.5 % of the line. The lower limit for a "tunnel-rich" route is 10 %. Although the Albula railway was designed principally to open up the tourist centres of the Engadin, its chief engineer Friedrich Hennings pointed out that it should also be seen "as part of a larger rail network… so that, after the completion of connections to Italy and the Tyrol […], it could be used to carry important transit traffic". Great value was consequently placed on building a track with curves of relatively large radius and with comparatively low gradients: this required the construction of many tunnels and bridges along the deeply cleft terrain of the Albula valley.

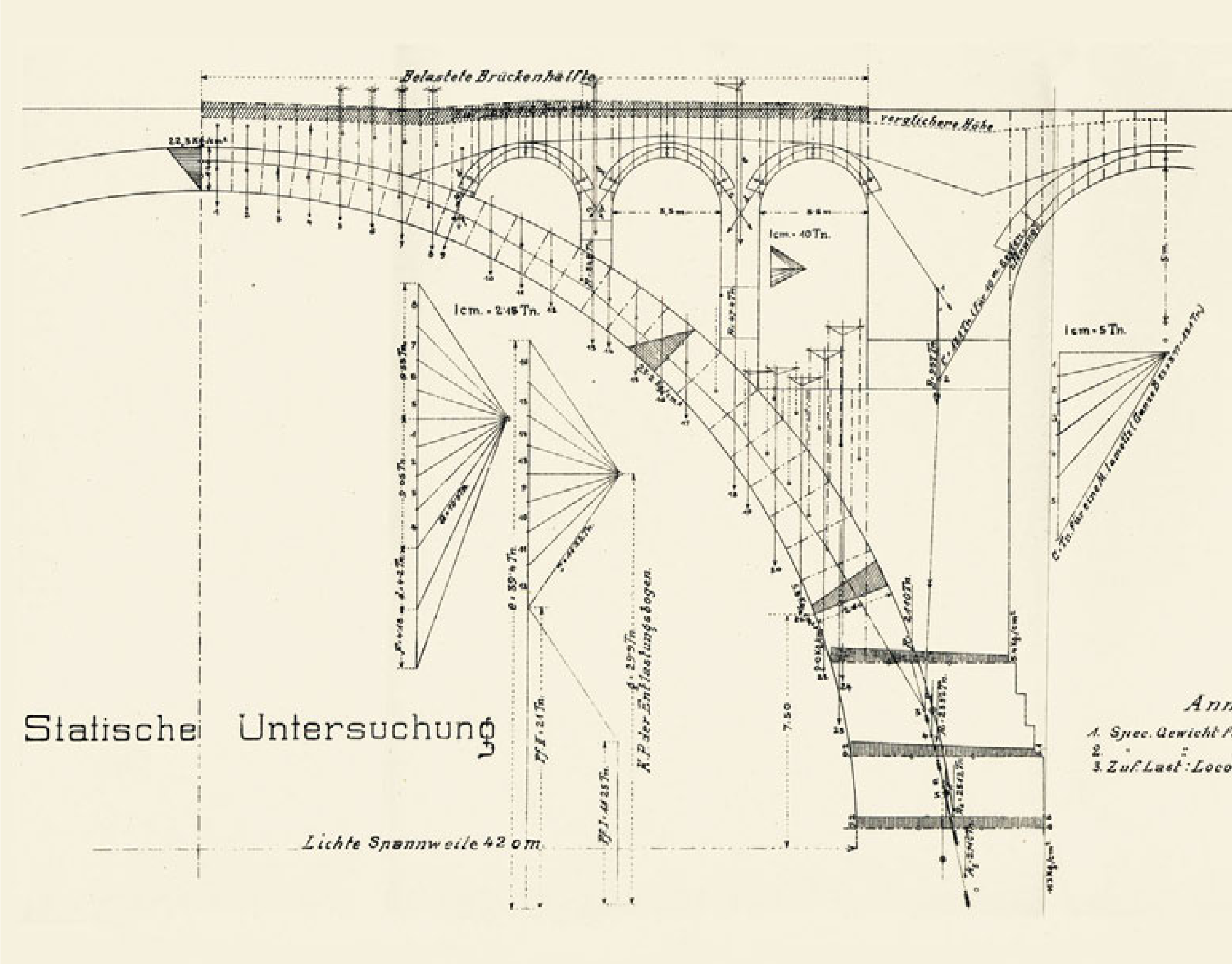
The Bernina line has a completely different character: with gradients of up to 70 ‰, the railway was operated with short, electrically driven trains. This allowed a flexible track layout that follows the terrain with narrow curves. Despite the extreme topographic conditions, the Bernina railway has few engineering structures in proportion to its length. Only 1.6 % of its route is made up of bridges and 3.65 % of tunnels.

The engineering structures, especially the bridges, are a characteristic element along the Albula route, both in terms of building technology and from the viewpoint of travellers. Hermann Behrmann, author of a travel guide published in 1908, felt a new type of "travel magic" in the Albula valley: "despite being uncommonly susceptible to natural beauty, […] I was often enough diverted away from even the most magnificent landscape by the details of the railway installations". On the Bernina route, in contrast, the engineers made a point of avoiding engineering structures as far as possible. The economic reasons for this approach

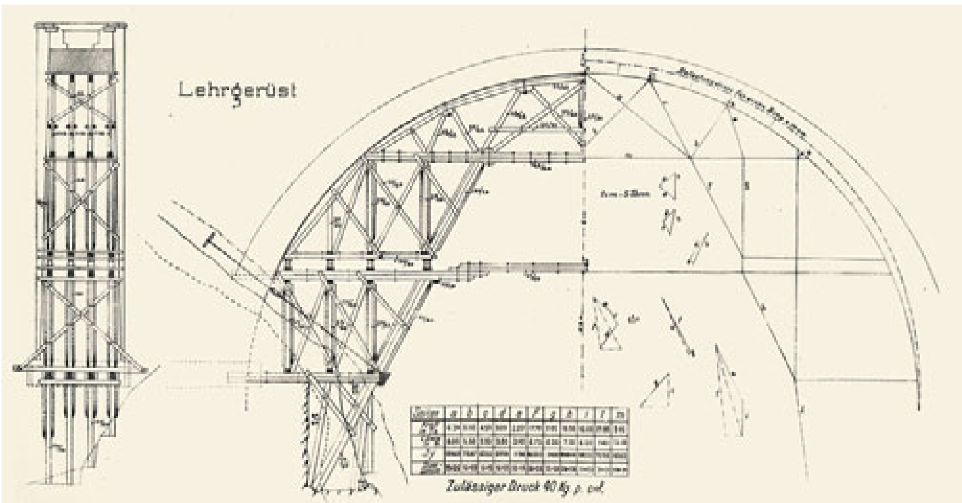
Albula line > The 42 m span of the Solis Viaduct under construction.
Rhaetian Railway

Historical photograph of the Solis Viaduct, in the foreground the road bridge over the Albula river.
Rhaetian Railway

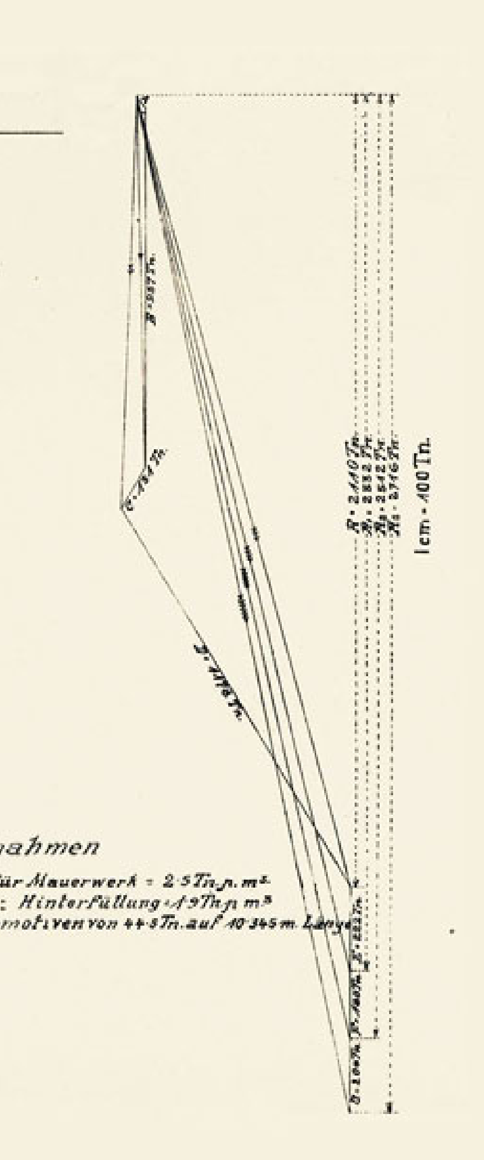
Solis > The Solis Viaduct is still in its original state.
T. Keller

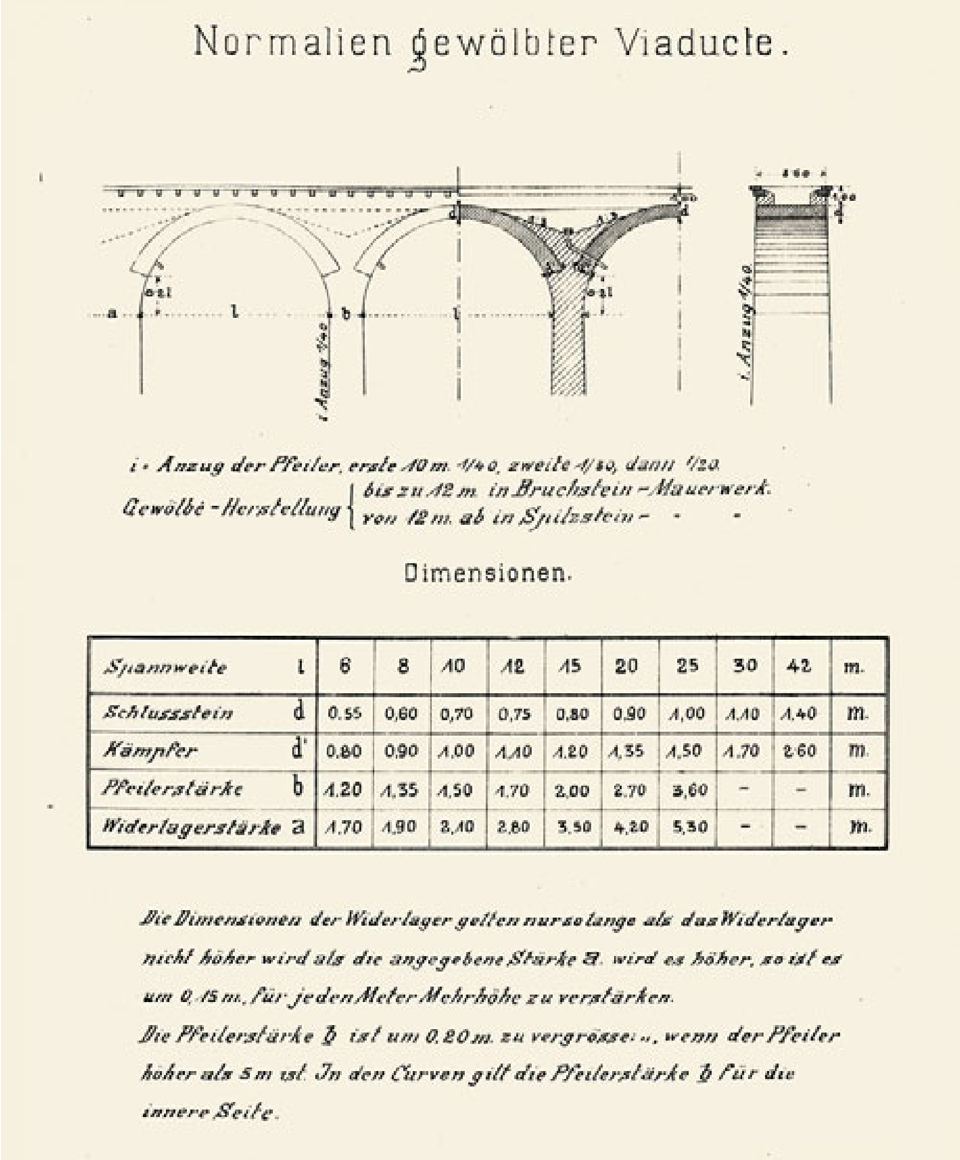


Solis Viaduct > Testing the statics.



Solis Viaduct > Plan of the framework.





Normalien gewölbter Viaducte.

i = Anzug der Pfeiler, erste 10 m. 1/40, zweite 1/30, dann 1/20.

Gewölbe-Herstellung { bis zu 12 m. in Bruchstein-Mauerwerk. / von 12 m. ab in Spitzstein- " " }

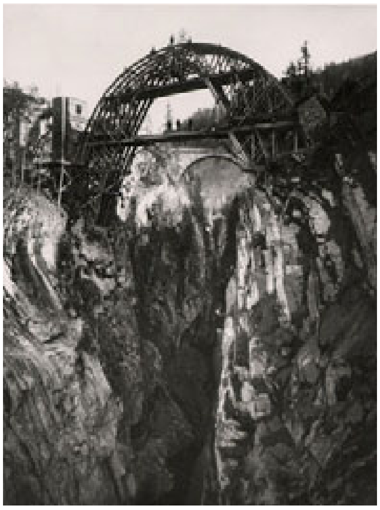
Dimensionen.

Spannweite	l	6	8	10	12	15	20	25	30	42	m.
Schlussstein	d	0,55	0,60	0,70	0,75	0,80	0,90	1,00	1,10	1,40	m.
Kämpfer	d'	0,80	0,90	1,00	1,10	1,20	1,35	1,50	1,70	2,60	m.
Pfeilerstärke	b	1,20	1,35	1,50	1,70	2,00	2,70	3,60	–	–	m.
Widerlagerstärke	a	1,70	1,90	2,10	2,80	3,50	4,20	5,30	–	–	m.

Die Dimensionen der Widerlager gelten nur so lange als das Widerlager nicht höher wird als die angegebene Stärke a. wird es höher, so ist es um 0,15 m. für jeden Meter Mehrhöhe zu verstärken.

Die Pfeilerstärke b ist um 0,20 m. zu vergrössern, wenn der Pfeiler höher als 5 m ist. In den Curven gilt die Pfeilerstärke b für die innere Seite.

Albula line > Standards for ached viaducts.



Solis Viaduct > The daring framework was built by the legendary bridge builder Richard Coray in 1901.
Rhaetian Railway

All the plans on this double page are taken from: FRIEDRICH HENNINGS: *Albulabahn. Denkschrift*, Chur 1908.

are evident, but it also reveals the will to preserve the landscape and as far as possible not to encroach upon it with “engineering art” in the form of conspicuous buildings.

Engineering structures along the Albula route

Bridges

The great majority of the bridges along the Albula railway are stone viaducts. Only at a very few places, for instance when a stream or river had to be crossed at a low height, were iron structures used. Some of these were later replaced by concrete constructions. The most prominent example of this type is the bridge over the Upper Rhine immediately after Thusis railway station, where the railway originally crossed the river on a rhomboid iron trellis with an 80 m span. Untypical of the “stone” Albula railway, this was a last salute to the great Rhine river bridges. A concrete arched construction now stands in its place.

The Solis viaduct can certainly be regarded as the most important bridge on the Albula line. It is located in the Schin gorge and bridges the Albula River with an arch spanning 42 m. The viaduct thus has the longest span of any of the Albula rail bridges. With a height of 85 m, it is also the highest viaduct on the Rhaetian railway. Accordingly, its structure is rather more complex than that of the other bridges. The pillars above the arch abutments are widened and provided with masonry parapet attachments that form a type of bridgehead. The base and copings are trimmed on all sides.

The viaduct is built of siliceous limestone quarried from the Schin gorge itself. This is a solid stone that breaks into layers (with parallel surfaces) and thus supplies building material of outstanding quality – in terms of both durability and ease of working.

Construction of such a large arch for a railway bridge was an innovation in Switzerland at that time, and the latest available method was used to calculate its static parameters, namely the elasticity theory according to the graphical method of Wilhelm Ritter. In addition to engineer Hans Studer, who was later to become a specialist in stone arches in Switzerland, the young Robert Maillart also worked on these innovative studies. The Solis viaduct is among the first “elastically” dimensioned stone viaducts. In his standard reference work “Grandes Voutes”, Paul Séjourné mentions only three arched bridges in Austria-Hungary (Jaremcze, Jamna and Worochta on the then Carpathian railway from Stanislau to Wronienka of 1893/94) that may be regarded as forerunners of the Solis viaduct.

The falsework was an early achievement by legendary constructor Richard Coray. He succeeded in designing it as a relatively lightweight structure, as the main arch was constructed in three successive concentric interleaved rings so that it had to be dimensioned only for the weight of the first ring.

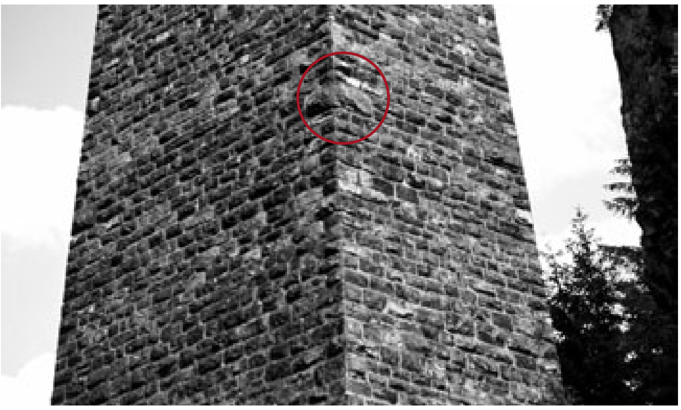
The Landwasser Viaduct at Filisur has the largest masonry cubage of any bridge on the Albula line – namely 9,200 m^3, its mass is about three times greater than that of the Solis viaduct. This is due to the pillars with their unusual height of 65 m and that they also stand a short distance apart, as the spans of the arches are a mere 20 m. The highest pillars measure approximately 8 x 8 m at their base, i.e. with a spacing of 23.50 m between the pillar centre-points, a third of the valley’s longitudinal profile is built up at the bottom. The spaces between the pillars are short because the railway on the bridge traverses an unusually narrow curve with a radius of only 100 m – otherwise minimum

Albula line > Landwasser Viaduct near Filisur under construction, 1902.
Rhaetian Railway

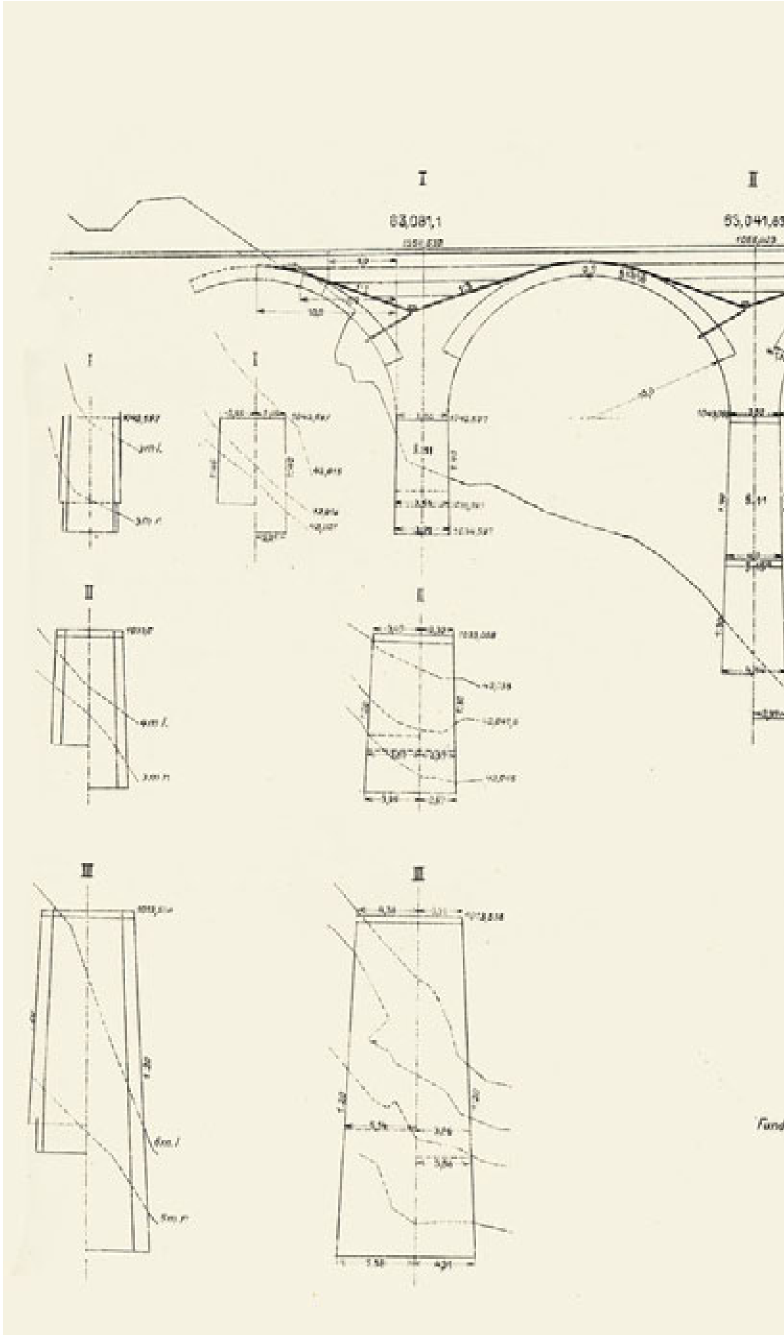
Albula line > Historical photograph showing the Schmittentobel and the Landwasser Viaduct.
Rhaetian Railway

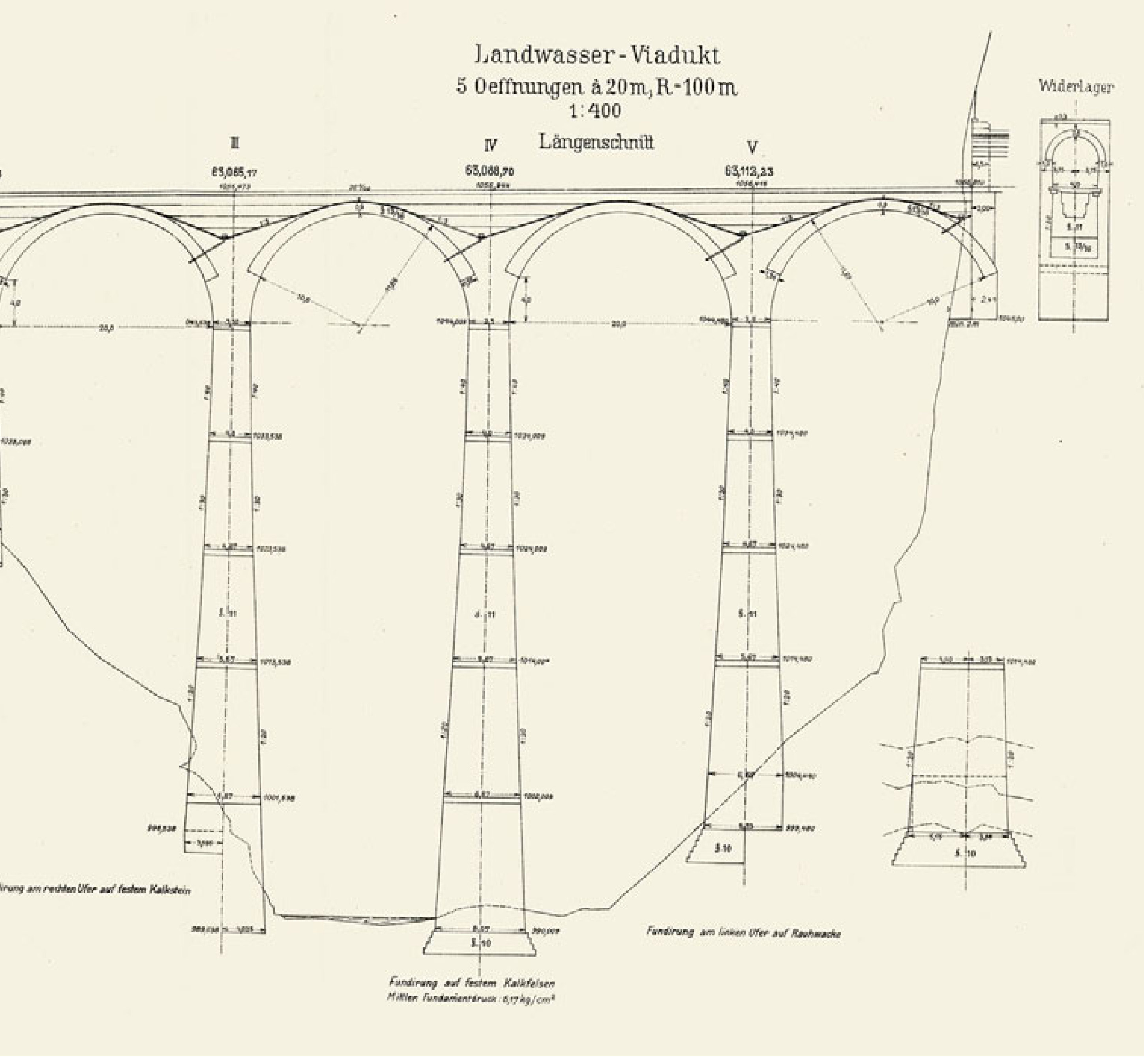
Filisur > The Landwasser Viaduct is still in the original state, over 100 years after it was built.
Canal, Engadin Press

Landwasser Viaduct > The iron towers supporting the bridge cranes were built into the piers. This made it possible to do without construction frameworks in an area liable to flooding.
Rhaetian Railway



Landwasser Viaduct > Detail of a pier. The circle pinpoints a cornerstone marking the position of the inner level course.
Rhaetian Railway





Landwasser Viaduct > Longitudinal section. Plan (reduced in size) taken from: FRIEDRICH HENNINGS: *Albulabahn. Denkschrift*, Chur 1908.

curve radii of 120 m were observed on the Albula route. In order to compensate for the resulting greater tractive resistance, the gradient here was reduced from 25‰ to 20‰. The individual arches have a polygonal ground plan, i.e. are slightly offset with respect to each other. As a result, the pressure forces in the pillars are directed slightly outwards, as the horizontal force components of the respective arch do not exactly compensate each other. The trains running over them generate centrifugal forces with a similar direction. In order to counter these effects, the pillars are constructed asymmetrically and transversally to the rail axis.

The narrow curve meant that the lengths of the Landwasser Viaduct and the directly adjoining Landwasser Tunnel could be kept comparatively short. This point of the railway installation shows in an impressive way how strongly the conditions of the track layout and the topography influence bridge-building technology and mutually affect each other.

The Landwasser Viaduct is built of dolomite limestone that was transported on a construction railway running from a nearby quarry to the building site. A problem arose with this bridge that is otherwise encountered only in flat river crossings, namely the restricted flow profile of the Landwasser between the two highest pillars. The contractor therefore decided not to place framework towers in areas of possible flooding and constructed the pillars without scaffolding with the aid of two gantry cranes whose steel towers stood in the middle of the pillars and were progressively encased by them. At the pillar head, the lowest part of the arch was extended in a kind of free projection so far outwards that the wooden constructions of the adjacent Schmittentobel Viaducts with somewhat shorter spans could be re-used as falsework, thus saving costs. Traces of this construction process may still be seen today on the iron fastenings placed above each other in two rows, and the arch stones seen from below in the free projection area are embossed identically to the pillar masonry, whereas they had to have a flat surface in the falsework section in order to lie smoothly on the boarding.

The design of the pillars and arches, at first sight completely unadorned, creates an effective contrast purely because of the consoles and copings of the upper bridge border, with their comparatively delicate appearance: it clearly reflects the architectural thinking of those years after 1900.

A closer look reveals a further design refinement that uses a constructional feature to create subtle structuring. In the pillars of the Landwasser Viaduct, each layer of the internal equalisation strata is marked by four larger cornerstones that extend over two height sections.

Other viaducts remarkable for their spans are the Muttnertobel Viaduct (30 m wide) before Solis and the Mistail Viaduct (27 m wide) before Tiefencastel. These arches were also constructed with wooden formwork and, similarly to the Solis viaduct, scaffolding costs were saved by constructing the arches with a ring structure, although in this case only two rings were used rather than three. The two arches over the Stulsertobel (25 m and 23 m) between Filisur and Bergün/Bravuogn are only slightly shorter than these viaducts.

Some viaducts were constructed in a typical way on the basis of several standardised spans so that their dimensions could be read directly from a table. This category of viaduct includes Albula Viaduct III (openings of 3 x 10 m, 3 x 20 m, 2 x 10 m) below Preda: with a masonry volume of 4,090 m^3, this bridge has the second largest cubature on the Albula route. The following viaducts also have 20 m spans: Albula Viaduct II

Albula line > Artificial elongation between Bergün/Bravuogn and Preda due to Viaducts and helical tunnel. The Albula Viaducts II (left) and III (right) can be seen clearly.
Foto Geiger

Albula line > The Albula Viaduct III, the bridge with the second largest cubature on the Albula line.
Foto Geiger

Albula line > Three arch design in the revetment wall at Fuegna 1; the passengers can see it as the train emerges from the Rugnux tunnel.
J. Conzett

Albula line > Three arch overpass at Bergün.
J. Conzett

Albula line > Layout above Bergün/Bravuogn. Illustration taken from: Friedrich Hennings: *Albulabahn. Denkschrift*, Chur 1908.

Captions:
❶ = Revetment wall at Fuegna
❷ = Albula Viaduct I
❸ = Rugnux Spiral Tunnel
❹ = Albula Viaduct II
❺ = Tuoa Spiral Tunnel
❻ = Albula Viaduct III
❼ = Albula Viaduct IV
❽ = Zuondra Spiral Tunnel

Albula line > The Albula Viaduct III ❻, under construction, 1902.
Rhaetian Railway

Albula line > The Albula Viaducts II ❹ (foreground) and III ❻ (behind) shortly after completion. Bottom right the Val Rots linesman's hut. Photographed in November 1902.
Rhaetian Railway

(three main openings of 20 m), Val Tisch (three main openings of 20 m) above Bergün/Bravuogn and Surmin (one opening of 20 m) above Filisur. The 16-m type is represented by the Bendertobel viaduct (three openings each 16 m wide) and the Lochtobel viaduct (5 x 16 m) in the Schin gorge, the Schmittentobel viaduct (7 x 16 m) between Alvaneu and Filisur shortly before the Landwasser viaduct and Albula Viaduct IV (2 x 16 m) below Preda.

The uppermost layers of the slope are liable to creeping movements, particularly in the Schin gorge. Dangerous cutting of such unstable slopes can be avoided by constructing leaning viaducts. The foundations that push through the slope at specific points required the construction of deep shafts, that – framed with wooden props – had to be sunk down to the stable rock surface. Thus the foundations of the Lochtobel viaduct extend up to 14 m below the terrain surface. Thanks to this structure, the Albula route has remained largely free of later repair work due to terrain sinking.

The small bridges are also of interest. Between Bergün/Bravuogn and Preda, the convoluted track route means that the railway installations are always visible to passengers looking forwards and backwards. This circumstance may explain why the railway builders frequently resorted to three-arched underpasses and overpasses here, a motif widely found in garden and park architecture. On one occasion, the "three arches" even appear in a supporting wall, near Fuegna, just at the point where the rail track runs parallel to itself on a short section before and after the Rugnux tunnel. This offers an unusual example of a "compositional" approach by the planning engineers with an eye to a clientele who can recognise the leitmotiv in a complete work of art.

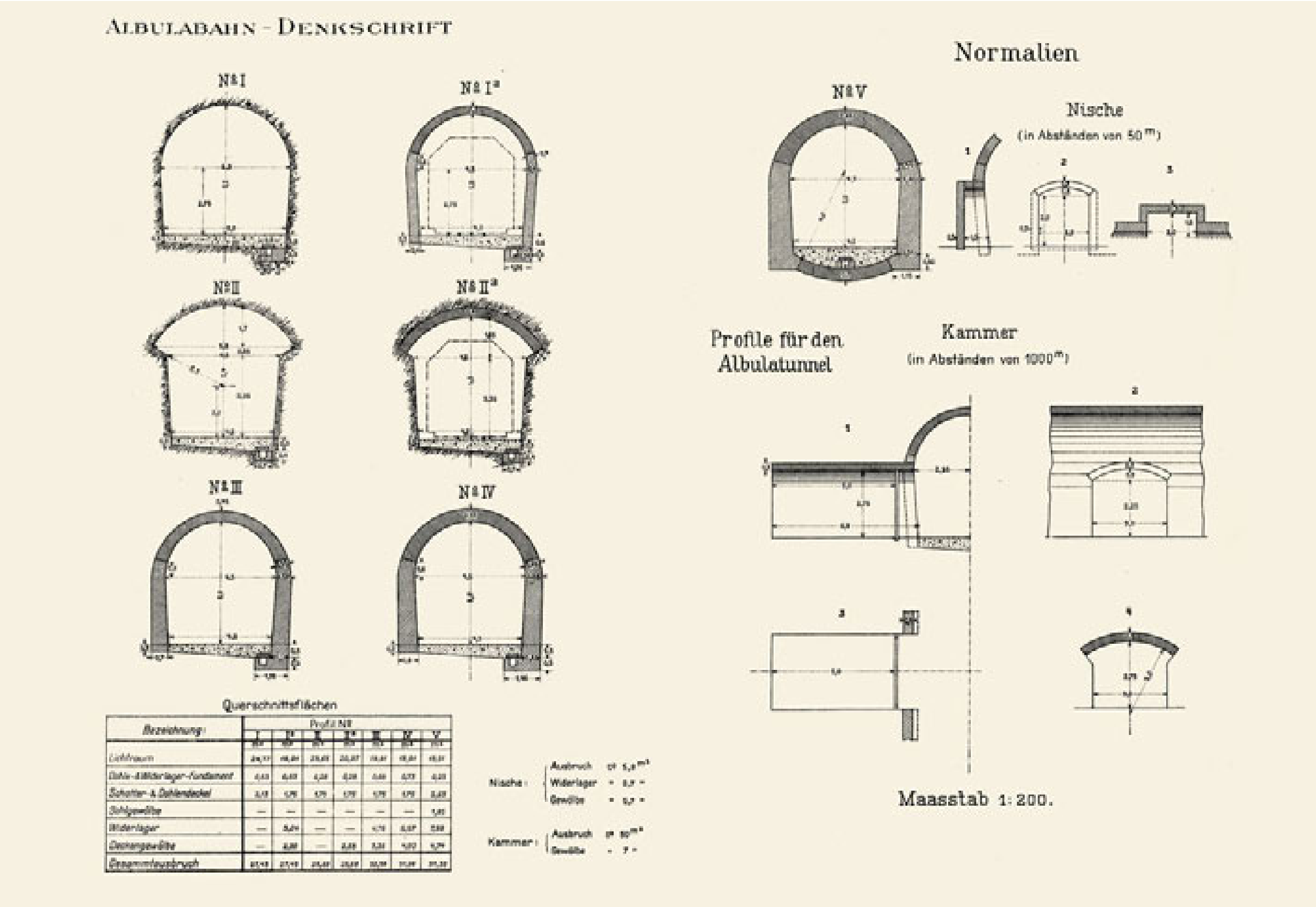
Tunnels

The most important tunnel of the Albula railway is the Albula tunnel. It is around 5,865 m long, extends from Preda in the Albula valley to Spinas in Val Bever, breaks through the watershed between Rhine and Inn and is the highest Alpine tunnel on any main-line railway, peaking at 1,823 m. It was constructed between 1898 and 1903. The rock in its middle zone consists of solid Albula granite, and formations that are more difficult to traverse are found on either side of it. On the north side, there is a 1,100 m layer of wet lime and clay shales, 110 m of cellular dolomite (the last 20 m of it in quicksand) and 50 m of solid Casanna schist: eleven months of work were needed to break through the cellular dolomite alone. On the south side, the tunnel penetrates a landslip area with large unstable blocks in the first 170 m; these had to be carefully braced during the construction. The granite was reached after a further 90 m in the moraine.

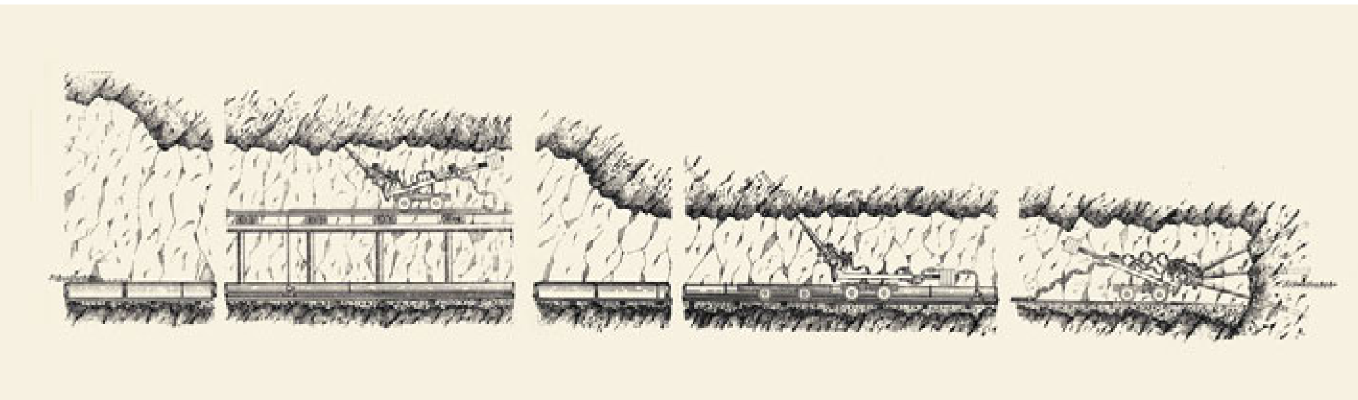
Brandt drilling machines driven by water under pressure were used to excavate the tunnel. These machines had been developed in the Gotthard railway Pfaffensprung helical tunnel and were later used in the Arlberg tunnel. The water pressure was 100 atü and the drilling implements were supplied by rigid pipes and corresponding fittings. The construction took place in the "Austrian" manner, with sole-gallery operation, so that the excavated material did not have to be reloaded on its way out. The sole gallery was then broadened with a "ridge groove" which was followed in the usual way by excavation of the roof section, bricking of the vault, excavation of the sidewalls and underpinning of the vault abutments. Extensive parts of the solid Albula granite could be left unfaced.

Other longer tunnels are found in the Schin gorge and in the loops between Filisur and Preda.

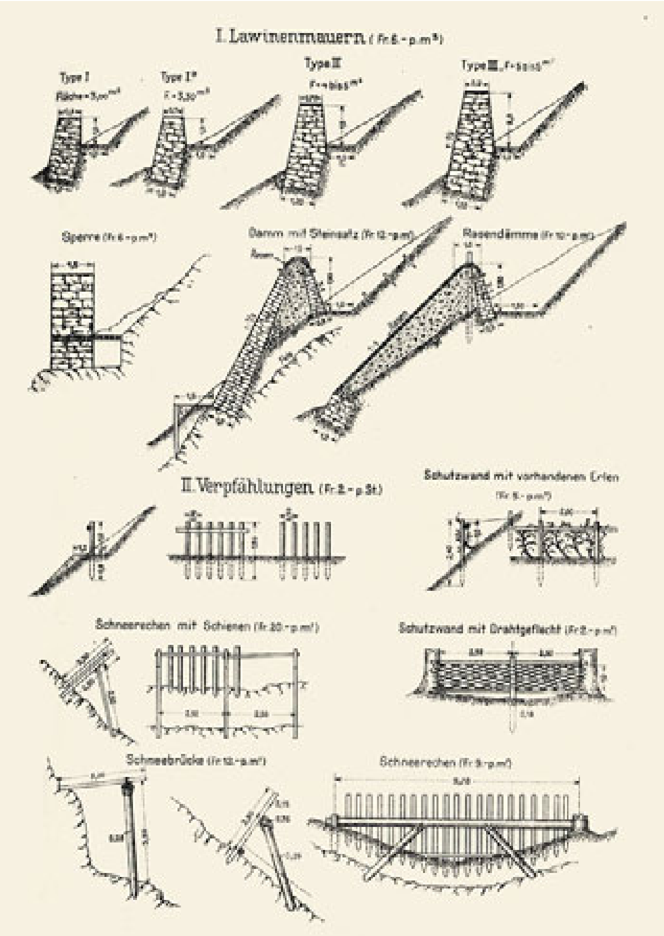
Albula line > Rugnux inclined Viaduct. A "Crocodile" engine hauling the Pullman Classic Express carriages.
P. Donatsch



Albula line > Profile for the Albula tunnel (reduced in size).



Albula tunnel > The sole tunnel and ridge groove excavation with the Brandt hydraulic drive drilling machines.



Albula line > Standards for avalanche walls and baffles to protect the railway line.

Albula line > When it was built, the largest avalanche baffle in Switzerland: Muot. Bottom right the Chanaletta gallery, 1907.
Rhaetian Railway

Albula line > Walls with snow catchers, Muot avalanche protection baffle.
Rhaetian Railway

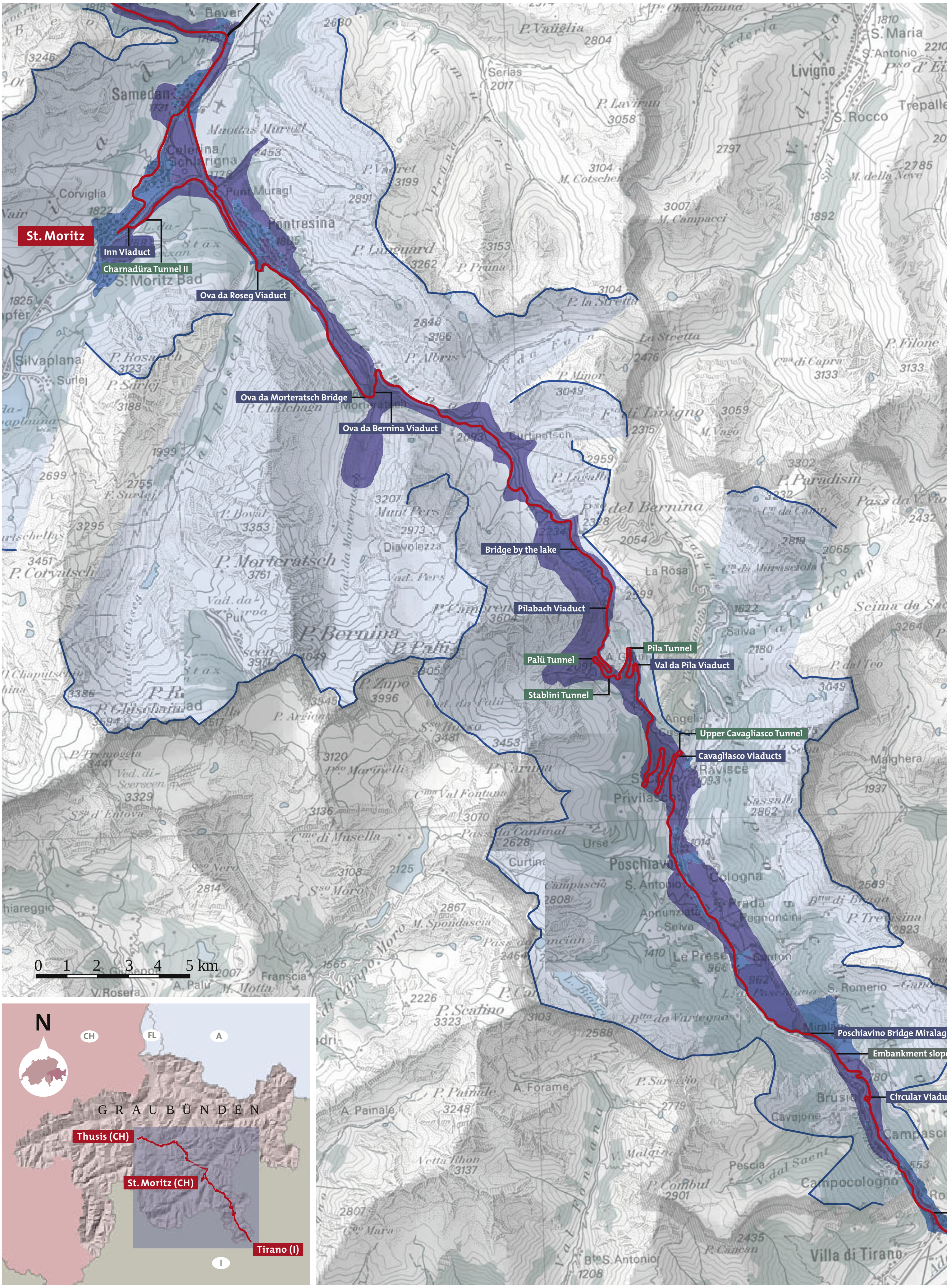
All the plans on this double page are taken from: Friedrich Hennings: *Albulabahn. Denkschrift*, Chur 1908.

The Schin gorge contains the following tunnels: Runplanas (502 m), Versasca (694 m), Passmal (420 m), Solis (986 m) and Alvaschein (609 m). The unstable layer of the uppermost slope of the Schin already mentioned also created problems for some of the tunnels. Thus at the upper end of the Versasca tunnel, where it traverses this unstable layer, the tunnel facing had to be reinforced and a sole vault built. In contrast, the Solis tunnel traverses such hard limestone layers that two-thirds of its length could be left unfaced.
Between Bergün/Bravuogn and Preda, the construction of the Rugnux helical tunnel (662 m), the first of three spiral tunnels of this route section, ran into special difficulties when it cut into cold-water springs that greatly hindered the progress of construction. And even when the tunnel was completed, ice formation within it was a constant nuisance. The problem was finally solved by the installation of a tunnel gate.
The engineering structures along the Muot-Preda route testify to an intensive struggle with the geological and climatic conditions of the region. The double terminal loop in Val Rots, originally planned for the left bank, was abandoned in favour of the right-bank Toua tunnel (677 m) because the track with its tunnel would otherwise have had to traverse the extensive wet debris area of a massive rockfall.
With the exception of the Albula tunnel, all the tunnels were constructed using the "Belgian technique" with ridge galleries. The excavation was carried out by means of manual drilling and dynamite blasting. All the portals are built in natural stone. In important tunnels, the stonework is graduated towards the terrain in a classicistic style (tunnel portals Solis [south], Versasca [north], Nisellas [south], also the portals of the Albula tunnel): as a rule, however, their outlines follow the adjoining terrain in a polygonal pattern.

Other engineering structures

Other engineering structures that mark the landscape include retaining walls and avalanche baffle works. The numerous retaining walls were constructed exclusively in natural stone (as mortared or drystone walls) and form a unity with the viaducts and tunnel portals by virtue of their material and surface treatment.
The traversal of the Muot valley slope above Bergün is particularly striking as regards the interaction between engineering structures and the track layout, because the open line route here incurred extraordinary costs. The first part of the slope traversal required the largest avalanche baffle works ever seen in Switzerland at that time. The train runs through a masonry-built gallery under the avalanche ridge known as "Blais Chanaletta" adjacent to this baffle-lined slope. The question arises as to why this open railway route was not simply run through a tunnel. Hennings remarked on this problem in general: "Where it was possible to build baffle works in an avalanche area, this approach was taken, partly because of lower costs and partly to save tourists a doubly undesired tunnel in such beautiful surroundings." However, a rough cost comparison (using price data from Hennings) gives the following picture in this case: the stretch exposed to avalanches is 700 m long. It is adjoined by the 117 m long Chanaletta Gallery.
The open route cost CHF 62,000 and the gallery CHF 115,000, making a total of CHF 177,000. To this must be added the costs of the baffle works of CHF 300,000. The cost of constructing this 817 m long route thus totalled CHF 477,000. A correspondingly long, regularly faced tunnel would have cost CHF 347,000, significantly less than the open route. Even if the Swiss Federal subsidy of CHF 137,000 for the avalanche baffle works is included, the open route was not

Bernina line > Circular Viaduct at Brusio.
P. Donatsch



St. Moritz
Inn Viaduct
Charnadüra Tunnel II
Ova da Roseg Viaduct
Ova da Morteratsch Bridge
Ova da Bernina Viaduct
Bridge by the lake
Pilabach Viaduct
Palü Tunnel
Pila Tunnel
Val da Pila Viaduct
Stablini Tunnel
Upper Cavagliasco Tunnel
Cavagliasco Viaducts
Poschiavino Bridge Miralago
Embankment slope
Circular Viaduct
0 1 2 3 4 5 km
N
CH
FL
A
I
GRAUBÜNDEN
Thusis (CH)
St. Moritz (CH)
Tirano (I)

Selected engineering structures on the Bernina line

Viaducts and bridges

Tunnels

Galleries

Dam embankments

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Jürg Conzett
Design: Süsskind, SGD, Chur

cheaper than a tunnel, especially if the expensive maintenance of the baffle works is included in the cost comparison. So the argument of attractiveness to tourists was a determining factor in favour of the open rail option. This is particularly remarkable because Muot represents the only point along the Albula railway where a conflict between a line's tourist appeal on the one hand and the search for cost effectiveness was decided in favour of tourism. At all the other points on the route of particular importance for tourism – one may mention the impressive interplay of the old road bridge and the more recent railway bridge at Solis, the Landwasser viaduct with its dramatic views from the train, the loops between Bergün and Preda offering broad views and surprising perspectives – tourist and technical-economic criteria largely coincide.

Engineering structures on the Bernina line

Bridges

The bridges on the Bernina line were built largely on the basis of the standards applied to the Albula railway. Some of the dimensions were merely reduced slightly in view of the differing operating requirements. As on the Albula route, stone viaducts were preferred. The bridges with the longest spans were the two Cavagliasco viaducts above Poschiavo, of identical design – each with an arch of 26 m – for which the same scaffolding was used to carry out the masonry work. Unfortunately both viaducts have suffered major distortions in the course of time due to slope movements. The upper Cavagliasco viaduct was replaced by a parallel steel-concrete composite bridge in 1989, and the lower Cavagliasco viaduct by a steel truss girder in 2002. Other longer spans are found on the north acclivity: they are the 20 m arch spanning the river Ova da Roseg and the 17 m wide Ova da Bernina viaduct on the ascent between Morteratsch and Montebello. Another one is the Inn viaduct at St. Moritz whose main opening has an 18 m span. Among the larger stone viaducts on the south side are the Pilabach bridge (10 m wide) between Ospizio and Alp Grüm, and the striking Val da Pila viaduct (3 x 10 m) above Cavaglia station. It was possible to preserve this viaduct despite strong slope movements by rebuilding the lower abutment in 2004 and placing it on friction bearings. The high point of bridge engineering on the Bernina route is the masonry-built circular viaduct of Brusio that bridges a height discontinuity analogously to a helical tunnel. It consists of nine openings each of 10 m that lie in a curve with a radius of 70 m. One opening spans the railway line running under it. The solution adopted for this viaduct was both cost-effective and attractive from a tourist standpoint, so this remarkable construction can really be seen as the embodiment of the objectives that guided the construction of the Bernina railway. In addition to the viaducts mentioned above, the Bernina line also has a large number of masonry passages and other leaning bridges. The stone bridges were built with granite at least on their outer parts, this material being available at various locations along the railway line, for instance in Montebello above Morteratsch station as well as in Ospizio Bernina, Cavaglia and Brusio.

Stone viaducts would have been unsuitable in certain cases because the construction height was too low or technical difficulties precluded them. The Ova da Morteratsch was originally traversed by a steel parable arch truss of 22 m span that was rebuilt in 1934, also as a steel dual-arch truss. The Poschiavino river is crossed at Miralago and La Rásica by truss bridges each

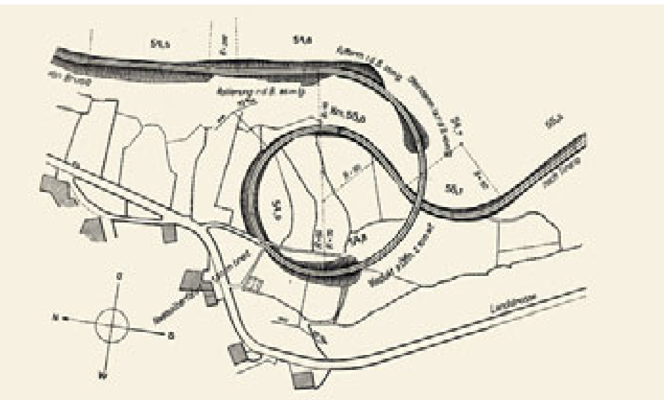
Bernina line > The lower bridge over the Bernina stream was built in 1934 in connection with a realignment above Bondo alp.
Rhaetian Railway

Bernina line > Upper bridge across the Bernina stream.
Rhaetian Railway

Bernina line > Alignment at Alp Grüm. Plan taken from: E. Bosshard: *Die Berninabahn*, Zurich 1912 (*Schweizerische Bauzeitung*, offprint).

Bernina line > Galleries protect the three traverses across theAlp Grüm slope against avalanches. The photograph was taken later than 1951.
Rhaetian Railway

Bernina line > The Bernina Express on the Brusio circular viaduct which climbs on the same principle as a helical tunnel.
P. Donatsch



Circular Viaduct at Brusio > Plan of the position and longitudinal section taken from: E. Bosshard: *Die Berninabahn*, Zurich 1912 (*Schweizerische Bauzeitung*, offprint).

Circular Viaduct at Brusio > Arch masonry 1907. Photograph taken from: E. Bosshard: *Die Berninabahn*, Zurich 1912 (*Schweizerische Bauzeitung*, offprint).

22 m wide that are preserved in their original form. The iron bridges of the route section between Bernina Lagalb and the lake Lei Nair were not built until later, namely in 1934, when a new line section with stronger avalanche protection was selected above Alp Bondo. In sharp contrast to the original design principles, these airy bridges with direct track placement and often with railings on only one side give an almost provisional impression and present a powerful image of the difficulties of building railways and maintaining them in the high mountains. The iron “bridge by the lake” that was only extended beyond Ospizio Bernina station in 1949 belongs to the same category.

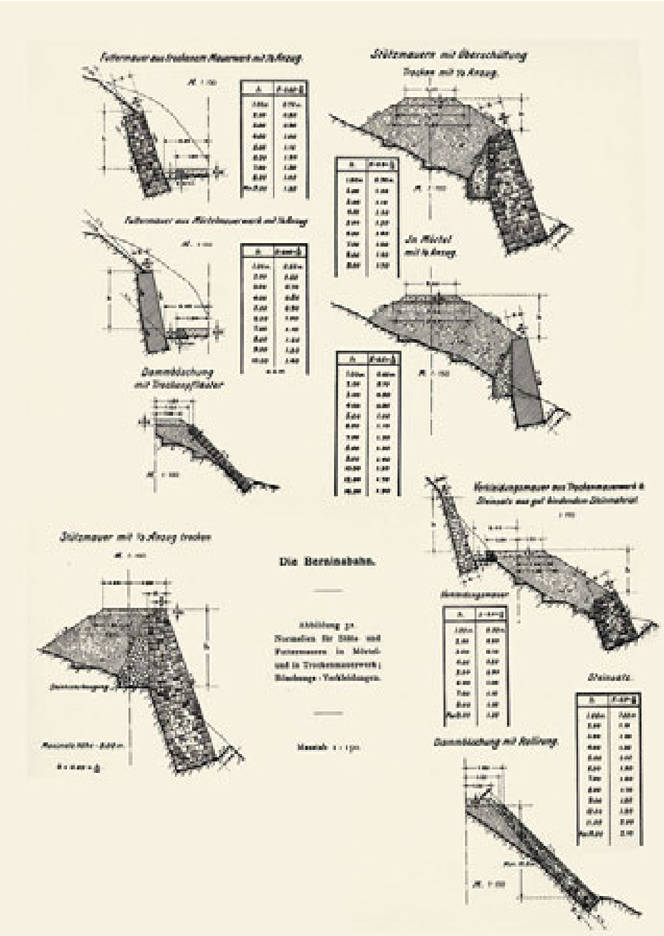
Tunnels

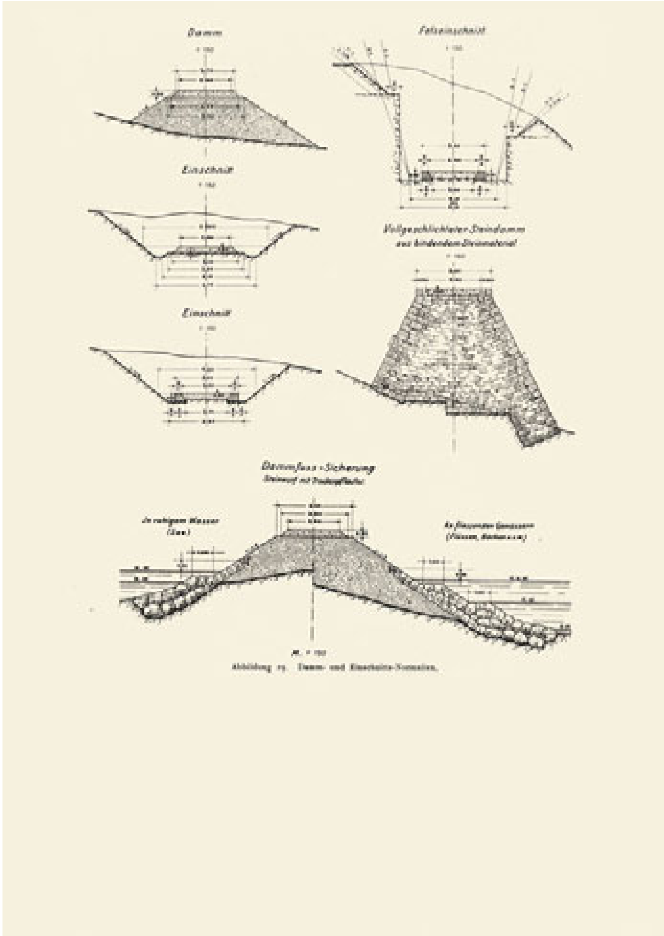
The longest tunnel on the Bernina railway is the 689 m Charnadüra tunnel II immediately after St. Moritz (opposite Charnadüra tunnel I of the Albula railway), the only tunnel on the north acclivity. This tunnel, that was not originally planned, had become necessary because adjacent communities and local preservation groups had objected to a direct connection between St. Moritz and Pontresina, as this would have intruded on the unspoilt moorland of the Stazerwald. The fight against this rail route was one of the reasons for the founding of the Bündnerische Vereinigung für Heimatschutz (Graubünden Heritage Society), which initially had a tense attitude to the idea of railway buildings. Several years passed before the Society finally declared the installations of the Rhaetian Railway and the Graubünden private railways to be both unique and exemplary.

The various tunnels on the south acclivity tend to be short but were difficult to construct. They were built in the “Belgian” manner with manual drilling. The most important ones are located in the section between Alp Grüm and Cavaglia, such as the Palü helical tunnel (254 m long), the Stablini tunnel (289 m) and the Pila helical tunnel (227 m). Difficulties due to geological conditions were encountered on the Upper Cavagliasco tunnel (32 m) that was built with walls up to 2 m thick from the outset so that it could withstand the slope movements. However, it had to be slit open in 1968 and replaced by an anchored retaining wall. In all the tunnels, the first 30 m from the portals are lined with masonry, this length corresponding to the frost limit. The mountain section above Cavaglia presented particular problems for tunnelling: the working season was of only brief duration, as the tunnels were not long enough to offer the workers sufficient protection from the winter cold. When the steep tunnels were being excavated, a process largely executed from below, the natural ventilation was deficient. For this reason, only blasting gelatine and dynamite were used in this phase of the construction. The dynamite called for great care, as it froze quickly and then exploded easily upon mechanical impact. But the safer explosive known as Cheddite could not be used until the ventilation conditions had improved with the cut-through of the driftway.

Other engineering structures

Retaining and lining walls are characteristic elements of the Bernina railway. Wherever possible, use was made of drystone walls with a slope of 1:3. Steeper walls were mortared, normally with a 1:5 slope, and in some cases were even vertical. Extensive walls were built for the joint rail-road foundations along Lago di Poschiavo. The “embankment slopes with dry paving” with a slope of 1:1 between Miralago and Brusio, where the track had to be built along an unstable landslip region, are also of interest.





Bernina line > Standards for revetment and supporting walls. Plan (reduced in size) taken from: E. Bosshard: *Die Berninabahn*, Zurich 1912 (*Schweizerische Bauzeitung*, offprint).

Bernina line > Below Miralago there is extensive dry stone masonry work supporting the embankments between the railway and the road; the size and type is unique in Graubünden.
J. Conzett

Background to the engineering structures

Typology

The engineering structures along these two rail routes illustrate pronounced conceptual thinking. The most varied initial factors might merge in a basically straightforward measure, such as the choice of semicircular masonry arches for bridges. These factors can then no longer be distinguished from each other in the completed product – precisely because a kind of irreversible, almost "chemical" process had occurred. It is particularly difficult to determine in retrospect which aspect had been weighted to what degree where the measures have a strong conceptual character and cover many aspects. At the same time there is a risk of decision-making processes seeming trivial by reducing them to simple motivations.

Almost without exception, all the bridges on the Albula route were built as viaducts in natural stone. The topographic and geological peculiarities of the Albula valley offered ideal conditions for this uniformity in bridge design; the lateral valleys to be traversed are usually deeply cut and permit the construction of high-arched viaducts. Their dimensions correspond to standards laid down in tables. The bridges on the Bernina route were originally built on the basis of similar principles. The different character of the railway as of the landscape it runs through and the later additions and rebuilding work explain the greater diversity of bridge buildings along this route. However, the typology was more than merely an arbitrary instrument of rational planning and execution, it formed a design principle that extended beyond the viaducts to cover overpasses and underpasses, stream and path traverses as well as tunnel portals and retaining walls. Differentiations may also be noted within this typology: almost all the viaducts on both rail routes have standardised railings with an upper angular steel bar and a centre tube, the Solis viaduct, however, has posts of flat steel and tubular spars. This refinement underscores the importance of this large arched bridge. It also shows that not only the perspective of the railway user but also the views seen by tourists (or specialists) not travelling by train were taken into account: looking from the old road bridge, they saw the viaduct from the front. The fine points of the design indicated here remained hidden from train travellers because of the speed of the train.

Further differences are due to the construction materials used. To avoid longer transport distances, the material for the engineering structures was usually taken from the immediate surroundings. It thus reflects the particular features of the local geology. In the buildings of the Albula valley, the nature of the masonry changes with increasing altitude towards more irregular stone forms: the changeover from the smooth strata-like siliceous limestone of the Schin gorge to the embossed dolomite blocks at Preda corresponds to the ascent from the cultivated plain to the wild, high mountain region.

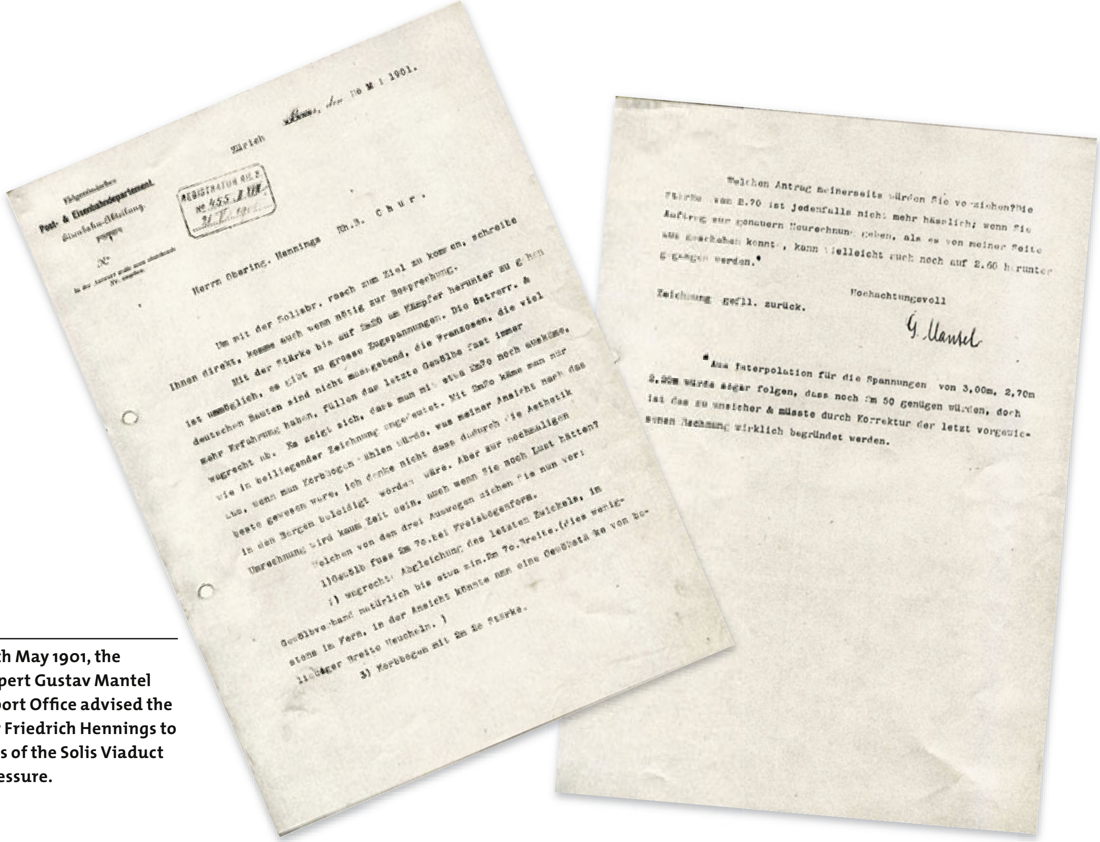
"Giving stone its due"

The bridges of the Albula railway indicated the beginning of a renaissance of stone bridge-building in Switzerland after a preceding period of fifty years during which railway bridges had been dominated by iron constructions, at least in the sector of longer spans. A tendency to stone building can also be noted in southern Germany and Austria-Hungary during the same period. In the second half of the 19th century, the theory of trusses had developed quickly: iron bridges were lightweight, could be quickly assembled and were correspondingly inexpensive. In larger

Albula line > A non-standard parapet was used for the Solis Viaduct that looks particularly delicate when viewed from the side.
J. Conzett

Solis Viaduct > Detail of the crown of the wall and the parapet.
J. Conzett

bridges, the iron trusses were usually supported by stone pillars and abutments, such as those of the Gotthard railway (1882) or the Landquart-Davos railway (1889). Not until the 1890s did the drawbacks of iron bridges become apparent. Locomotives had become increasingly heavy and powerful, the trains ran more frequently, and questions of iron fatigue became significant. It became evident in 1891 that by no means all iron bridges could cope with these growing stresses when the Birsbrücke in Münchenstein collapsed under a heavy express train. Traumatised by the accident, the Swiss Railway Department issued a new bridge-construction directive in 1892 that required all existing iron bridges in Switzerland to be redimensioned for updated loads. This led to extensive reinforcements to existing bridges. New iron bridges were now built to heavy and strong specifications. Where previous practice had been to screw the tracks directly onto the bridge with timber sleepers, they were now laid into a ballast bed on bridges too in order to cushion the impacts of the trains. However, this greatly increased the loading of the bridges, which was in turn associated with higher costs. Under these conditions, Robert Moser (1838 – 1918), then chief engineer of the North-East Railway, began to campaign in favour of stone bridges. Moser, together with Gustav Mantel, won the competition for the Lorraine road bridge in Bern in 1897. Their concept bore the motto “Give stone its due”. Moser sent photographs of a plaster model of the project to all Swiss building contractors. He pointed out in an accompanying letter that stone bridges had hitherto been far too neglected in Switzerland and the choice often fell in favour of iron bridges even if these were associated with higher costs than a stone construction. He set himself the aim of gaining new friends for the “national and solid” manner of building. Three years later, Moser published detailed and systematic specifications “on the construction and costs of railway viaducts” in the Swiss construction magazine that confirmed his thesis of the cost-effectiveness of stone bridges.
At the Rhaetian Railway, its director Achilles Schucan and chief engineer Friedrich Hennings as well as section engineer Hans Studer were also proponents of Moser’s ideas. In his 1926 article on “Stone Bridges of the Rhaetian Railways”, the latter criticised the “incorporation of relatively delicate iron trusses into a mighty granite environment shaken by avalanches” on the Gotthard railway as “something completely inorganic”. In contrast, he praised the Albula railway, “whose construction had been determined by lofty ideas … by avoiding the use of materials alien to nature wherever possible and choosing a bridge-building material that was in the truest sense of the word solidly grounded in order to blur the distinction between human activity and nature as far as possible, to fit this human product as imperceptibly and modestly as possible into the beauty and majesty of the sublime mountain environment, and to minimise or completely avoid disturbing its harmony!”
With the exception of some low bridges and passages, all the viaducts of the Albula railway have semicircular arches. Even for the widely spanned arches of the Solis viaduct, Hennings insisted on the statically slightly sub-optimal semicircular shape. It would have been better to adapt the arch to the line-of-thrust, wrote inspection engineer Gustav Mantel from the Transport Office in an instructive exchange of correspondence, he “does not think that this would detract from the aesthetic appeal of the mountains.” What was to become self-evident a few years later in other large stone viaducts, namely the adaptation to the ideal static form, was still questioned around



Eidgenössisches Post- & Eisenbahndepartement. Eisenbahnabteilung.

Registratur Rh.B. № 455

Zürich, den 30 Mai 1901.

Herrn Obering. Hennings Rh.B. Chur.

Um mit der Solisbr. rasch zum Ziel zu kommen, schreibe Ihnen direkt, komme auch wenn nötig zur Besprechung.

Mit der Stärke bis auf 2m50 am Kämpfer herunter zu gehen ist unmöglich, es gibt zu grosse Zugspannungen. Die Betrerr. & deutschen Bauten sind nicht massgebend, die Franzosen, die viel mehr Erfahrung haben, füllen das letzte Gewölbe fast immer wagrecht ab. Es zeigt sich, dass man mit etwa 2m70 noch auskäme, wie in beiliegender Zeichnung angedeutet. Mit 2m50 käme man nur aus, wenn man Korbbogen wählen würde, was meiner Ansicht nach das beste gewesen wäre, ich denke nicht dass dadurch die Aesthetik in den Bergen beleidigt worden wäre. Aber zur nochmaligen Umrechnung wird kaum Zeit sein, auch wenn Sie noch Lust hätten?

Welchen von den drei Auswegen ziehen Sie nun vor:

1) Gewölbfuss 2m 70 bei [illegible].

2) wagrecht Abgleichung des letzten Zwickels, im Gewölbverband natürlich bis etwa ein 2m 70 Breite. (dies weniger schön in Form, in der Ansicht könnte man eine Gewölbstärke von bescheidener Breite heucheln.)

3) Korbbogen mit 2m 50 Stärke.

Welchen Antrag meinerseits würden Sie vorziehen? Die Stärke von 2.70 ist jedenfalls nicht mehr hässlich; wenn Sie Auftrag zur genauern Neurechnung geben, als es von meiner Seite aus geschehen konnte, kann vielleicht auch noch auf 2.60 herunter gegangen werden.*

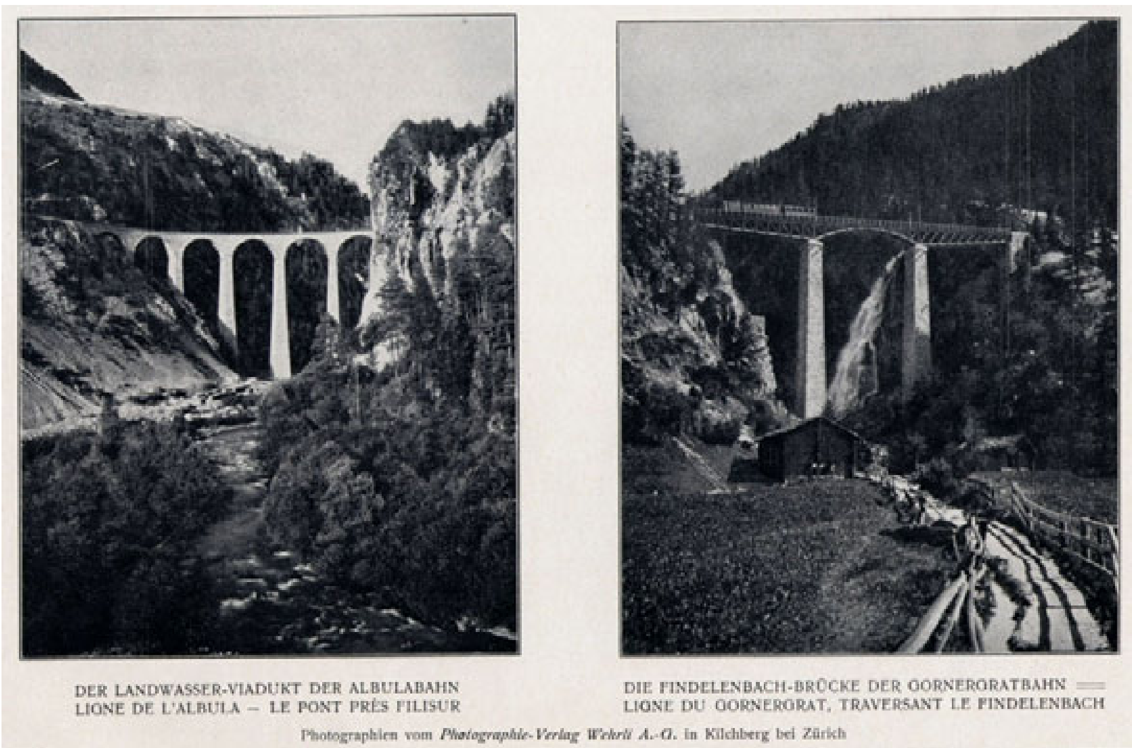
Hochachtungsvoll

Zeichnung gefl. zurück.

G. Mantel

* Aus Interpolation für die Spannungen von 3,00m, 2,70m 2,20m würde sogar folgen, dass noch 2m 50 genügen würden, doch ist das zu unsicher & müsste durch Korrektur der letzt vorgewiesenen Rechnung wirklich begründet werden.

In a letter of 30th May 1901, the engineering expert Gustav Mantel from the Transport Office advised the senior engineer Friedrich Hennings to adapt the arches of the Solis Viaduct to the line of pressure.



Cross comparison in the zero edition of the "Heimatschutz" (1905/1906). The Landwasser Viaduct on the Albula line as "good" example and the Findelenbach bridge on the Gornergrat Railway as "bad" example.

1900 for aesthetic reasons. In parallel to the use of the modern theory of elasticity, a last "artistic intent in a struggle with utilitarian purposes" (Alois Riegl) can be traced here on the part of the engineer.

National Heritage and National Romanticism

The Bündnerische Vereinigung für Heimatschutz (Graubünden Heritage Society) was founded in 1905. The organisation was not limited only to preserving popular culture and natural beauty, but also called vehemently for "education for the appreciation of beauty" and in this context for the renewal of Graubünden's architecture. The canton's leading architects Nicolaus Hartmann junior, Emil Sulser, Martin Schäfer and Otto Risch, as well as engineers Achilles Schucan and Gustav Bener were members of the Association. The magazine "Heimatschutz" (Heritage Conservation) published by the Swiss Heritage Society, the umbrella organisation of all local preservation groups active in Switzerland, on several occasions contrasted the bridges of the Albula railway as "good" examples compared with the "bad" iron bridges. In the issue of January 1913, Jules Coulin pondered with reference to the Rhaetian Railway on the "magnificent local preservation work of a railway company": "The secret of the great impact that ultimately brings honour not only to the company but to its narrower and broader homeland, lies in the individualised treatment of the various technical and architectural challenges. Dedication to the finest ways of treating materials, the rhythm of form and characteristic building methods has led to the viaducts and bridges of the Rhaetian Railway representing not only marvels of technology but also of good taste for all time […]".

The heritage conservation movement was a part of a general cultural mood known as national Romanticism (cf. 2.a.5). The "national art in a good modern spirit", that Richard Kuder called for in 1900 with reference to the Scandinavian countries, was expressed simultaneously in painting, literature, architecture and now also in bridge construction. Typical features of national Romantic architecture were a preference for regional materials and artisan traditions, compact proportions and restrained mass impacts, but also "the spirit of objective design". In the bridge construction for the Albula and Bernina railways, not only does the preference for stone point to the Romantic movement, the elaboration of the details also shows affinities with it. Sentences such as "they seek to bring out the effect of piled-up masses and undisguised material […]. Bare walls rather than façades in a scenic style, rich and delicate details only where necessary on significant points as a contrast to large areas", that J.J. Tikkanen expressed in the Swiss construction magazine of 1906 with reference to Helsinki's main railway station, read like a program for designing the stone viaducts of the railway lines described here. Here lies the key to the unusually strong formal reference of the bridge construction practice of the time to the contemporary architecture of Graubünden, but it also underscores the importance of finishing the upper parts of the viaducts with cover panels and corbels that can also be read as "rich and delicate detail" with an ornamental effect.

Impact

In the years between the construction of the Albula railway and the First World War, the bridges along newly laid railway lines ever more frequently took the form of stone viaducts: there are stone bridges on the Engadin line of the Rhaetian Railway, the Chur – Arosa railway, the

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DIE RHÄTISCHE BAHN.

DER achte Jahrgang unserer Zeitschrift wird heute mit einer Veröffentlichung begonnen, die ganz der grossartigen Heimatschutzarbeit einer Bahngesellschaft gewidmet ist. Noch vor wenigen Jahrzehnten wäre es kaum denkbar gewesen, dass ein verkehrstechnisches Unternehmen die Eigenart der Landschaft, den Charakter ihres Baustiles in ganz eingehender Weise berücksichtigte. Ebensowenig hätte man daran gedacht, dass Heimatfreunde, denen die Schönheit des Vaterlandes und die Erhaltung seiner Natur- und Kunstdenkmäler eine Herzenssache ist, das Walten modernster Technik in ihren mannigfachen Erscheinungen freudig begrüssten. Es ist gar noch nicht so lange Zeit her, dass die englischen Reformatoren des Kunstgewerbes und des volkstümlichen Kunstgeschmackes — ein Ruskin und W. Morris — nicht nur alle maschinelle Arbeit verpönten, sondern auch der Eisenbahn grundsätzlich den Krieg erklärten; Morris hätte die Waren, die aus seinen Werkstätten kamen, nicht einmal einer Bahn anvertraut; er liess sie zu Wagen in die Stadt befördern. Das war zu jener Zeit, wo Technik und

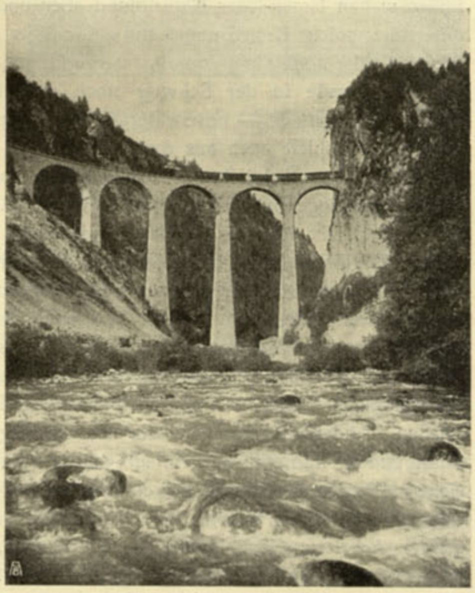


Abb. 1. Viadukt der Albulabahn bei Filisur. Eines der elegantesten und zugleich grossartigsten technischen Werke aller Zeiten. Aufnahme von *Wehrli A.-G.*, Kilchberg-Zürich. — *Fig. 1.* Le viaduc du chemin de fer de l'Albula, près de Filisur. Une des plus élégantes et en même temps des plus grandioses constructions industrielles de tous les temps.

1

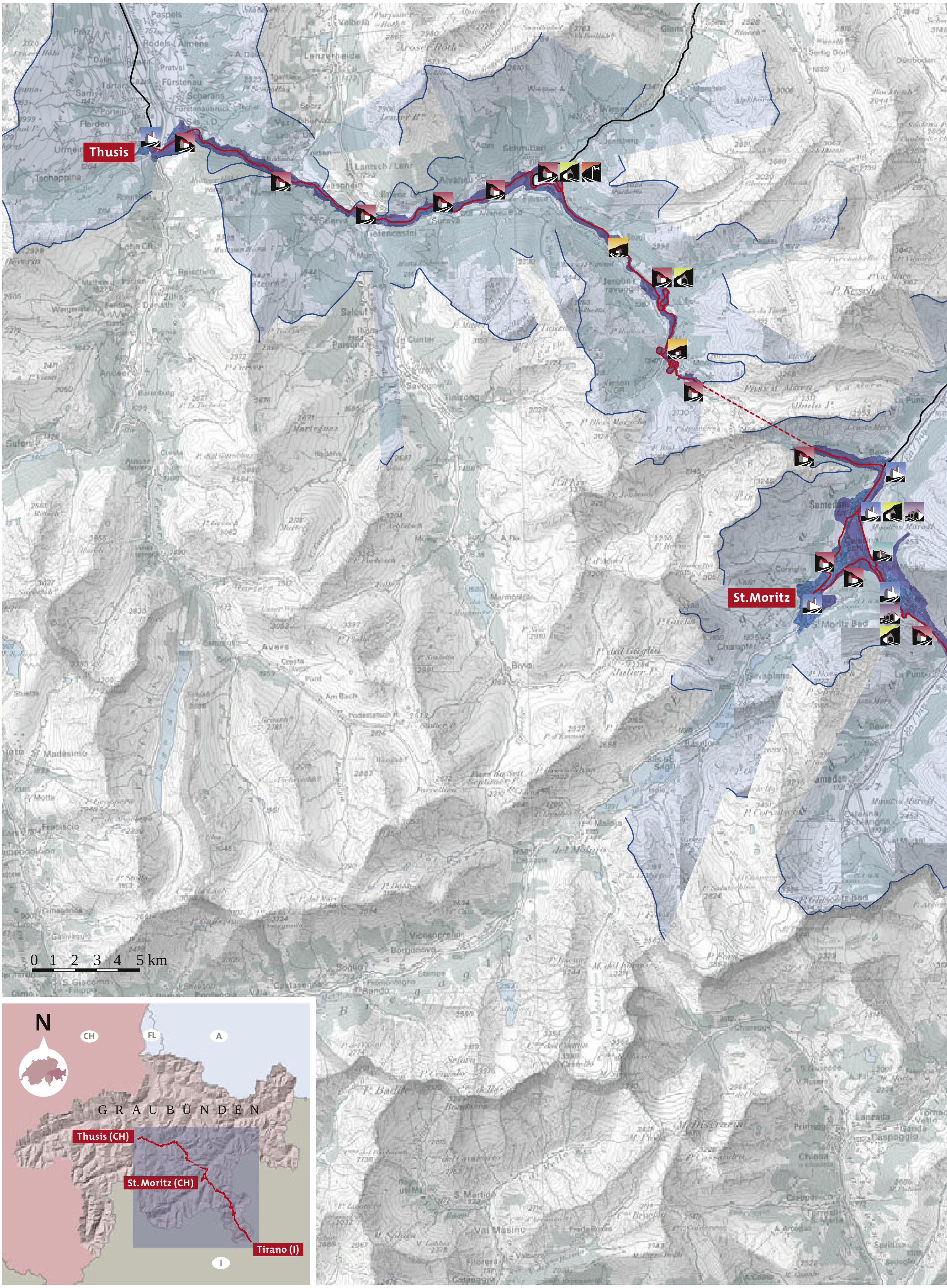
The Swiss Heritage Society "eulogy" on the Rhaetian Railway buildings and installations.

Lake Constance – Toggenburg railway and on the Centovallina line. A large number of stone bridges were also built on international transit routes such as the Lötschberg and Tauern railway. These bridges usually corresponded down to their details to the types on the Albula railway. However, the experience gained in the construction of larger stone arches could also be transferred to concrete as a building material. The concept of elevated concrete arch bridges was taken over from stone construction. One line of development leads from the Solis viaduct (semicircular arch) via the Wiesen viaduct (line-of-thrust arch with concrete blocks) to the Langwies viaduct (line-of-thrust arch with two edgewise concrete ribs).

After the First World War, stone increasingly gave way to the less expensive concrete. However, it continued to be used for bridges with a claim to national importance. The bridge-rebuilding work on the Gotthard railway used stone (or at least stone facing) from 1920. The same applies to the bridges of the Susten pass road (opened in 1946) and the new Devil's Bridge in the Schöllenen gorge (1956).

These stone viaducts have remained well preserved for a century where the terrain has not moved too strongly. Today, the sealing of their arches is in most cases no longer intact and there are signs of frost damage. Repair of the stone viaducts while retaining their architectural character represents a major challenge for the years to come (cf. 4.a.1).

Bernina line > The Alp Grüm reception building and mountain guesthouse by Nicolaus Hartmann the younger, built 1923.
T. Keller


Thusis
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N
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GRAUBÜNDEN
Thusis (CH)
St.Moritz (CH)
Tirano (I)
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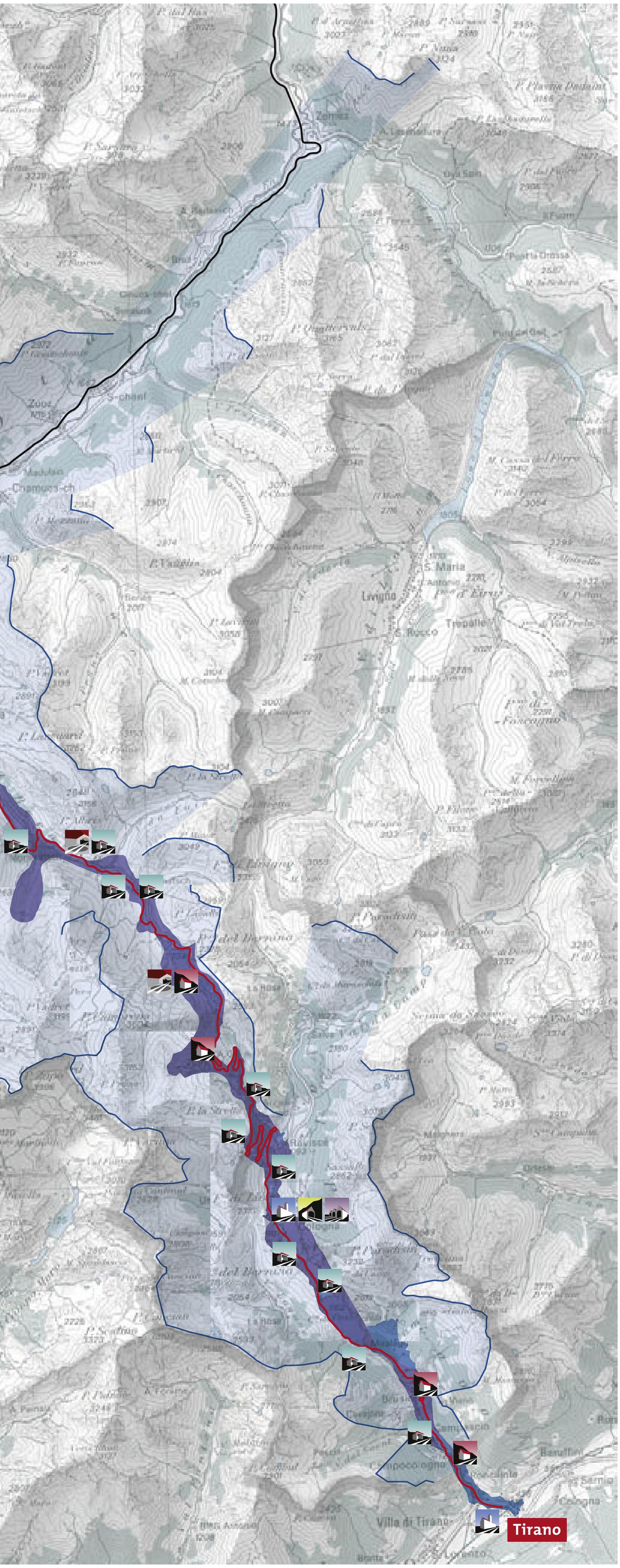


Structures on the Albula and Bernina line

Larger reception building

Medium-size reception building

Small reception building

Linesman’s hut

Shed

Workshop

Covered turntable

Water crane

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200’000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Leza Dosch
Design: Süsskind, SGD, Chur

2.a.5 Structures on the Albula and Bernina line

The buildings on the Albula and the Bernina railway lines are of special architectural and historic significance as examples of different concepts of traditionalism. The largely standardised buildings along the Albula line were built during the period of the Swiss timber style of architecture. However, during the 1920s the mountain pass area the Bernina line runs through saw the development of an individualised ensemble under the influence of Regionalism and Neoclassicism.

The buildings on the Albula line

The person in charge of the buildings on the Albula section was an architect called Ludwig; nothing more is known about him at this juncture. The buildings along the north side were of timber construction, whilst the reception buildings in the Engadin – apart from the one in Spinas – were in plastered quarry stone. According to the builder, the reason for this difference was not due to architectural considerations but “partly due to the climate and partly to the high price of wood”.

Reception buildings

In its reception buildings the Rhaetian Railway distinguished between larger structures – mostly individually designed for the main stations – and smaller, standardised designs for the intermediate stations. In terms of arrangement and style, the design of the buildings on the intermediate stations on the Albula line was based on the existing structures along the railway line from Landquart to Davos, which was opened between 1889/90. The design and construction were realised by Kuoni & Cie. in Chur who were involved in the construction of chalets all over Switzerland. Their presentation brochure even included a timber-style villa called ‘Tokugawa’, in Japan. Two types of intermediate station had been developed for the section Landquart – Davos, but only one model was used for the Albula line. A long, two-storey square-sawn timber block structure was developed, with a goods room with timber plank walls, available in the two options ‘goods room to right’ and ‘goods room to left’. The construction work was now contracted out to a number of local construction companies.
The intermediate reception building has a floor area of 6 x 15 meters and a roof ridge height of 7.35 meters. It is divided lengthwise into three rooms of equal area, the waiting room, station office/stairwell and the goods room. The station office is the heart of the building; it opens onto the neighbouring rooms, and is connected with the waiting room by the ticket counter. The station office and stairwell are built over cellars, and the waiting room is furnished with a cylindrical wood-burning stove. The upper storey contains a three-room apartment for the station master and his family. To save space the design has three rooms adjoining each other, without a corridor. The living room has a wood-burning stove, and the kitchen a wood-burning cooking stove. A toilet and an attic storage room extend into the space above the luggage area. The exterior of the building is influenced by efforts to combine the different functions as far as possible into a regular whole. The block structure is mounted on a low, walled plinth. On the longitudinal sides the projections reflect the interior sub-division of the building. The large overhang of the ridged roof functions in part as a platform roof, but has the disadvantage that the apartment’s windows in the eaves of the

Albula line > St. Moritz station. Reception building built 1927.
L. Dosch

Albula line > Bever station. Iron platform roof built by Versell & Cie., Chur.
L. Dosch

Albula line > Spinas reception building, from the trackside.
L. Dosch

roof are in the shade. Windows and doors are surrounded by profiled wood frames. Carved decorative beams emphasise the horizontal, and on the narrow side of the waiting room they frame the station sign. The ridge of the roof is higher than that of the buildings on the intermediate stations on the line to Davos, allowing the buildings to appear less like sheds. Window shutters now appear for the first time in an intermediate station type on the Rhaetian Railway. These give the structure the character of a residential house. With its two symmetrically-arranged high windows and its straight window roofs the narrow side of the waiting room remains true to the ideal of late-classic stone buildings. In an extension of this concept the station in Tiefencastel was given a goods room which was three times as long and a veranda which served as a summer waiting room for the mail service. The intermediate reception building in Celerina with a massive main section and a wooden freight shed extension, and the buildings on the two junction stations at Stugl/Stuls and Muot are special examples. There was no passenger traffic in Muot.

Over the course of time, most of the ten intermediate reception buildings along the Albula line have been substantially modified or extended. The building in Spinas is the one which has most closely retained its original form. The buildings in Sils i. D., Solis, Surava and Alvaneu were given smaller extensions. Thanks to their remote location the buildings on the junction stations of Stugl/Stuls and Muot managed to escape any large-scale alterations.

From the architectural point of view, the reception buildings in Bever, Samedan and St. Moritz can be considered as main railway reception buildings. A primary criterion in this respect is the siting of the goods room as a separate freight shed. The main reception building on the north, or Thusis side, had been constructed as the terminal for the railway line from Landquart as early as 1896; but was obliged to give way to a new building in 1991/92.

The reception buildings in Bever and Samedan were designed as two-storey structures with a false hip-roof and an enlarged attic storey. This type of reception building, which was also used for Ilanz on the upper Rhine, varied only in size. The widely varying ornamentation played a large role, covering the building with features such as corner edgings, cornices and window frames. Another striking feature were the openings on the tympani, with a central palladio motive between two lateral oculi. In functional terms, there was little change to the scheme which had been developed for the two main stations in Davos. On the ground floor the vestibule, cashier's and luggage office are located between the 1st/2nd class waiting room and the 3rd class waiting room. The upper storeys contain residential quarters for station staff. The waiting rooms have wood panelling and are actually designed for visual impact.

The size and greater number of the waiting rooms and the comparatively wide platform roof indicate that a higher passenger volume was expected at these stations than at the intermediate stations.

The roof has an iron framework with cast iron columns supplied by Versell & Cie., a company based in Chur, adding a distinct technical tone to the building. The stout form of the roof with its framing of picturesque wood ornamentation provides a contrast, while the building itself is structured in line with the conventions of late classicism.

The general form of the reception building in Bever is still well preserved, but the ornamentation was removed during improvement work. In 1983 the building in Samedan was obliged to give way to a new structure.

The first reception building in St. Moritz was designed to a larger and richer scale than the reception buildings in Bever and Samedan. The arrangement of the ground floor and the use of the

Albula line > Stugl/Stuls station. A unique, complex of historic buildings with linesman's hut, station fountain, lavatories and reception building.
L. Dosch

Albula line > Stugl/Stuls station. Passenger lavatory.
L. Dosch

upper floors for residential purposes was in line with the established scheme but from the outside the building appeared as a grand structure in three parts. Two cross-tracts with false hip-roofs flanked a flat-roofed connecting element. The facility was enlarged in 1909 and 1912. With a view to the Winter Olympics of 1928, in 1927 the important Swiss regionalist Nicolaus Hartmann the younger carried out an extensive conversion which gave the reception building a new architecture. Since then a symbol of the St. Moritz railway station has been the asymmetrically situated clock tower – probably in homage to the Badischen Bahnof in Basel (1913) designed by Karl Moser and the main railway station in Helsinki (1912/13) designed by Eliel Saarinen. A spectacular feature from the very beginning was the electrically illuminated clock faces with their diameter of 3.4 meters. The reception building was converted and extended in 1986 and 2002.

Small buildings, workers' houses, workshops and sheds

On the smaller stations a separate timber-built lavatory for the passengers was constructed at some distance from the main reception building. Type A included a urinal, one toilet for men and one for women. Type B included a urinal, one toilet for men and two toilets for women. The entrances are hidden by a wooden wall. The passenger lavatories in Stugl/Stuls and in Spinas are well preserved (type A). In the main stations the lavatories were integrated into the reception building.

The small buildings category also includes the linesman's huts which were erected at a number of different locations. These are timber buildings with a pitch roof on a base area of 2.5 x 3.2 meters. These temporary quarters were provided with a stove, a table, a bed and a cupboard. Examples which present a well-preserved overall appearance can still be found at the railway stations in Sils i. D., Tiefencastel, Filisur, Bergün/Bravuogn and Samedan, and at the stations between Celerina and St. Moritz. A double-unit linesman's hut is located between Muot and Preda.

Houses located along the whole line were used as permanent accommodation for the section linesmen and their families, and these had to meet higher, if still very modest, standards. Known as linesman's houses, these were built as block structures with a stall for small animals built on; examples can still be found in Stugl/Stuls, Bergün/Bravuogn, Preda, Spinas, Bever (2 buildings) and Celerina. The stalls (also built by the Rhaetian Railway at isolated stations) and the kitchen gardens in front of the houses provided the inhabitants with the necessary infrastructure to allow a certain degree of self-sufficiency.

The station in Stugl/Stuls presents a special situation; here a group of buildings has been preserved which is of some importance in terms of railway history. The reception building here is modelled on the lines of an enlarged linesman's house; with the actual linesman's house located to the northwest. The group also includes an accommodation building for workers with a front garden, a wash-house, a lavatory for passengers and a more recent station well, made in artificial stone. The preserved accommodation building bears witness to the temporary architecture of the pioneering days, similar to those which existed in larger numbers in Preda and Spinas on both sides of the Albula tunnel. When this tunnel was being built the huts in Stuls were used as accommodation for workers; later, two-thirds of the building was relocated here. From 1910 the simple structure served for some years as a schoolhouse for the few children of the station in Stuls, whilst during the construction of the power station (cf. 2.b.7) it was used as a canteen.

Besides linesman's houses and other timber accommodation buildings for workers, the Rhaetian

Bernina line > Alp Grüm reception building and guest house, 1923.
L. Dosch

Albula line > Linesman's hut and water crane at Filisur station.
L. Dosch

Albula line > Five apartment house built by the Rhaetian Railway in Filisur, 1913.
L. Dosch

Railway also arranged for the construction of larger and more robust staff houses. In this context, some years after the construction of the railway, the Albula section saw the building of some important examples of regionalism – in Samedan the section engineer's house (1907) designed by Nicolaus Hartmann, in Filisur the five-family residential building by Ulrich Lys and the section engineer's house by Meinrad Lorenz (both 1913). Two staff houses above the St. Moritz railway station date from the period around 1904. The four 6-family buildings and two 12-family buildings in the Samedan railway station district built between 1904 and 1914 and the houses in the railway settlement of Ariefa (1913/1914) in the same town have now been replaced by new buildings.

The Rhaetian Railway's main workshops are located in Landquart. A depot with ancillary workshops was constructed in Samedan as part of the construction of the Albula line. The initial facility was substantially extended in view of the construction of the railway line between Bever and Scuol, opened in 1913, and was replaced by new buildings in 1982/83. A wagon and engine shed was built in Samedan around 1903. There were sheds at all the medium-sized and larger stations; those in Filisur and Bergün/Bravuogn have been preserved. The Filisur station depot yard also has a water crane to supply the steam locomotives. Other water cranes are found in Tiefencastel, Bergün/Bravuogn, Muot and Samedan.

The buildings on the Bernina line

Reception buildings

The line from St. Moritz to Tirano was the only section on Graubünden's narrow gauge network that did not have any intermediate station types. The reception buildings were constructed in two main phases. When the line was opened in 1910 the buildings available were very modest. At that time Bernina Hospiz, Poschiavo, Brusio and Campocologno (with post and customs) had reception buildings with office, goods room and apartment. The stations in Celerina-Staz, Surovas, Morteratsch, Bernina Suot (Berninahäuser), Alp Grüm, Cavaglia, Cadera and Campascio only had waiting rooms, in some cases with ticket counters and luggage rooms. In St. Moritz and Pontresina the Bernina line was allowed to share use of the reception buildings belonging to the Rhaetian Railway, whilst in Tirano they contributed to the construction of the reception building for the Alta-Valtellina railway (1909).

The most important period for the railway reception buildings on the Bernina line was the 1920s. In the North, in Celerina-Staz and Surovas, the company arranged for rustic chalets to be constructed whilst in the South, in Tirano, they constructed a reception building of their own – an urban facility in the Italian Liberty and Art Déco styles (1920). For the mountain pass area the architect Nicolaus Hartmann constructed new buildings and extended existing buildings, creating an ensemble of architecturally important work. In Bernina Suot , a staff house constructed ten years earlier by Hartmann to a design based on the "Engadin farmhouse type" (cf. 2.a.6), was converted into the reception building in 1922. In 1927 the building was given an extension, and was demolished in 1992. Today a linesman's cottage stands in its place. In 1923 Hartmann's reception building and mountain guest house in Alp Grüm was constructed as a monumental new building with a hip roof. It is located at a point which has a magnificent view towards the Palü glacier. An additional balcony which is aligned towards the natural panorama has a thin reinforced concrete slab and an elegantly curved iron railing that hints at the technical possibilities offered by the emerging Modern style. The mountain and station

Bernina line > Bernina Hospiz. Group of buildings built 1925/26: covered turntable, driveway and converter station. On the right, the official's house built in 1912.
L. Dosch

Bernina line > Bernina Hospiz. Driveway through the group of buildings built 1925/26.
L. Dosch

Bernina line > Bernina Hospiz reception building, 1925.
L. Dosch

side on the other hand are completely influenced by the sober appearance of the exposed stone masonry and the large semicircular arches of the ground floor. Natural stone block window ledges increase the oppressive feeling. The preceding polygonal stair tower, the smaller tower on the valley side and the two powerful chimneys enrich the silhouette of the neoclassical building, giving it something of the appearance of a fort. In 1925 Nicolaus Hartmann extended the reception building in Bernina Hospiz and created a severe neoclassical facility with lateral risalits, beam-like cornices and a flat triangular gable. The alignment of the gable on the track side led to an overwide building form. More striking than the neoclassic detail, is the use of quarry stone here for the façades.

The work of the architects Otto Schäfer and Emil Sulser takes a key place in architectural history. The reception building in Pontresina on the Bernina section was constructed in 1906/07, but by the Rhaetian Railway and not by what was then the private Bernina Railway. It is one of the largest reception buildings in Graubünden and at the same time marks the transfer from late classicism to an architecture which is more closely oriented towards giving a picturesque impression. From the viewpoint of railway history more importance is given to the goods room and goods transport than in St. Moritz and Samedan. The rooms were no longer so strictly aligned in terms of symmetry but were rather arranged to meet practical requirements. The exterior shows a certain degree of indecisiveness between schematic symmetry and free rhythm. Two cross gables on the track side represent the old method for sub-dividing a large volume, as applied in St. Moritz. But above this there now appears an extensive and centralising roof landscape with hip roofs which culminates in a small clock tower. Picturesque motives are also provided by the large semicircular arches of the ground floor, the windows of the upper floors which are arranged in pairs, and the baroque bat-shaped dormers of the roof. The lightly embossed natural stone rusticated masonry of the ground floor is lively and deliberately irregular. The original platform roofing on the track side of the reception building – fine, cast-iron columns with tori and goblet-shaped capitals support an iron framework – has also been preserved.

Two larger reception buildings were constructed following the incorporation of the Bernina line into the Rhaetian Railway in 1914, namely the new reception building in Campocologno in 1948, with rooms for the railway and for the Swiss customs (architect: Arnold Rietmann, St. Moritz) and the reception building in Poschiavo in 1962 (architect: Theodor Hartmann, Chur).

The longitudinal structure erected in Campocologno with its oculi and the slightly projecting hip roof seems inspired by models from the Italian Baroque, such as can be found in nearby Tirano. For the iconography of railway and customs, the mural by Paul Held with its representation of a traveller heading for Rome is of importance.

Staff houses, workshops and sheds

In 1912 a staff house was built in both Bernina Suot and Bernina Hospiz to plans prepared by Nicolaus Hartmann, based on the lines of the "Engadin farmhouse". As explained, the former was converted to the main reception building whilst the latter, with its connecting stones jutting into space, still shows evidence of a planned but not completed extension. In 1911 Hartmann, working on behalf of the Bernina line, constructed the railway settlement of Cuntschett not far from the railway station in Pontresina. It consists of three, 6-family houses with vegetable gardens. The architecture was designed when regionalism was at its peak and is surprisingly practical. The only picturesque motifs can be

Pontresina > Cuntschett railway settlement, built 1911.
L. Dosch

Pontresina > Reception building built 1906/07.
L. Dosch

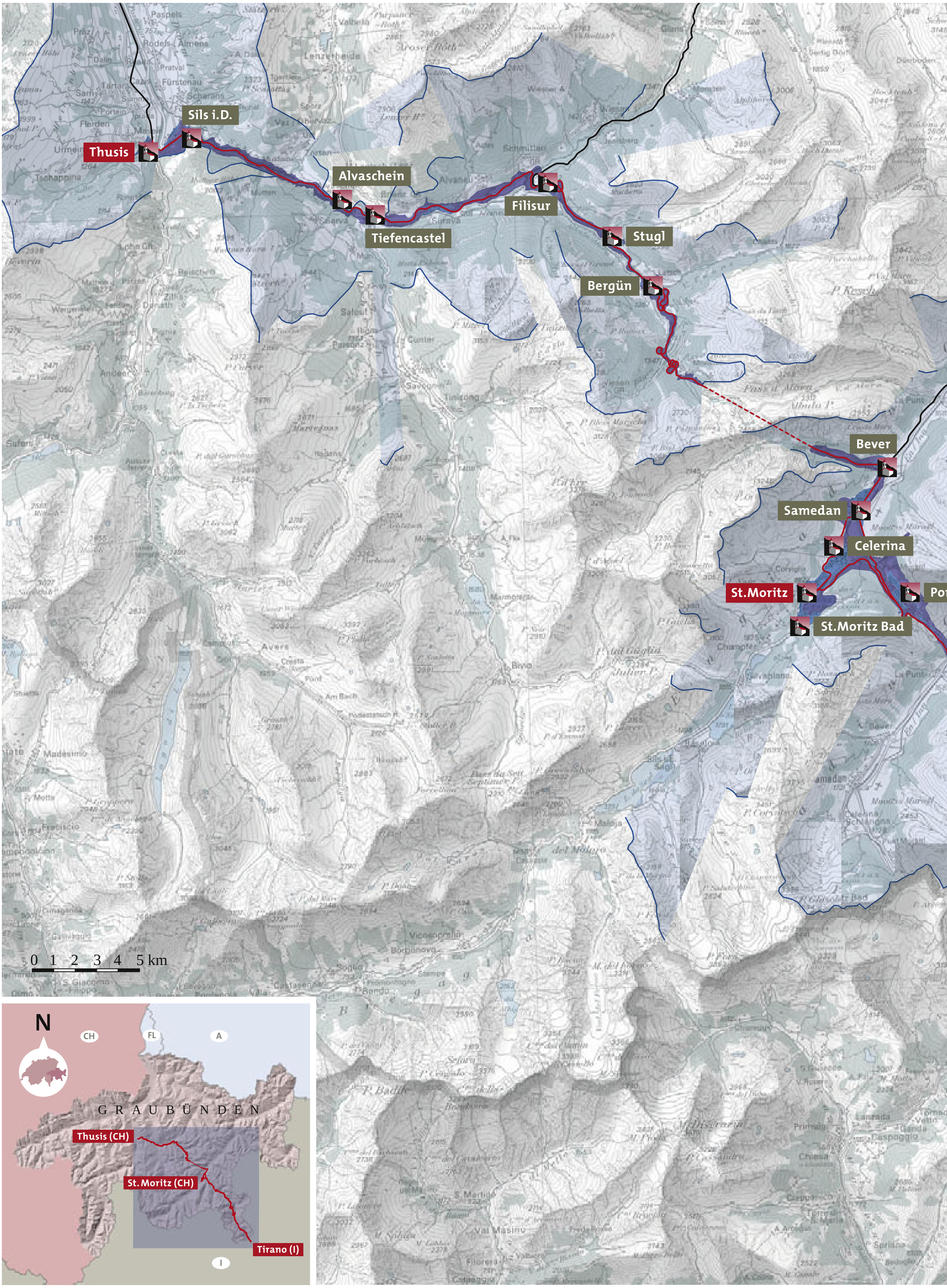
Bernina line > Reception and customs building Campocologno, 1948. Mural by Paul Held: Rome traveller.
L. Dosch

seen in the siting of the third house before the alignment of the two others, in the archway between the houses and in the curved windows under the eaves. The workers' houses issue, then much debated in the urban context, appears to have forced the rural connections into the background here.
The railway company had wagon sheds constructed in Pontresina, Poschiavo and Tirano. In Pontresina and Poschiavo these were linked to a repair workshop and storerooms. In the 1920s both Bernina Suot and Bernina Hospiz were given a covered turntable. At the Hospiz station this is linked to a group of buildings which were based on an extension dating from 1925/26, from the mountain to the lake-side transformer station, followed by a through passage for the train and then by the turntable. Maintained using the 'pietra rasa' technique, these structures together with the reception building in exposed stonework and the plastered staff house, form a distinctive ensemble in terms of railway history on the Lago Bianco.

Appraisal

The buildings on the north side of the Albula line follow the ideal of the 'Swiss Chalet', a concept 'coined' by the English implying the traditional Bernese Oberland farmhouse style. In the 19th century, and in Switzerland itself around 1900, this 'Schweizer Holzstil' ('Swiss timber style') had itself become a trademark for tourist-related and exhibition architecture. However, the fact that the main railway reception buildings were constructed in stone agrees with the general requirements of the time for prestige buildings.
Between the construction of the Albula line and that of the Bernina railway lies the development of a style of construction which is based on picturesque forms and which preferred to find its ideals in the traditional architecture of the farmhouse. This development is an international phenomenon, one which in northern countries such as Finland is described as 'National Romantic' and in Switzerland as 'Heimatstil' ('Homeland' style) or 'Regionalism'. In contrast to the Swiss Chalet style this regionally varying concept found a great echo, particularly in railway architecture. Important examples of this are the smaller buildings of the Württemberg State Railway constructed shortly before the First World War, the reception buildings of the Bodensee – Toggenburg Railway, the reception buildings on the lines between Ilanz–Disentis (1912) und Bever–Scuol (1913) on the Rhaetian Railway and the reception buildings of the Chur – Arosa Railway (1914).
Constructed in the later part of the early Regionalism period, the buildings of the Bernina railway from the 1920s in Graubünden can be split into the chalets and Engadin houses of the north side and in the stone buildings with their rudimentary appearance in the area of the mountain passes. This difference can certainly be seen as an architectural programme. Nicolaus Hartmann's buildings in the highest reaches of the Bernina railway, with their exposed stone masonry and the plastering in pietra rasa are based on the local alpine buildings and mountain huts. In so doing they also continue the architect's line of creativity established with the Segantini Museum in St. Moritz (1908), a rotunda in raw granite. In general the stone façades in the mountain landscape give the impression that they have grown up out of the ground. Hartmann was able to find analogies in the dry stonework of the domed milk cellars of the Poschiavo valley (cf. 2.b.4). This stone architecture provides an impressive setting for the passage of a railway line from northern into southern Europe. The high alpine ensemble is rounded off by the power stations in Palü and Cavaglia designed by Hartmann (1927; cf. 2.b.7), which are not far from the railway line.

Alvaschein-Mistail > The Carolingian church of St. Peter with the characteristic three-apse ground plan. The former stonework bell yoke can still be recognised in the east gable, which was raised at a later date (the tower dates from the early 14th century).
E. Süsskind


Thusis
Sils i.D.
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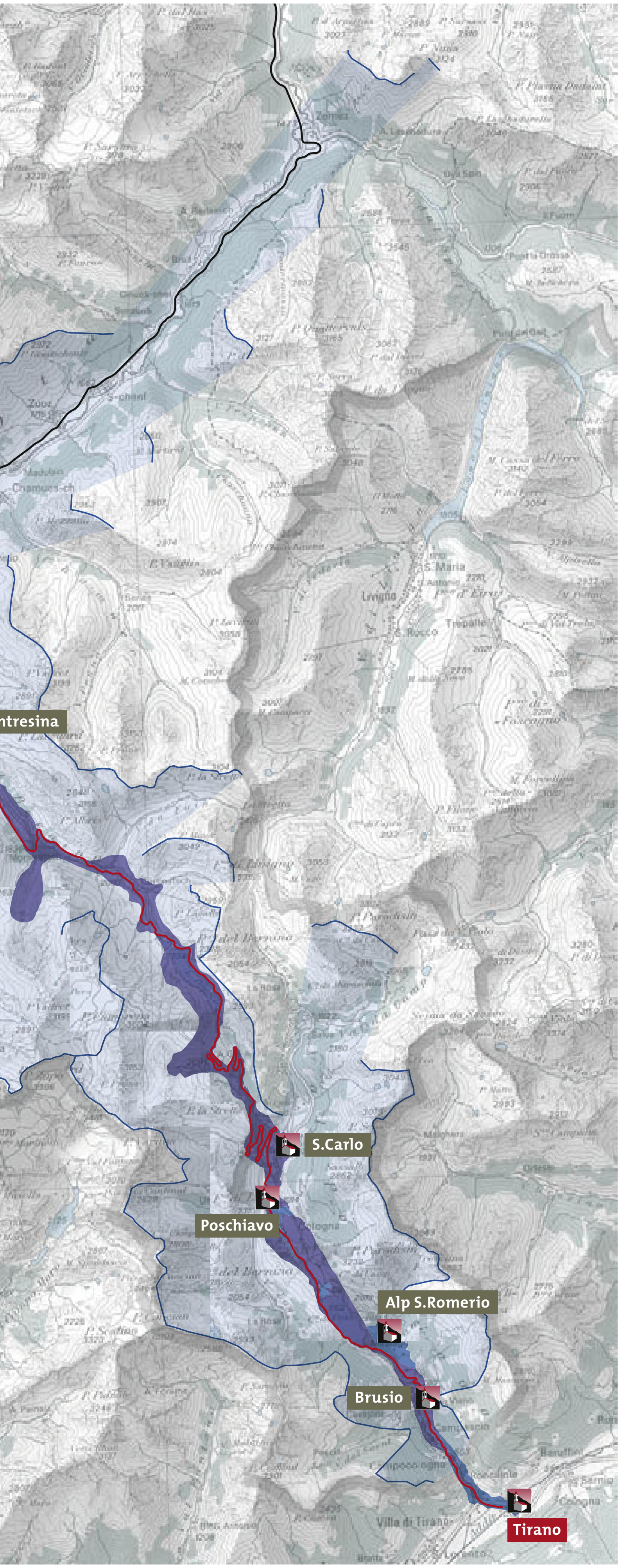

Sacred buildings along the Albula and Bernina line (selection)

Churches and chapels

Thusis	Protestant Church
Sils. i. D.	S. Cassian, Church of the Holy Sepulchre
	Church at Hohenrätien
Alvaschein-Mistail	St. Peter's Church
Tiefencastel	St. Stephan, Catholic parish church
Filisur	Protestant Church
Bergün/Bravuogn	Protestant Church
Stugl/Stuls	Protestant Church
Bever	Protestant Church
Samedan	St. Peter's, Church of the Holy Sepulchre
	Protestant Church, in the village
	Catholic Sacred Heart Parish Church
Celerina	"Bel Taimpel" Protestant Church
	San Gian Protestant Church.
	Sta. Maria Protestant Church in Crasta
St. Moritz	Former St. Mauritius (S. Murezzan) Church
St. Moritz-Bad	Former English Church (today Protestant Badkirche)
	Former French Church (today Protestant Church)
	St. Karl Badkirche Catholic Church
Pontresina	Sta. Maria, Church of the Holy Sepulchre
	Protestant Church, in the village
S. Carlo	San Carlo Borromeo Catholic Parish Church
Poschiavo	S. Vittore Collegiate Church
	Oratorio Sant'Anna.
	S. Pietro Chapel
	S. Maria Assunta Catholic Church
	S. Trinità Protestant Church
Brusio	S. Carlo Borromeo Catholic Parish Church
	Protestant Church
Alp San Romerio	S. Romerio Church
Tirano	Madonna di Tirano, pilgrimage Church
	St. Perpetua's Church
	St. Martin's Church
	St. Peter's Oratory
	St. Rocco's Church

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Ludmilla Seifert
Design: Süsskind, SGD, Chur
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2.a.6 The sacred and secular buildings along the Albula and Bernina line

The various cultural areas along the Albula and Bernina line provide a rich treasury of buildings from the medieval, early modern and modern periods. Taken as a whole, they reflect the cultural and economic history of the valleys traversed by the trains in a graphic and impressive way. A wide variety of types of both sacred and secular buildings are represented. The openness of this transit region to artistic influences from the South and North, West and East, and even from the Orient, is particularly tangible in the churches and their interiors.

Graubünden (Switzerland)

Sacred buildings

Early medieval to Romanesque

The church of Mistail, dedicated to St. Peter, stands alone and impressive on a rocky plateau above the Albula gorge; it is the oldest sacred building on the Albula/Bernina line whose original substance has been largely preserved. Built around 775, it was part of a monastery complex dating from the early 8th century. Besides its spiritual and cultural duties, the monastery assumed functions in connection with the Alpine transit traffic, as the Roman road from Chur to the Septimer and Julier passes crossed the east-west route through the Schin gorge near the monastery (cf. 2.b.3). St. Peter's Mistail has great importance for the history of art as the sole example of a three-apse church that has been preserved without alterations in the whole of Switzerland. The term describes a type of layout where three virtually equivalent apses prolong a rectangular nave. Although archaeological excavations have found traces of it in several places in Graubünden, standing walls have been preserved only in Mistail and Müstair. The convent church of Müstair – on the UNESCO World Heritage List since 1983 – is somewhat larger than that in Mistail, which was built about the same time but whose interior is dominated largely by late Gothic renovations.
Today, the three-apse interior characterises the concept of sacred architecture in Graubünden at the time of Charlemagne like no other type of building. However, the majority of sacred buildings erected since the 7th/8th centuries, when a comprehensive parish system was established, did not follow this pattern, which was imported from the Adriatic and apparently reserved for larger monasteries and parish churches. They tended to have conventional ground plans from the pre-Carolingian period: single-aisled churches without an apse, with a simple or narrowed apse or an apse integrated in the wall block. A sacred building from the period of early Christianisation of Rhaetia (5th century), recently excavated within the confines of the Hohenrätien fortress complex above Sils i.D., displays a rectangular hall, a baptistery added in the 5th/6th century as well as a hall construction with a cladded apse and an octagonal font. It is one of the earliest of its kind and suggests links to northern Italy.
The increase in population during the High Middle Ages and the expansion of the Swiss frontiers in the 12th / 13th centuries occurred parallel to a process of detachment in which smaller church groups broke away from the large parishes of the early medieval period. The

Sils i.D. > The recently excavated 5th/ 6th century font on Hohenrhätien.
Archäologischer Dienst Graubünden, Chur

Sils i.D. > The church of San Cassian stands in an exposed position outside the settlement, characteristic for the rural churches of the Romanesque period in Graubünden.
A. Badrutt

Brusio > The Romanesque monastery church of San Romerio on a rock terrace, with a precipitous fall of 900 m to the Lago di Poschiavo.
Unknown

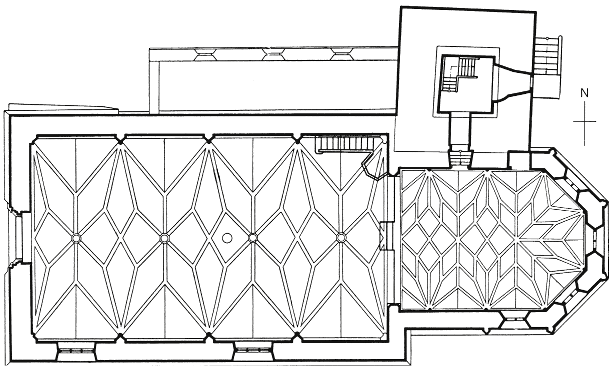
Samedan > The church of St. Peter, situated above the old settlement nucleus, with its striking Romanesque tower. The nave and chancel are Late Gothic.
Ch. Meisser/ Staatsarchiv, Chur

Poschiavo > Collegiate church of San Vittore. The tower (the upper storey was added later) reflects the Romanesque origin of this church, which was converted in the Late Gothic period.
Denkmalpflege Graubünden, Chur

Celerina > San Gian Protestant church. The small Romanesque tower is from period when the church was built, the massive tower behind it from the significant Late Gothic conversion.
Denkmalpflege Graubünden, Chur

Bergün/Bravuogn > Protestant church. Late Gothic panelled ceiling with elaborate decorative painting about 1500; Renaissance frescoes along the walls of the nave.
R. Pedetti

Celerina > San Gian Protestant church. Late Gothic panelled ceiling dated 1478, about the same time as the frescoes on the wall of the chancel vault and in the apse.
Denkmalpflege Graubünden, Chur



Thusis > Protestant church. Nave and polygonal chancel; this uniform Late Gothic ensemble built between 1491 and 1506; elaborate sculpted figures adorn the vaults.
Gesellschaft für Schweizerische Kunstgeschichte, Berne

resulting boom in church building was characterised by a tenacious attachment to elementary ground plans. Thus on Hohenrätien, the Romanesque church replaced its early medieval predecessor: it has a rectangular, flat covered nave and a flush-finished chancel with groined vault. St. Cassian's church above Sils i.D. is of the same type. S. Pietro chapel near Poschiavo, built during the same period, has the same ground plan with a single nave and a narrowed semicircular apse, whereas the Stugl/Stuls chapel above Bergün/Bravuogn represents the earliest rectangular form. In its original state, it was without a chancel. Where later periods have obscured the character of the building work that took place during the High Middle Ages, often only the towers hint at new building or conversions during the Romanesque period, for example in the churches at Filisur, Bergün / Bravuogn, Samedan (St. Peter), Celerina (Sta. Maria in Crasta and S. Gian), St. Moritz (S. Murezzan), Pontresina (Sta. Maria), Poschiavo (S. Vittore) and S. Romerio above Brusio. Only from the 11th/12th centuries did church towers begin to appear in place of the old bell yokes. These towers, with their slim proportions, blind arcades and round-arched windows linked in rhythmic groups, recall the campaniles of northern Italy. If the sacred Romanesque buildings remain modest in their architectural appearance, in many instances they acquire a monumental effect thanks to their exposed and commanding position in the landscape. Striking examples are the little monastery church of S. Romerio, built on a rocky outcrop 900 m above the lake of Poschiavo, and the churches set apart from the heart of the settlements of St. Peter above Samedan, S. Gian at Celerina and S. Cassian at Sils i.D.

Late Gothic

Romanesque features were not completely ousted from European architecture until the second half of the 15th century. In the course of a striking wave of reconstruction, numerous sacred buildings were remodelled between 1450 and 1525 with an orientation to the Gothic style. The initiators of this building activity were the communities who used the conversion of their churches in a new or contemporary style to express their greater autonomy vis-à-vis the feudal nobility and the bishopric or even to assure their rights (cf. 2.b.2) – the late Gothic features were introduced by Austrian master builders and stonemasons. The churches of Thusis (1491 – 1506), Samedan (St. Peter, 1491/1492) and Poschiavo (collegiate church, 1497/1503) show, each in their own way, the ideal-typical form of a late Gothic church in our region, with a rectangular nave and a narrowed chancel closed on three sides. In these examples, both parts of the interior are decked with reticulated or stellar vaults, though these were not introduced so consistently everywhere. In many places, the new polygonal chancel was terminated elaborately whereas the tradition of the flat wooden ceiling from early Christian or Carolingian times was retained in the nave. S. Gian near Celerina (1478), Sta. Maria above Pontresina (1497) and the village church in Bergün/Bravuogn (about 1500) have particularly impressive timber ceilings: the rich decorative painting, covering both frames and panels, has an almost tapestry-like effect. S. Gian was built in 1478 by a master from the Veltlin at right angles to the previous Romanesque building. It is the only late Gothic church along the route that, with its groin vault, follows a southern architectural tradition from Lombardy rather than the late Gothic canon.

Tiefencastel > St. Stephan Roman Catholic church. An "exemplary" edifice built by the Capuchins in the mid 17th century.
T. Keller

Poschiavo > Sta. Maria Assunta church from about 1700 built outside the Burgo on a site that was then completely free of buildings.
R. Pedetti

Brusio > Protestant church. The Protestant baroque sacred building combines a rectangular nave with a polygonal "chancel" with no narrowing. (Rococo gallery and organ 1786/87, pulpit 1727).
A. Troehler

Bever > Protestant church. The 1665 – 67 Baroque building is designed as a single rectangular room.
A. Troehler

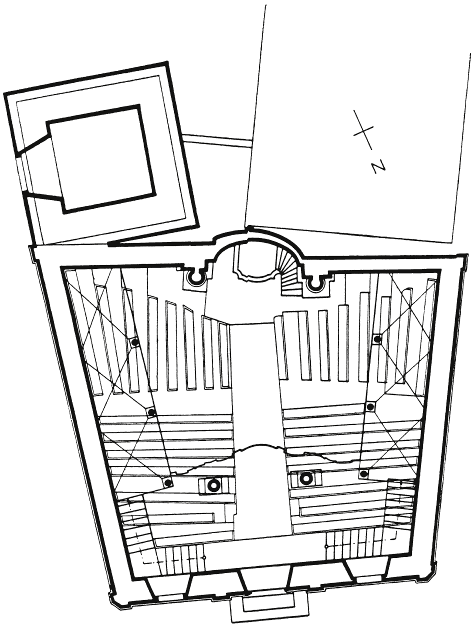
The pointed spire cap of the massive tower, next to the Romanesque campanile, was destroyed by lightning in 1682, giving the whole complex a picturesque appearance.

Baroque

The late-Gothic boom in church building ebbed with the beginning of the Reformation. Only after the end of the Reformation and Post-Reformation upheavals in Graubünden (cf. 2.b.2) did sacred building activity rise, in the second quarter of the 17th century, to a level that can be compared to that in the late Gothic period. This was principally the case in the regions that had remained Catholic, like the Poschiavo valley and the lower part of the Albula valley. In the spirit of the Tridentine reform, building new churches was seen as an expression of the firm centralising hand of the Catholic Church. The religious buildings of the period are consequently characterised by the adoption of Italian Baroque features. The wave of Baroque building was promoted by Capuchin monks from northern Italy who had organised the "missione retica" since 1621 and assumed pastoral duties in these valleys and the surrounding regions. They had the new parish church, dedicated to St. Stephen, built in Tiefencastel, the regional base of the Capuchin mission. It is an exemplary building in the form of a Latin cross, with a monks' chancel and two lateral chapels; a faux façade with a raised tympanum was set before the vaulted nave. Although the sacred structures of the Counter-Reformation are based on standardised liturgical and architectural models, they do not follow a uniform building pattern like the late Gothic parish churches but rather show great diversity according to their function as parish or secondary churches, pilgrimage or roadside chapels. This great diversity can be demonstrated by the two most valuable Baroque buildings in Poschiavo: virtually all sacred buildings were renovated there after the Counter-Reformation. By the addition of two lateral chapels, Sta. Maria Assunta outside Poschiavo, with its dramatic flight of steps, built in 1692 – 1712 in an area then completely free of buildings, grew into a series of three rectangular units resembling a central building, set apart from the exterior by an octagonal crossing tambour. In contrast, the Oratorio Sant'Anna in Poschiavo, built for a community of lay monks and set between two residential buildings, is designed as a purely nave-focussed construction. Three interior expanses with diverse vaults of decreasing heights connect to a grillework arcaded walk to blend into a whole of remarkably harmonious proportions.

Many a Protestant parish was also infected by the Baroque building euphoria: the Protestant church of Pontresina, built in 1640, and the Bel Taimpel in Celerina, built in 1667 – 1669, retain the pre-Reformation pattern with their architectonic separation into nave and chancel; this concept of the ideal sacred space was apparently so firmly rooted that it could be retained even in new non-Catholic structures.

In the Protestant church of Brusio (1645), in contrast, a longitudinal structure enclosed on three sides without narrowing of the chancel demonstrates the determination to pare down nave and chancel to a single unit. Thus a synthesis is achieved between the traditional type with a separate chancel polygon and a simple hall more appropriate to a Protestant service. The majestic Protestant parish church of Poschiavo (1642 – 1653) and the church in Bever built in 1665 – 1667, in part incorporating the previous building, are designed as rectangular halls. The village church of Samedan



Samedan > The Protestant village church, built 1682, is an example of Protestant secular building of the period.
Gesellschaft für Schweizerische Kunstgeschichte, Berne

Samedan > Protestant church. The front façade is highly decorated by Graubünden standards; the polychrome, painted campanile dates from the 18th century.
R. Pedetti

San Carlo > Roman Catholic church of San Carlo Borromeo. Post-Gothic-early Baroque ensemble from the 17th century; the polychrome painted tower has a mortared zigzag roof.
R. Pedetti

Samedan > The Roman Catholic Herz-Jesu or Sacred Heart church from 1910 expresses neo-Romanesque lines reflecting the 'Heimat' tradition.
Engadin Press

can claim to have the most ingenious design of a building designed for Protestant preaching. Built in 1682 on the site of a medieval chapel, the trapeze shape with galleries running along three sides and the interior decked by an umbrella vault is fully oriented to the chancel-apsidiole with a communion table set before it. As in the case of the tall campanile in Samedan, built in 1770 – 1773, the Baroque church towers of both denominations are characterised by lines set off with cornices and pilasters, while the essential octagonal capitals have either low domed or conical roofs or terminate in onion-shaped roofs in the style typical of Austria and southern Germany. Apart from their architectonic ornamentation, Baroque church towers were often characterised by a lively medley of colours that we can now appreciate again since the renovations of the churches in Samedan, Bever, Poschiavo (Protestant church) and San Carlo.

19th/20th centuries

Classicism has left hardly any traces worth mentioning on the sacred buildings in the region. New church buildings came only with the emergence of tourism: an interesting historic ensemble has been preserved in St. Moritz Bad. Besides the former English church (1870/73 with a neo-medieval rubble masonry structure and a tower with a rhomboid roof) there was the French church, built in 1875 – 1877, above the hall where the guests ‘took the waters’ with a façade tower in delicate neo-Gothic and finally, St. Karl’s Catholic spa church, also built by Nicolaus Hartmann the Elder, a three-nave neo-Romanesque basilica with a freestanding campanile. The Catholic parish church of the Sacred Heart in Samedan, built in 1910 by Nicolaus Hartmann the Younger in massive rubble masonry, is a two-nave church with tower, an attached vicarage and authentic attributes. It left the academic neo-Romanesque style behind to approach something like folk art (cf. 2.a.5).

Sacred murals

Murals are among the most important evidence telling us what the earliest churches still in existence originally looked like. The Carolingian church of St. Peter in Mistail was covered in murals throughout but only small elements have been preserved. However, it can be seen that the biblical scenes covering the lateral walls of the nave and apses were, as in the convent church of Müstair, enclosed in a multi-register framework. In contrast, the west wall depicted a monumental Last Judgement – together with that in Müstair the earliest known fresco on this theme. There are also close stylistic links to the frescoes in Müstair, created between 785 and 795, probably in a north Italian studio. The paintings in the sacred buildings along the Albula/Bernina line dating from the High Middle Ages are better preserved. The late-Romanesque layer of painting from about 1230 in Sta. Maria above Pontresina again reveals a south-eastern influence: the three scenes that have been preserved (the Epiphany, Baptism of Christ, Washing of the Feet and Last Supper) are the most westerly example of the Marienberger school active in nearby South Tyrol: it was strongly influenced by Byzantine art, with respect both to iconography and style, following the crusade of 1204. In 1350/60, a school of wandering artists from the southern Tyrol or Verona created the exterior frescoes of the parish church in Bever depicting St. George battling with the dragon, Michael weighing souls and a St. Christopher.

Pontresina > Protestant church of St. Maria. Late Romanesque, with an Epiphany, strongly influenced by Byzantine art, on the west wall.
Denkmalpflege Graubünden, Chur

Alvaschein-Mistail > Church of St. Peter. paintings in the “gotico internazionale” style in the central apse.
Denkmalpflege Graubünden, Chur

Bever > Protestant church. St. George fighting the dragon on the outside west wall 1350/60.
Denkmalpflege Graubünden, Chur

Stugl/Stuls > Protestant church. Painting in the Giotto style, about 1360/70.
W. Roelli

An entirely different world opens up to the observer in the small barrel-vaulted church in Stugl/Stuls, painted in 1360/70 with scenes from the life of Christ and a Majestas Domini. These frescoes painted by wandering artists are directly related to Giotto's murals in the Arena chapel in Padua and, together with those in Sta. Maria Assunta (Brione-Verzasca TI) and Santa Maria dei Ghirli (Campione d'Italia), are the most northerly examples of the Giotto school. The paintings in the central apse and on the north wall of Mistail church, created about 1400, are fine representatives of the soft style also known as gotico internazionale that predominated in European art between 1390 and 1430.

Towards the end of the 15th century, wandering artists from north Italy and southern Tyrol stylistically adhering to the early Italian Renaissance appear in the Albula / Bernina area: particularly noteworthy here are the comprehensive, well-preserved murals in the churches of Sta. Maria in Pontresina (1495) and S. Gian at Celerina (about 1480/90), and particularly a cycle of frescoes painted about 1500 in Bergün / Bravuogn parish church. The painting fields with an Annunciation, a passion cycle and a series of apostles are partly framed by acanthus borders set with rosettes, partly by friezes with medallions of the prophets between garlands of leaves and fruit. The paintings in Filisur church are stylistically related to the Bergün murals. With the Renaissance, the traditional pattern in the apse – mostly a Majestas Domini between evangelists below a row of apostles and an Annunciation on the wall of the chancel vault – was often replaced by freer configurations. An example is found in the little church of S. Pietro by Poschiavo, where a master painter from Lombardy painted a Lamentation of Christ in 1538 in lively colours against a landscape background in the apsidiole, framed by a transverse arch with medallions and a frieze of grotesque figures and coats of arms.

The themes become more differentiated in the Baroque period together with the increasing use of stucco decoration, an essential element of Catholic sacred architecture. A first, particularly fine example of Baroque painting dominating the entire room can be found in the polygonal vaulted passion chapel of S. Carlo Borromeo church (about 1629), the work of a Lombard master. The overwhelming visions of heaven depicted in ceiling frescoes are particularly characteristic of the late Baroque; examples are the vault fresco that seems to dominate the architecture of Sta. Maria Assunta (1719) and, also in Poschiavo, the ceiling painting from 1760 with the Adoration of the Apocalyptic Lamb in the Oratorio Sant'Anna. On the other hand, the architectonic or ornamental stucco work can also dominate the wall paintings; this is the case in the parish church of Tiefencastel, where the sculptural stucco in the chancel and lateral chapels severely restricts the painting fields. Protestant church interiors were often embellished with such stucco work. The ornamentation in the village church of Samedan is particularly original.

Altars and pulpits

In the church of Mistail, the three "empty" Carolingian block altars in the apses give us an idea of how the chancel zones, so important to Carolingian liturgy, looked in the 14th/15th centuries. Not until the late Gothic period, between the second half of the 15th and the early 16th centuries, does the reredos, mostly in the form of a winged altarpiece, become the central

Poschiavo > Roman Catholic church of Santa Maria Assunta. Illusionist cupola representation of the Assumption of the Virgin with the Holy Trinity, painted by Giuseppe Brina in 1719.
R. Pedetti

Poschiavo > Oratorio Sant'Anna. Illusionist painting with the Adoration of the Apocalyptic Lamb in the cupola of the nave, painted in 1760 by Lorenzo Piccioli (painted over 1879).
R. Pedetti

Poschiavo > Roman Catholic church of Santa Maria Assunta. Left lateral chapel with stucco work ensemble and altar 1712 – 30.
R. Pedetti

Tiefencastel > St. Stephan Roman Catholic church. Mesocco stucco work and painting on the vault over the chancel.
R. Pedetti

element of the churches. In Protestant regions, the carved retables made in workshops in southern Germany disappeared only a few years after they had been mounted, whereas in the Catholic churches caught in the Baroque wave of the Counter-Reformation they often had to give way to "modern" altars. Parts of a late-Gothic carved altar have been preserved in the immediate vicinity of the Albula/Bernina line only in the collegiate church of S. Vittore in Poschiavo, where older reliefs have been integrated in the neo-Gothic main altar, which forms a historic ensemble together with two side altars and the pulpit; the interior was renovated in the Gothic style in 1902/04.

The Tridentine reform led to the replacement of the built-in tabernacle by one placed on the high altar, often with tempietto. Consequently, most altars were rebuilt during the Baroque period. Worth mentioning are the uniform marble altars of S. Carlo or the wooden altar to St. Stephen in Tiefencastel (1650) that, together with the one in Brusio (1625), represent the Italian tabernacle-altar type. The Tiefencastel chapel altars with their great altar paintings are made of stucco like most of the Baroque altars in the Poschiavo valley.

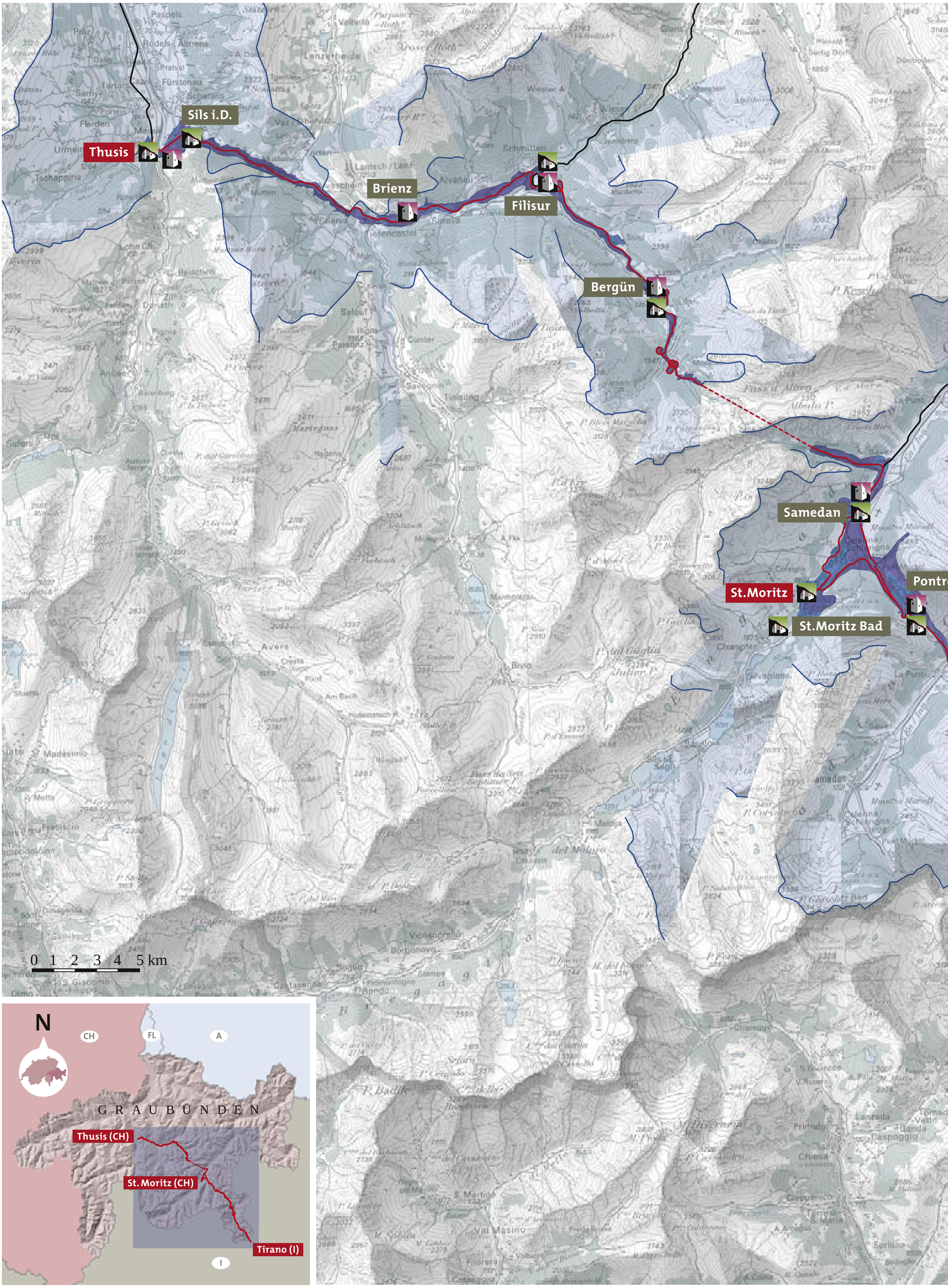
In the 17th and the first half of the 18th centuries, decorative wooden pulpits were introduced to many churches of both denominations in Graubünden. The octagonal pulpit in the chapel of Sta. Maria Presentata of the old convent in Poschiavo (about 1680), attributed to a master from the nearby Veltlin, is the most richly sculpted octagonal pulpit in our region; also remarkable is the exquisite Renaissance pulpit built in 1624 in the church of Sta. Maria Assunta in Poschiavo.

Sils i.D. > Fort Hohenrhätien. The four-storey residential tower in the foreground is one of the oldest buildings that has survived complete – to the tip of the gable.
Kantonsarchäologie Zürich

Brienz/Brinzauls > The imposing ruins of the Belfort fortress built on a narrow spur of rock. Construction started about 1228 and was continued in several phases.
Archäologischer Dienst Graubünden, Chur

Filisur > Greifenstein castle. Typical example of a Graubünden small scale castle, built early 12th century.
Archäologischer Dienst Graubünden, Chur

Sils i. D. > Burg Ehrenfels. The Middle Ages fort was expanded in the 17th century to a aristocratic residence.
Denkmalpflege Graubünden, Chur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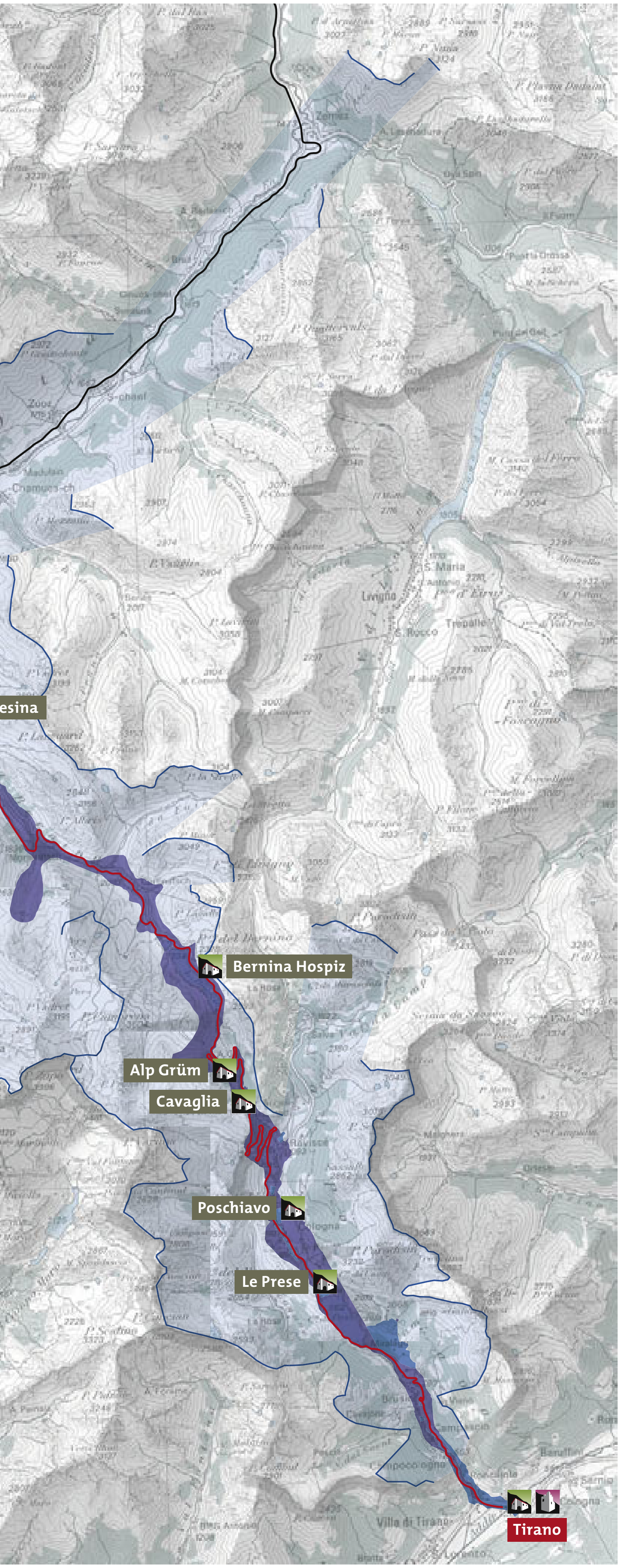


Secular buildings along the Albula and Bernina line (selection)

Forts and residential towers

Aristocratic and upper-class houses, farmhouses, hotels and museums

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

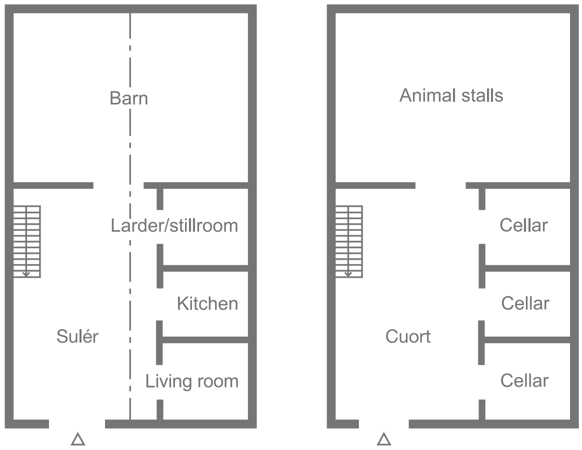
Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Ludmilla Seifert
Design: Süsskind, SGD, Chur

Secular architecture

Forts and residential towers

The oldest secular buildings along the railway whose walls are still standing are defensive structures dating back to the 12th/13th centuries. These forts were the focal point of smaller dominions or served as bases for the more extensive developing territories of individual noble families or for the Bishop of Chur (cf. 2.b.2). One of the bishopric's feudal towers was Hohenrätien, built on a crag rearing above the eastern entrance to the Viamala gorge (cf. 2.b.1) that has been used a settlement site since prehistoric times; it was expanded into a citadel in the early medieval period. The lords of Rialt, as officers of the bishop, built a four-storey residential tower here in 1180 – today one of the oldest secular buildings in Switzerland that has been fully preserved, right to the tip of the gable. With the building of a stone house and two further towers as well as an outer and an inner circumvallation, by the 13th century the complex had acquired the impressive dimensions still apparent today even in its ruined state.
The fort of Belfort, near the village of Brienz/Brinzauls, which can be seen for miles around, symbolises the territorial ambitions of the free lords of Vaz who had risen to be the most powerful noble family in Rhaetia during the 13th century in bitter rivalry with the Bishop of Chur (cf. 2.b.2). This defence complex was built on a narrow ridge of rock in 1228 and expanded into a feudal residence with a main tower, a gate tower, living quarters and new buildings around a central courtyard; it was destroyed in 1499. However, most of the forts do not have such imposing dimensions, but are smaller, more rural, comprising a tower-shaped main building surrounded by smaller outbuildings and are circumvallated. Examples of such small representative rather than military forts are Ehrenfels, Baldenstein and Campi in the village of Sils i.D., all three built in the early 13th century as residential towers and expanded in stages with circumvallation and other residential buildings. The fort of Greifenstein should also be mentioned in this context; it was built in the late 12th century by the lords of the same name on the precipitous crest above Filisur as a power base for the upper Albula valley.
The Bishop of Chur had been able to secure all the rights due to a count in the Upper Engadin since 1139. Any tendencies to establish territorial powers centred on a fort were quashed. The bishop's valley chancellors, officiating until 1244, were the Pont-Zarisinos from Pontresina; they resided in the pentagonal tower above Pontresina, near the church of Sta. Maria. In the 13th century, the defensive residential tower also became established as a construction model among the upper classes of the local villages. Thanks to their height and design, these towers stood out against the surrounding farmhouses which were built in timber and dry masonry until the 14th century; mortar construction was restricted to churches, defence works and the representative buildings mentioned above. While the residential towers in villages had been integrated into farmhouse buildings since the 16th century, those with a feudal function were often given a new purpose: in Poschiavo the community acquired the tower of the Bishop of Como's bailiff on the piazza and had it converted into a Rathaus tower. It thus became a symbol of the independence and judicial sovereignty of the village community. Events followed a similar pattern in Samedan, where the village tower served the community as a prison,

Celerina > Typical Engadin style house in the Crasta district (the tower of the Protestant St. Maria church in the background). Loaded hay carts could drive through the enormous door on the left of the façade straight into the barn.
Denkmalpflege Graubünden, Chur



Ideal layout of an Engadin house.
Denkmalpflege Graubünden, Chur

Filisur > Engadin style house with façade murals by Hans Ardüser, the 'peripatetic' master from Graubünden, dated 1595.
Denkmalpflege Graubünden, Chur

Samedan > Detail of a 17th century sgraffito decoration.
J. Arni

or in Bergün / Bravuogn where the Platzturm was turned into a bell tower in the 17th century, losing its medieval character by the addition of a Baroque cap roof.

Farmhouses

Rural architecture accounted for by far the greater part of secular building until well into the 19th century. The Albula/Bernina area produced something unique in this respect, namely the Engadin house, a style that was developed in the 15th/16th century and was found solely in the Engadin until the end of the 18th century. The Engadin house is not restricted to the Engadin itself, but extends to the neighbouring valleys, to the north as far as Bergün/Bravuogn and Filisur, and in isolated cases as far as Alvaneu and Surava. It combines all the functions of a farmstead under one roof. In contrast to other multi-purpose buildings, it has two passages through the living area, the Sulèr to the barn and the Cuort below it providing access both to the stables and cattle shed and to the cellars, and even including the manure heap in the house. The exclusive access to the farm through the home and the consequent combination of two elements in both constructional and functional respects make the Engadin house typologically unique. The basic room layout of the Engadin house includes a timber-panelled living room with a bedroom above it, a vaulted kitchen and a storage chamber that is also usually vaulted. The position may vary, but the living room and kitchen are always alongside the Sulèr: the connection between the smoke-free living room and fire-safe kitchen is predetermined, as the living-room stove is always fired from the kitchen. The characteristic asymmetry of the façades, aligned to the valley road and the well wherever possible, results from the contrast between the small, heated living rooms and the spacious Sulèr designed to take a loaded hay cart. From the exterior, the Engadin house appears as a sturdy stone construction, although the masonry often covers an older timber framework. Southern influence and the need to be representative, but perhaps also fire protection, may have been the reasons for the stone cladding. Typical decorative elements on the Engadin houses are small oriels and wrought-iron grilles in front of the windows. In the Upper Engadin, sgraffito became the predominant facade ornamentation from the 16th century. This decorative technique for flat surfaces was developed in medieval Italy: ornaments are scraped, scratched and incised on a layer of plaster with a wash of chalk to reveal their figures against the darker underlying plaster. The motifs are mostly drawn from Italian Renaissance models and are primarily used to emphasise the corners of houses, doorways, windows and roof-lines. In contrast, many façades were painted in the Albula valley and the designs are freer, as shown in a particularly impressive example in Filisur dating from 1595 that is attributed to the painter-poet Hans Ardüser from Davos, a well-known figure in Graubünden.
Val Poschiavo also has a dominant type of farmhouse that is geared to cart transport: this comprises a single stonework unit with drive in, sometimes splitting into two ramps in the interior, one to the stabling the other to the hay barn. The Casa Tomé in Poschiavo is a well preserved example.

Aristocratic and upper-class houses

In the 15th century, the “free state” of the Drei Bünde established itself in the territory of Graubünden: it was fundamentally a democratically constituted but de facto oligarchic state.

Samedan > The Chesa Planta (built 1595, extended to a two-family house in 1760). A particularly impressive example of an Engadin-style aristocrat's house.
Denkmalpflege Graubünden, Chur

Poschiavo > Palazzo De Bassus-Mengotti (built 1655, extended 1701-1713 and early 19th century). The most striking aristocratic seat in Poschiavo.
Studio Pollini, Sondrio

Poschiavo > Hotel Albrici. Elaborate 17th century panelled room, called the "Room of the Sibyls".
Studio Pollini, Sondrio

Sils. i.D. > Palazzo. Aristocratic building in Domleschg, built about 1740.

Today, the term aristocrat implies a representative of a small group of local gentry who managed to share out all important political offices among themselves (cf. 2.b.2). This social group promoted a building style of their own in secular architecture. In contrast to the feudal buildings of the Middle Ages, that as a rule sought to maintain a certain distance from the village, the aristocratic dwellings are integrated in the existing settlement structures. The deliberately sought-after place within the village unit was expressed by the adoption of traditional local building patterns. Whereas the rural ground-plan is long retained, the typological identity is gradually and increasingly overlaid. The means of aristocratically enhancing the rural types of the local building tradition are invariably the same. Apart from the sheer size of the exterior, it is the stronger emphasis on the entrance area as well as the cladding of the timber parts that defines the difference to a conventional farmhouse; in the interior it is the generous size of the rooms, their greater number and the luxury of the furnishings. In general, the introduction of vaults and the generous design of a flight of steps in the interior make a more representative impression. Further, a vaulted reception room usually at ground level, known as the "sala terrena" is usually integrated in the room structure. Also the "stüva bella", the ostentatious best room, with superior panneling, becomes an established feature. The aristocratic attitude to building aimed – if to differing degrees in the exterior – at a clearer differentiation from rural farmsteads by greater size and embellishment while keeping to the ground plan of a farmhouse on principle. Prominent examples include the Chesa Planta in Samedan, extended in 1595 by the von Salis family and converted into a two-dwelling house; the present Hotel Albrici in Poschiavo, built for a local potentate in 1678; but above all the Palazzo de Bassus-Mengotti built in 1655 (extended in 1701 – 1713 and the late 19th century), also in Poschiavo though outside the historic nucleus of the town. The move away from the farmhouse pattern was not completed until the 17th century, and in the Engadin only in the following century. The central-corridor building based on Italian models, where the rooms run along a – vaulted – passage, now becomes the aristocrats' preferred model. The Palazzo in Sils i.D., built in 1740 for an officer serving in Piedmont, with its symmetrical design of façade, ground plan and garden, is a perfect example of this change in aristocratic building patterns.

International architectural trends in secular building were not established until the 19th century, when, as a consequence of the emigration of craftsmen, the middle-class type of village architecture developed: the villas of confectioners who had been successful abroad and returned to their native valleys have left their stamp on many a village in the region. They include the Lorsa (1829) and Frizzoni (1836) houses in Celerina and Fenner (about 1860) in Samedan, and in Poschiavo the unique row of Palazzi (1857 – 1891) give the southern rim of the village its unmistakable profile (cf. 2.b.4).

Tourism architecture

One can hardly speak of a specific tourism architecture in the Albula/Bernina region before 1850. Travellers and spa tourists were accommodated in simple guest-houses and hospices, often in private houses. The earliest examples of Upper Engadin tourism in Samedan were the Hotel à la Vue du Bernina opened by Johannes Badrutt in 1845 in a barrel-roofed commercial building, and from 1856 his Hotel Engadiner Kulm in the

Bergün/Bravuogn > The "Hotel Kurhaus" opened after the Albula line was built; the only surviving "grand hotel" in the Albula Valley (built 1904–06).
L. Fleischer

St. Moritz > Segantini-Museum. Built in the "Heimat" style by Nicolaus Hartmann the Younger, in 1908.
A. Mende/Kur- und Verkehrsverein St. Moritz

The planned Railway Museum designed by the Hans-Jörg Ruch, Axel Fickert and Kaschka Knapkiewicz group of architects.

St. Moritz residence of the aristocratic Faller family. Since 1864, the classicistic Neue Kurhaus has defined the profile of St. Moritz Bad, which was later developed with further palatial hotels and landscaped gardens (cf. 2.b.4). In 1865, the double-angled Bernina hotel at the edge of the village of Samedan was built as a purely tourist hotel. In other places, particularly in Pontresina, the hotels developed successively from small-scale buildings: with their dimensions and neo-classical, neo-Baroque or castellated features, these establishments made an ever sharper contrast to the village settlement, reflecting the sharp social difference from the hotel guests. Later hotels were built at a distance from the villages in locations with a particularly good view. Particularly striking examples of the many tourist buildings along the Albula and Bernina line include the former Hotel Viamala in Thusis (1845/96) and the art-nouveau Kurhaus Bergün (1904 – 06), in St. Moritz the eclectic showpiece of the Palace Hotel (1896) or the La Margna Hotel (1906/07). Pontresina has the luxurious Hotel Kronenhof (1850/1898) and the Saratz (1875/1995), extended in modern style, and Poschiavo the romantic Le Prese Kurhaus (1857) on Lago di Poschiavo.

The Modern

The “Heimatstil”, a regionalising version of the architectural reform movement in the 1900s (cf. 2.a.4 and 2.a.5) has left its mark in the Albula/Bernina area: The already mentioned Hotel Margna, the Museum Engiadinais (1906) and the Segantini Museum (1908) are text book examples of this style. All three of these works in St. Moritz were designed by Nicolaus Hartmann the Younger, who also built for the railway (including the Bernina Ospizio and Alp Grüm stations; cf. 2.a.5) and the hydroelectric companies (including the Palü and Cavaglia command stations; cf. 2.b.7). Interest in regional building traditions and forms revived at the close of the 1970s. A characteristic example of this new regionalist trend is Robert Obrist’s municipal hall in Bergün / Bravuogn built in 1977. The subtle juxtaposition with the rural surroundings, the quest for an appropriate contemporary response to tradition and topography also characterise the work of a younger generation of local architects who even succeeded in evoking an international echo. The Railway Museum in Bergün/Bravuogn promises to become a highlight of contemporary architecture along the Albula/Bernina line; its completion is scheduled for 2007. It will contribute to a heightened awareness of the cultural significance of this Alpine railway far beyond Graubünden.

Tirano (Italy)

Sacred Buildings

Tirano nestles in the southern foothills of the Alps. It lies at the heart of the Veltlin (Valtellina) and is notable for its wealth of sacred buildings.
The parish church of St. Martin was built in the 13th century and converted to the Baroque style in the 17th. The façade was designed by Milanese architect Carlo Maciachini in 1870. Shortly afterwards, Giovanni Gavazzeni added the frescoes in the narthex. However, the bell tower, built by Jacopo di Valsolda, is in the Renaissance style. So is the interior of the church, which is divided into one principal and two lateral naves separated by vaulted pillars. The 16th century St. Peter’s oratory stands to the left of the church square. It was built when the parish was enlarged and today houses five remarkable 17th century oil paintings. Tirano

Bernina line > The Bernina Railway crossing the square in front of the Madonna di Tirano church.
Foto Geiger

Tirano > St. Perpetua church.
Fondazione Provinea

gained fame due to the vision of the Madonna granted to blessed Mario degli Omodei on 29th September 1504. The most important sacred building in the town, the pilgrimage church of Madonna di Tirano, was erected to commemorate this event. The foundation stone was laid on 25th March 1505. During the upheavals of the Reformation the church was a bastion of Roman Catholicism. The architects of the church, which was consecrated in 1528 but not completed until 1703, were the Rodari brothers from Como. Other renowned artists were also involved: the dome was built by Pompeo Bianchi, the frescoes painted by Cipriano Valorsa and the imposing marble portal built by Alessandro Della Scala from Ticino. The massive church structure fits in harmoniously with its setting on the square, once the site of the most important market in the Veltlin. The lofty bell tower is exceptional with its post-Romanesque fenestrations and tiered Baroque dome. In the background, on an outcrop of rock above the basilica, is the small 11th century church dedicated to St. Perpetua. It was built along the pilgrims' route leading from Tirano to Brusio and the Bernina Pass. The church includes a hospice to accommodate the pilgrims. The octagonal church of St. Rocco, in the Via Rasica, has a striking large-format canvas of the Crucifixion dating from the 16th/17th century and a notable veduta of the city of Jerusalem; according to legend the old city of Tirano stood as 'model' for this painting. The church of La Chiesetta, dedicated to St. Borromeo, was built at the beginning of the 17th century and served the von Salis family as their private chapel. There is a single-nave church dedicated to St. Teresa in the Via XX Settembre with a Baroque façade dating from the 17th century. This church houses five large oil paintings from the same period.

Secular Buildings

Parts of the city walls of Tirano, with its three Renaissance gates and numerous old patrician houses, have survived. The old St. Jacob's church on the Piazetta Arcari has been converted to house the municipal library (Biblioteca Civica "Paolo e Paola Maria Arcari"). The civic council is housed in the old Palazzo Marinoni on the Piazza Cavour. At one time the building was an Augustinian monastery; namely from the late 14th century until 1654. The cloister with its old fountain and 16th century entrance are of particular interest.

One of the most beautiful buildings in Tirano, at the beginning of the Via Salis, is the Palazzo Sertoli Salis. This monumental late 16th century edifice was the city residence of the von Salis family who came from Bergell in the Graubünden; numerous dignitaries in the Veltlin under the Ancien Régime came from this clan. The 16th century façade is flanked by two towers. The massive stone portal was created by architect Giacomo Vignola. The crenellated façade is decorated with antique spoils – inscriptions, coats of arms and friezes. Three ceremonial rooms in the interior deserve special mention: the 'Honours' room (Salone d'Onore), the 'Great' reception room (Salone) with an 18th century painted ceiling attributed to Enzo Cucchi, and the smaller reception room (Saloncello) with an excellent painted ceiling dating from about 1700 and a Baroque fireplace with the Salis-Wolkenstein 'Alliance' coat of arms in stucco work.

The Palazzo Visconti Venosta in the street of the same name is one of the most striking buildings in the old part of Tirano. The famous politician Emilio Visconti Venosta and the equally famous writer Giovanni Visconti Venosta lived here.

The Palazzo Torelli in the Via Torelli – once the residence of the statesman Luigi Torelli –

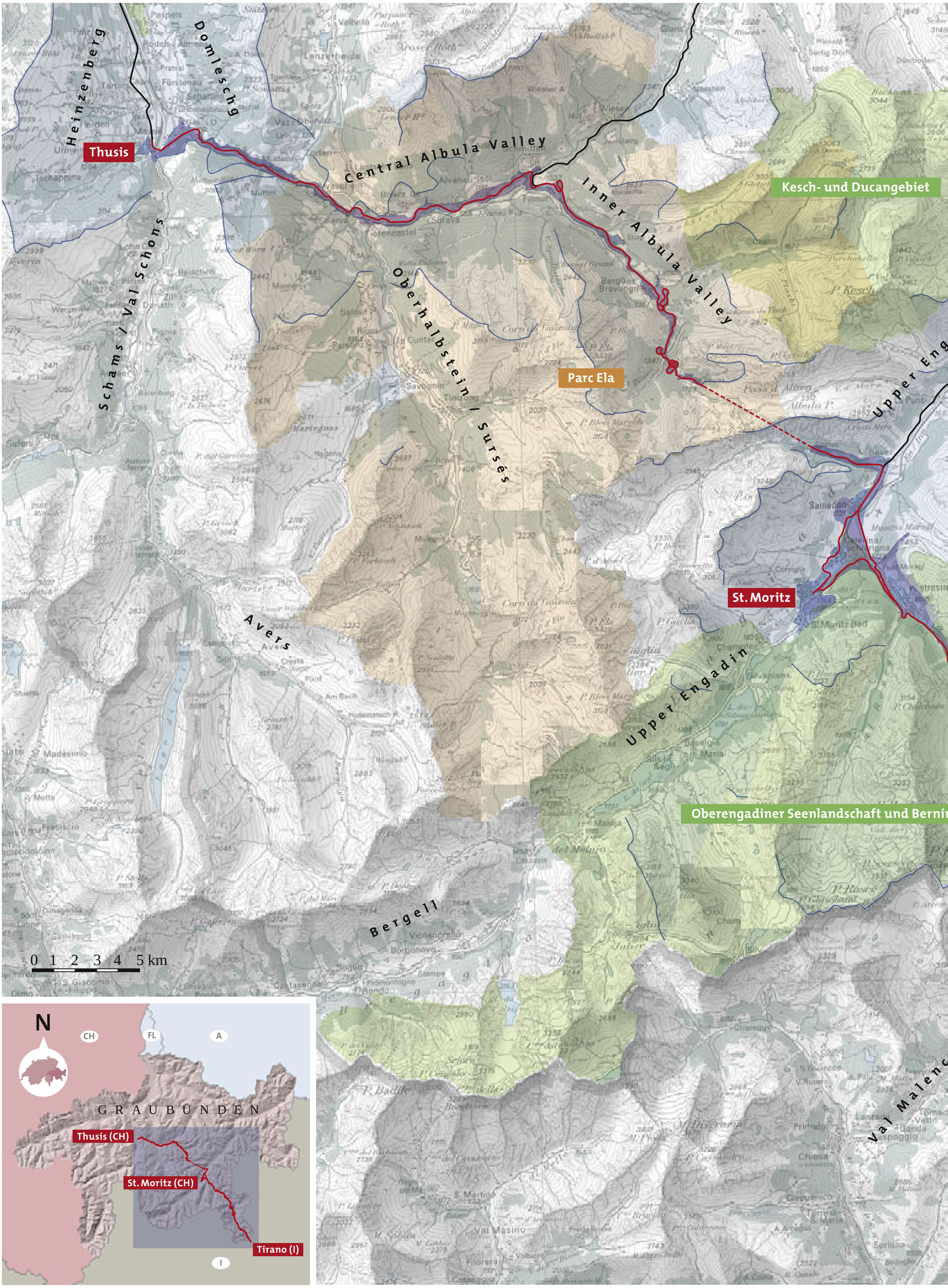
Tirano > Castello di S. Maria was part of the town defences in the Middle Ages; only a few ruins can be seen today.
Fondazione Provinea

Tirano > Porta Milanese.
Città di Tirano

Tirano > Porta Bormina.
Città di Tirano

is impressive with its Baroque doorway surmounted by a balcony. Alberto Caimi painted a scene depicting St. Karl Borromeus who was in Tirano in 1580. Further on is the massive Torelli Tower which was refurbished in the 19th century in the Historismus style. In contrast, the Porta Poschiavina, one of the three city gates, is largely in its original state; commissioned by Duke Ludovico il Moro, it was built between 1492 and 1498. The murals have in part survived with a Justitia, two 'noble savages' as well as coats of arms and inscriptions. Along the Via Besta is the Porta Milanese, the mighty city gate that opens the way to Milan. Today, all that is left of the Porta Bormina is a simple arch linking two houses on the start of the road to Bormio. The ruins of the Castello di S. Maria can be seen in the Via Trivigno; better known as the "Castellaccio" it was once a strategic element of the city's defence system. The large 16th century Palazzo Paravicini dominates the square named after it. On the Piazza della Basilica, near the Madonna di Tirano pilgrimage church, is the Ethnographic Museum (Museo Etnografico Tiranese), founded in 1973 and displaying Roman finds and ethnographic artefacts from the region. A magnificent wine press is a particularly striking item.

Bernina Pass > Bleak Alpine landscape with natural lakes (Lej Pitschen und Lej Nair/Lago Nero) in the foreground and Lago Bianco behind them.
A. Badrutt


Thusis
Heinzenberg
Domleschg
Central Albula Valley
Inner Albula Valley
Schams / Val Schons
Oberhalbstein / Surses
Parc Ela
Kesch- und Ducangebiet
Upper Eng
St. Moritz
Avers
Upper Engadin
Oberengadiner Seenlandschaft und Berni
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0 1 2 3 4 5 km
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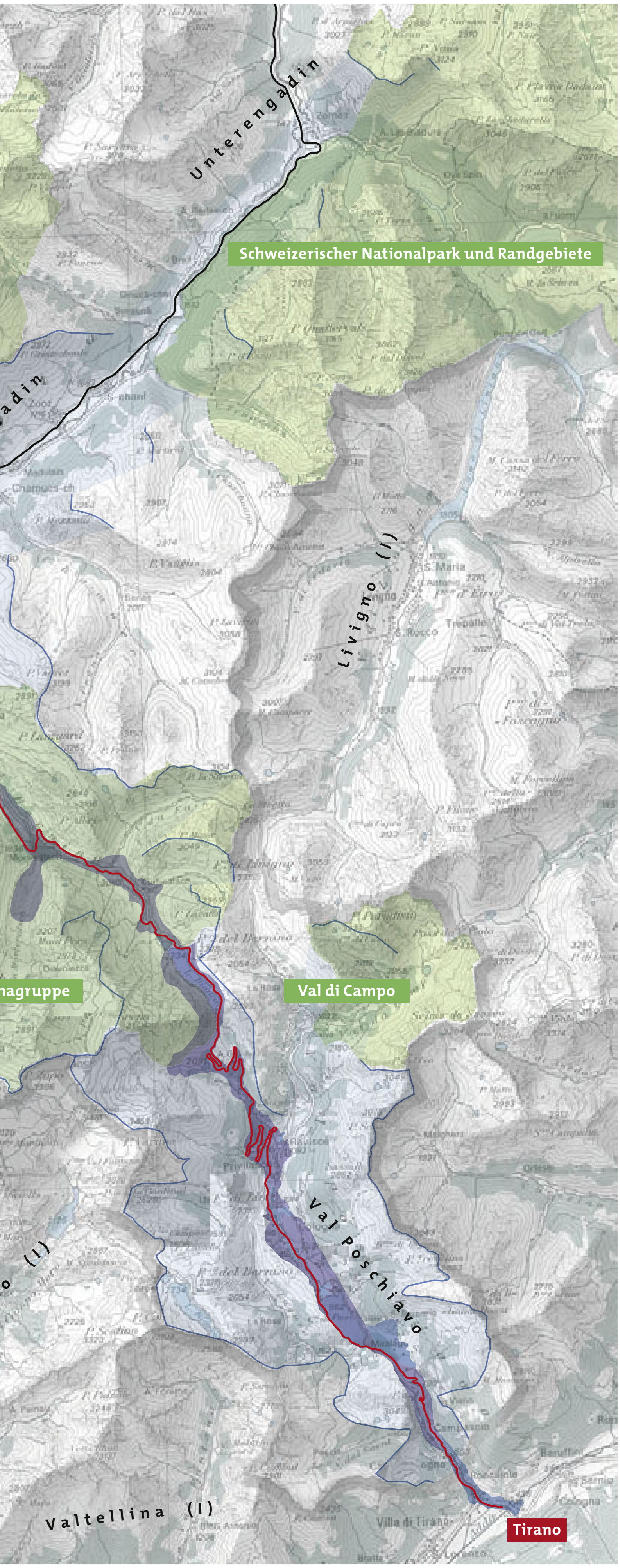
GRAUBÜNDEN
Thusis (CH)
St. Moritz (CH)
Tirano (I)



Cultural landscapes along the Albula and Bernina line

Landscapes and natural monuments of national importance

Parc Ela

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: RIP 2000
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2.a.7 Cultural landscapes along the Albula and Bernina line

The cultural landscapes along the Albula / Bernina railway line differ considerably both in appearance and in the way they are used. If exploitation in the Heinzenberg / Domleschg region is moderate to intensive, the Albula valley is characterised rather by utilisation that is close-to-nature and principally agrarian. In the Upper Engadin, cultural landscapes largely determined by tourism alternate with virtually intact natural environments, whereas Val Poschiavo and the Veltlin Valley, with its southern ambience, juxtapose the greatest contrasts within a very small area. On its way from Thusis to Tirano, the railway runs through several altitude levels as well as differing climatic and tectonic-geological zones; what is more, it passes through three different cultural areas that are reflected in completely disparate building styles. The railway installations have had a strong impact on the landscapes in the regions traversed and have given important impulses to settlement and economic development. Some structures built for the railway have in fact become "landmarks" or even "trademarks" for that particular region.

A cultural landscape is a natural landscape that has been changed by man. Its development is determined by natural conditions such as topography, climate, geology, soil, water resources and vegetation and by the type of settlement pattern and exploitation of the land as well as essential infrastructure systems such as traffic routes and power lines. There are several different cultural landscapes along the Albula/Bernina railway line. These can be named after the various valley communities: in Switzerland the Domleschg/Heinzenberg, Albula, Upper Engadin and Poschiavo valleys, in Italy the Veltlin. The cultural landscapes cannot be considered apart from their surrounding natural environments, which are either intact or hardly touched. These "backdrops" are extremely important for the overall perception of the cultural landscape; they are the backgrounds on the postcards and are frequently a landmark for the entire region.

Domleschg/Heinzenberg

High above Thusis, the starting point for the Albula Railway, is Piz Beverin – effectively the landmark for the whole Domleschg/Heinzenberg valley community. The mountain is particularly impressive in spring and early summer when - still in purest winter white – it stands out against the lush green meadows and the blossom of the fruit trees down in the valley.
Thusis, an old market town, is situated slightly higher, above the upper reaches of the Rhine.
The line forks behind Thusis: the once so important north – south transit route continues through the Viamala gorge and on across the Splügen or San Bernardino Pass. Towards the east, through the Schin gorge, the track climbs to the Albula Pass before descending into the Engadin. The way through the sinister Viamala, a deep gorge cut by the Hinterrhein (Upper Rhine) that pierces the almost insurmountable rock barrier behind Thusis is still impressive today; it is hardly surprising that the uncanny mystery of the Viamala is sung in numerous legends and stories.
The cross section of the Domleschg and Heinzenberg is an asymmetric transverse valley. The form of the flanks of the valley is defined

Heinzenberg/Domleschg > Monumental secular buildings, like Ortenstein castle, are a striking feature of the Domleschg cultural landscape. On the right, the gently sloping Heinzenberg with the snow covered Piz Beverin in the background.
M. Kunfermann

Sils i.D. > The Holy Sepulchre church of St. Cassian in the Domleschg valley stands isolated on a hilltop.
A. Badrutt

by the tectonics of the underlying rock, or rather their formation by glaciers and erosion. The gradient of the rock (Graubünden slate), runs from west to east and the western flank of the Heinzenberg is gently inclined in the same direction whereas the eastern flank, the Domleschg, is characterised by the precipitous mountain slopes, ridges of rock and the peaks of the Stäzerhorn chain. The particular cultural landscape of the Domleschg – on a national comparison it is classed as "important" – is characterised by small lakes and wetlands nestling between moraines, by meadows, hedgerows, fields and fruit trees as well as compact villages surmounted by forts perched on striking outcrops of rock or hills. The "Domleschg apples", once highly prized at aristocratic tables throughout Europe, are a particularly interesting feature of farming history in the Domleschg. Today the cultivation of this rare, old variety of apple is again being promoted. In the Domleschg, the villages and the previously only temporarily occupied Maiensässe (cf. 2.b.4), cling to the terraces like swallows' nests. The sunny situation and relative dryness made tillage possible up to a high altitude; the old field terraces are still clearly visible. Cereals are no longer cultivated in the Domleschg today.

The cultural landscape on the Heinzenberg is very different to that of the Domleschg. Here, it is the cultivation of feed crops that dominates. The landscape is characterised by meadows, forests, Maiensässe and alps.

At the beginning of the 19th century the valley floor belonged to the meandering young Rhine, the Hinterrhein. A mid 19th century land-improvement project made the valley floor suitable for farming: the river was straightened and the flatland covered with alluvial deposits from the Nollabach, that flows down from Piz Beverin carrying a great deal of fine material. The fertile land created by this project is still farmed intensively today. New roads were built from the mid 19th century onwards and the Chur – Thusis railway line was opened in 1896. The beginning of the power station and road-building boom attracted trade to the Thusis – Sils i.D. region. The siliceous limestone quarried in Sils i.D. is used, among other things, as ballast for the rail track, and is still loaded on to the rail trucks at Sils i.D. station. The former Rhätische Werke below Thusis station is one of the oldest industrial buildings in Graubünden and once produced the carbide for the station lighting. The power plants in the Thusis – Sils i.D. area still make a major contribution to the present day power supply for the Rhaetian Railway (cf. 2.b.7). High-voltage cables from the Albula valley and from the south link up here before being led to the north and the major agglomerations. From 1960 the settlements expanded as a consequence of the rapid growth in population. The building of the A13 motorway in the 1970s had an incisive impact on the Heinzenberg/Domleschg cultural landscape. It follows the canalised Rhine; the engineers opted for a tunnel to solve the Viamala problem.

Albula Valley

The Albula valley extends from the Schin gorge to the Albula Pass. It can be subdivided into various sections: the Schin gorge, the central and the inner Albula valley. The section as far as Filisur – an inner alpine, longitudinal valley – continues in the Landwasser valley, famous for its Zügenschlucht and the world-renowned health resort of Davos. After Filisur, the Albula valley changes direction and starts to run south, to the Al-

Schin gorge > Solis Viaduct on the Albul line, behind it the dry meadows and the terrace villages of Zorten, Lain and Muldain.
Foto Geiger

Surava > “Crap Furo” (Romansh for “rock full of holes”).
R. Zuber

Central Albula Valley > Sunny slopes and terraced hedge and bush land-scape.
A. Badrutt

bula Pass. The Albula valley is one of the most sparsely populated regions in Graubünden; together with the Oberhalbstein valley it is part of the “Parc Ela” nature park. The Rhaetian Railway with its particular structures and vegetation is an important element of the nature park.

Schin gorge (Thusis to Tiefencastel)

The Schin is a deep-cut gorge in geologically very unstable layers of rock (Graubünden slate). Earlier, the road (“Old Schin”) led from Obervaz or Alvaschein into the Domleschg, along the rock on the right bank of the Albula river. In contrast, the railway line was laid on the left, steep and densely forested, side of the valley. Numerous engineering structures were necessary to overcome the Schin section; the Solis viaduct is the most impressive of these (cf. 2.a.4). The northeast slope above the gorge is characterised by extensive dry meadows, the former terraced fields that are still visible and the compact villages of Zorten, Lain and Muldain. Mutten, a Walser village, lies on the rather shady slope opposite; the settlement breaks down into three separate groups of buildings at altitudes between 1,470 m and 1,870 m. The Walsers are a German-speaking people who probably immigrated from Davos or Avers during the 15th century.

Central Albula Valley (Tiefencastel – Filisur)

The central Albula valley is a dry valley with low precipitation and relatively mild temperatures. It extends from Tiefencastel to Filisur; its two flanks, on either side of the rather narrow valley floor, differ considerably as there is a pronounced sunny and shady side. The landscape of the central Albula valley is dominated by the Muchetta, that towers above Filisur, with its “textbook” scree slopes, similar to those found in the Swiss National Park. The Bergünerstöcke – Piz Mitgel and Corn da Tinizong – rising above the forests are almost invisible from the valley floor.

The forests (some are intact natural forests) dominate the shady slope, interrupted only by rocky outcrops and crags, such as Crap Furo, a greywacke pointing up out of the forest like a finger. This Silvretta nappe sediment marks the geographical centre of Graubünden. The tributary valleys emerging on the shady side are steep and end in steps; the imposing waterfall in the Schaftobel flows over one of these rockfalls. The streams carry large quantities of alluvial detritus.

The sunny side breaks down into three steps. Farming is intensive on the valley floor. As the gravelly soil is very permeable, the fields have to be irrigated in dry periods; traces of old irrigation systems can still be found here and there. Previously the slopes above the valley floor were tilled; dry-stone walls supported the terraces and prevented the fertile soil being washed down from the steep slopes. With the exception of potatoes, arable farming was abandoned after the Second World War and the old terraces gradually became overgrown with grass and bushes. The outcome was a hedgerow landscape that is quite unique in Graubünden. It extends from Mon and Stierva over Alvaschein, Brienz/Brinzauls, Surava, Alvaneu and Schmitten as far as Filisur. It is particularly important as a refuge for biodiversity. The hedges and the extensive dry meadows are an eldorado for butterflies, birds and other animals. Recently, a few terraces have again been used for the organic cultivation of old species of cereals (e.g. buckwheat).

Albula line > The loop entering the Schmittentobel and the Landwasser Valley.
T. Keller

Bergün/Bravuogn > "Il Crap" a rock barrier (also called the "Bergünerstein") before Bergün/Bravuogn is pierced by a tunnel; in contrast, the road runs along the rock face.
T. Keller

Bergün/Bravuogn > The inner Albula Valley is mostly steep and narrow. View from Bergün/Bravuogn towards the Albula Pass.
D. Enz

The settlements include both nucleated and ribbon-built villages. On the higher reaches of the sunny slope they are built on terraces, so only church steeples and isolated houses are visible from the railway. The church complex of Schmitten, which is built on a striking roche moutonnée, is particularly notable in this respect.

The traffic junction of Tiefencastel, with its once-fortified church hill, today dominated by a baroque church, derives most of its income from the tourists who stay at the two large hotels and eat at the restaurants.

Since the 19th century, Surava has been considered industrial: the match factory, rusk factory, mill, sawmill, pottery, dyeing works and previously a chalk works all document an earlier industrial era. Trade plays a major role in the economic life of Surava today as well; Misapor, a cellular glass ballast, has been produced here since the 1980s and is even exported abroad. The village comprises a western part of farming aspect with houses in the Engadin style (cf. 2.a.6) and the more commercial quarter in the east.

Alvaneu Bad developed into a well-known spa resort in the mid 19th century thanks to its iron and sulphurous spring; the large spa hotel built at that time was not used after the Second World War, gradually fell into ruin and was eventually demolished. Today it has been replaced by a new spa building with its own golf course.

Filisur has become an important traffic hub since the railway was built. It is here that the line through the wild Zügen gorge, also built and operated by the Rhaetian Railway, branches off from the Albula line. Besides farming, running hotels and catering for guests, trade and crafts have always played an important role in Filisur. The building of the Albula/Landwasser power station (cf. 2.b.7) with regulating reservoirs and command stations in Bergün/Bravuogn, Filisur and Tiefencastel, had a significant impact on the further economic development of Filisur and the entire Albula valley after the Second World War. The well-conserved village nucleus of Filisur is a compact whole with a large number of Engadin-type houses. The structural transformation of agriculture led to the setting up of new farming units beyond the edge of the village; the cramped conditions inside the village prevented any rational farming – the same applies for all the villages throughout the Albula valley (cf. 4.a.2).

The Landwasser Viaduct has made an indelible impact on the area. This technical structure blends harmoniously but self-confidently with the landscape and has become the “trademark” for the Rhaetian Railway.

Inner Albula Valley (Filisur – Preda)

The inner Albula Valley is steep and narrow; forests, and the courses of rock slides and avalanches define the landscape. Protection from the forces of nature like rockfalls and avalanches was essential where the railway line runs across open terrain. The railway pierces the natural rock barrier of the “Bergünerstein” before Bergün/Bravuogn with a tunnel; the road, in contrast, runs along the rock face. In view of the topographic conditions in this part of the valley, agriculture was only feasible in the hollow of Bergün/Bravuogn and around the villages of Latsch and Stugl/Stuls that lie on natural terraces and in the environs of Preda. The railway uses the Bergün/Bravuogn basin to overcome a difference in altitude of 100 m in two loops. Altogether, the

Preda > The plain at Preda-Naz, previously only occupied by the Bergün farmers for a few months of the year as Maiensäss, became a permanent settlement following the construction of the railway.
B. Studer

Bever > The entrance to the Engadin. The broad, open, 1,700 – 1,800 m Upper Engadin landscape gives the impression of being surprisingly expansive.
A. Badrutt

railway layout, like the road, clearly defines the cultural landscape in the narrow section of the valley from Bergün/Bravuogn to Preda. The Dolomite massif of Piz Ela closes the horizon to the west majestically.
Bergün/Bravuogn with its touch of the Engadin is well conserved. Since the beginning of traffic across the pass, tourism has been the most important source of income in the village. After the railway was constructed, several hotels were built, including the remarkable Hotel Kurhaus which tapped the mineral springs. Today this spa hotel has been restored to its former glory. The plain at Preda-Naz, previously only occupied by the Bergün farmers for a few months of the year as Maiensäss (cf. 2.b.4), became a permanent settlement following the construction of the railway.

Upper Engadin

The Upper Engadin is entered through Val Bever, a landscape of pastures and larches, with steep screes and courses gouged out by avalanches. In comparison to the ruggedness and narrowness of the inner Albula valley, the countryside here is broad and gentle. The Upper Engadin is part of a tectonically defined inner alpine, longitudinal valley stretching from Maloja to Martina. The trough shape is due to glacial erosion. The Upper Engadin separates the east alpine Bernina nappe in the south from the Julier and Err nappe in the north. The broad, open, 1,700 – 1,800 m landscape gives the impression of being surprisingly expansive. Unusual for a high altitude valley is the broad flatland called the “Campagna” around Samedan; it was built up by the Flaz, flowing from the Bernina valley, and the river Inn. To counter the danger of serious flooding, the Flaz was recently directed into a new bed using the latest river-correction and ecological know-how (cf. 4.a.2). The Bernina massif rises to heights of some 4,000 m, standing out clearly from the surrounding peaks that barely attain 3,400 m. The Bernina massif is in fact the highest in the eastern Alps. The river Inn, which flows through the Engadin and gave the valley its name, rises on the Lunghin Pass and joins the Danube at Passau before flowing into the Black Sea. The orientation of the axis of the valley is responsible for the great contrast between the northern, sunny and the southern, shady flank. The shady side is largely covered with larch and Swiss stonepine forests; the tree line is at an altitude of 2,300 m! On the plain and on the sunny side, in contrast, airy larch forests predominate. A large proportion of the settlements and the traffic routes are on the sunny side of the valley.
Unlike today, when crops are only grown for fodder, until the 16th century agriculture in the valley was at subsistence level – an extraordinary fact considering the altitude of the farms. The farmers even grew bread cereals on their own land; “Chantarella”, the name of an area above St. Moritz, at 2,000 m, means “little field” indicating that the land was once tilled. The floor of the valley was unsuitable for arable farming due to the danger of frost in the pockets of cold air; instead the farmers had recourse to the lower parts of the slopes. The old field terraces are still visible above the villages of Celerina, Samedan and Pontresina. With few exceptions, agriculture in the Engadin was organised at only two levels; a Maiensäss level with the associated buildings is completely lacking here, similarly there are no outbuildings for livestock, so typical of other

Upper Engadin > A broad, high Alpine U-shaped valley, left St. Moritz, right, the Samedan "Campagna" plain in the background.
A. Badrutt

Celerina > The old terraces, still clearly visible on the slope high above the village (1,800 m) prove that arable farming was commonplace here in earlier years.
A. Badrutt

St. Moritz > The pioneer tourist resort of St. Moritz is today one of the best known tourist destinations world-wide.
A. Badrutt

valleys in the Graubünden (cf. 2.b.4). The countryside beyond the villages is open, with no buildings. The historic nucleate villages are characterised by the typical Engadin houses; sturdy, massively built houses with living quarters, stables and a utility zone all under one roof (cf. 2.a.6).

The lakeland area with the Sils i.E., Silvaplana and Champfèr lakes, the towering peaks to the north and south and the eternal snows of the mountain massif, the glaciers creeping towards the valleys and above all the vibrant colours of the larch forests in autumn make the Upper Engadin one of the most unique regions in Switzerland. The air and the light in the Upper Engadin are also quite extraordinary – due to the high altitude. Since the beginnings of tourism, all this has attracted visitors from all over the world and has inspired poets, writers and painters like Giovanni Segantini, Rainer Maria Rilke and Friedrich Nietzsche.

The rapid spread of tourism in the Upper Engadin during the second half of the 19th century was the impetus for the construction of the Albula Railway (cf. 2.b.9 and 2.b.10). Today tourism is all-important here. Most of the people living in the valley live directly or indirectly from this industry. St. Moritz, the pioneer of tourism, is today one of the best-known mountain resorts worldwide; it has a cosmopolitan, even urban ambience of its own. About 1800 the medicinal spring (ferrous carbonated water) at St. Moritz-Bad (St. Moritz-Spa), which was already tapped in prehistoric times, started to attract visitors in large numbers (cf. 2.b.1). A first, rather modest Kurhaus was built in 1832; later this gave way to much larger and more luxurious establishments: these Grand Hotels stand like castles in the landscape, giving it a very special character. Originally the guests spent the summer months in the Engadin, sport-oriented winter tourism started to develop gradually from the 1880s onwards. This also gave the impetus for the construction of the first cable cars; the Muottas Muragl cable car, built in 1907, was the first and famous for the breathtaking view of the Upper Engadin lakeland. The second cable car in the Upper Engadin was built in 1913; it ran from St. Moritz-Dorf to Chantarella. The cable car was designed primarily to provide access to the Chantarella hotel complex built at the same time. Early highlights of winter tourism were the 1928 and 1948 Winter Olympic games. In preparation for the 1928 Olympiad, the Chantarella funicular railway was extended to Corviglia in 1927 to transport the winter sports enthusiasts. A real boom in cable cars and building in general broke out after the Second World War. Skiing became a popular sport and mass tourism arrived in the Engadin. The new cable railways – the Diavolezza and the Corvatsch in 1956, with a view of the Bernina massif, the Lagalb in 1962 – together with the ski tows, holiday homes, tourist infrastructure and roads changed the face of the landscape enormously.

Samedan, as a railway and traffic hub with its own rail settlement, developed naturally into the logistics centre of the Upper Engadin during the 20th century. A regional airfield, schools, hospitals, retirement homes, commercial buildings and utilities complexes are the outward signs of a tourism-oriented cultural landscape.

The “hotel palaces” are also the dominant feature in Pontresina, at the entrance to the Bernina valley, and in the Val Roseg (cf. 2.a.6 and

Bernina region > The Morteratsch glacier with Piz Palü and Piz Bernina.
Kur- und Verkehrsverein St.Moritz

Bernina Pass > The Lago Bianco reservoir is coloured white by the glacier milk from the Cambrena glacier, the blue-black Lago Nero, behind it, is fed by spring water.
A. Badrutt

2.a.9). The countryside between Pontresina and the Bernina Pass is bleak and alpine; railway, road, alp buildings and a high-voltage cable are virtually the sole signs of civilisation here. The valley in the Morteratsch region offers a breathtaking vista of the mighty Morteratsch glacier surrounded by Piz Palü, Piz Bernina and Piz Morteratsch: a unique mountain panorama; however, the glacier has shrunk considerably in recent years due to global warming. There is a geologically interesting feature at the foot of Piz Alv, not far from the Lagalb and Diavolezza cable car valley stations: the red Alv-Brekzie from the Triassic period. This blend of crystalline and chalk rocks, found only in a very restricted area, is responsible for a variety of plants in Val Fain (Hay Valley) that is unique to Europe. The plants here have been protected for many years (plant reserve).
The railway approaches the alpine zone on the Bernina Pass. The pass is a textbook example of a glaciated transfluence area, marked by Piz Cambrena with its glacial tongue, stream deltas and screes, roches moutonées, moraines and lakes. Lago Bianco, originally two small lakes with broad silted zones, was dammed in conjunction with the construction of the Kraftwerke Brusio AG (today Rätia Energie) power station at the beginning of the 20th century. Since then, it has formed the upper basin reservoir of the generating plant, which is one of the oldest power stations in Switzerland and closely linked to the establishment of the Bernina Railway (cf. 2.b.7). The storage reservoir is harmoniously embedded in the landscape; the dam to the north is hardly noticeable. Lago Bianco gets its white colour from the "glacier milk" coming from the Cambrena glacier. Lago Nero, the 'Black Lake', which is fed solely by spring water, makes a sharp contrast. The climate at an altitude of some 2,260 m is merciless.

Poschiavo Valley

From the eternal snows of the Bernina group, the Poschiavo valley drops, only about 25 km as the crow flies, to the southern ambience of the Veltlin. Every possible vegetation step can be found within a relatively small area, from the sparse growth and bleak stone-strewn crest of the pass over green pastures, lush meadows and dense larch forests to the tobacco fields and chestnut, peach, fig, cabbage and mulberry trees near the border. The flora and the great variety in types of agriculture reflect the southern influence of the climate.
With the exception of the serpentine (Pennine stone) that is quarried in the Selva district, the underlying rock comprises east alpine nappes. The Sassalbo in the eastern mountain range, which is formed of several different kinds of marble, is particularly striking. The valley follows the tectonically defined shifts between the upper and lower east alpine nappes. It is drained by the Poschiavo river, which joins the Adda in the Veltlin, which in turn flows into the Po and on to the Adriatic / Mediterranean. Two large tributary valleys branch off from Val Poschiavo: the Val di Camp from Sfazu, and the Val dal Saent from Campascio. The Val di Camp is renowned for its beautiful lakes that were originally formed by a massive rockfall (landscape of national importance). The high-altitude hamlet of Cavaione in Val dal Saent is only partly inhabited today. The Val dal Saent did not definitively become part of Switzerland until 1875; for over a hundred years it was "no man's land" belonging neither to Switzerland nor Italy. The inhabitants

Alp Grüm > A natural dome, moulded and polished by the glacier. In its shade the Lago di Palü.
A. Badrutt

Alp Grüm > Spectacular view of the Palü glacier. In the foreground the Lago di Palü.
T. Keller

Poschiavo > The bowl of the valley, with Lago di Poschiavo is characterised by various alluvial fans, in part overgrown with hedges, intensively used meadows with the first potato fields and settlements some of which have an urban air.
A. Badrutt

made the most of this situation by assuring the Swiss authorities that they were Italian, and the Italian authorities that they were Swiss.
The first stage of the Poschiavo valley stretches from the Bernina Pass to Alp Grüm. Whereas the road makes its way through Val Agoné, the railway follows the route through the Cavaglia taken by the old mule track years ago (cf. 2.b.3). Alp Grüm, rounded by glacial erosion, is a favourite with tourists thanks to the fantastic view into the Poschiavo valley with Piz Palü and its glacier. From Alp Grum the valley drops down to the Cavaglia plain with the hamlet of the same name at 1,700 m, originally only inhabited for a few months of the year. The beautifully formed moulins are an interesting feature. They are some 500 m to the south of Cavaglia rail station, where the Cavaglia river cuts through a smoothly polished rock barrier. The next large step is formed by the basin and Lago di Poschiavo (1,000 m). This is characterised by various alluvial fans, some overgrown with hedges, intensively used pastures and the first potato fields and settlements, some of which already have an urban air. The lake was dammed up by a massive rock fall in the Motta / Miralago area. The fourth step descends through the ever-narrowing valley to Campocologno (700 m).
The railway has made a strong impact on the Poschiavo cultural landscape; among the striking structures are the loops winding up from San Carlo to Alp Grüm, perfectly embedded in the countryside, and the circular viaduct at Brusio. Agriculture was long the principal source of income in the valley. The traditional division of the utilised zones into valley, Maiensäss and alp, so typical in Graubünden, applies here as well (cf. 2.b.4). At the lowest valley level (from Campocologno to above Brusio) are the homesteads of the “field-alp farms”, the typical form in dry valleys. Farming is varied, with fields separated from one another by supporting walls and hedges. The irrigated meadows can be mown up to four times a year. At the next valley stage (from Miralago to San Carlo), farming is less varied. The “meadow-alp farms” are found here. Conditions are similar on the terraces at Viano and Cavaione. The Maiensässe are built on natural flat patches in forest clearings at an altitude of 1,100 to 1,600 m. The associated settlements come in all forms from scattered homesteads to small villages. The alpine pastures are very extensive, but the terrain is frequently very steep. The local livestock was insufficient for comprehensive grazing so the Poschiavo farmers fetched cattle from the Veltlin and sheep from Bergamo to spend the summer on the alps.
Since earliest times the restricted opportunities for making a living in Poschiavo have obliged many of its people to emigrate. Besides military emigration, economic emigration was also widespread; the Poschiavo confectioners, in particular, who travelled to all the countries of Europe and often made considerable fortunes abroad, are well known. When they came home again they often invested their money in real estate. One particularly impressive example of ‘returning emigrant’ architecture is the row of “palazzi” along the southern edge of the Poschiavo Borgo with its urban air (cf. 2.b.4).
Besides employment in the power station, today trades and crafts, passing traffic and the rapidly developing tourist trade offer earning opportunities. The beginnings of tourism in Poschiavo go back to the mid 19th century, when a spa hotel was built on the lake at Le Prese that

Poschiavo Valley > Thanks to its mild climate, the valley floor of the lower Poschiavo Valley is densely populated and the land is farmed intensively. The slopes are covered with deciduous trees.
A. Badrutt

Lago di Poschiavo > The lake was dammed by a massive rockfall and is used to generate hydro-electric power.
A. Badrutt

Campascio > Carefully cultivated terraced landscape below the Campascio halt.
A. Badrutt

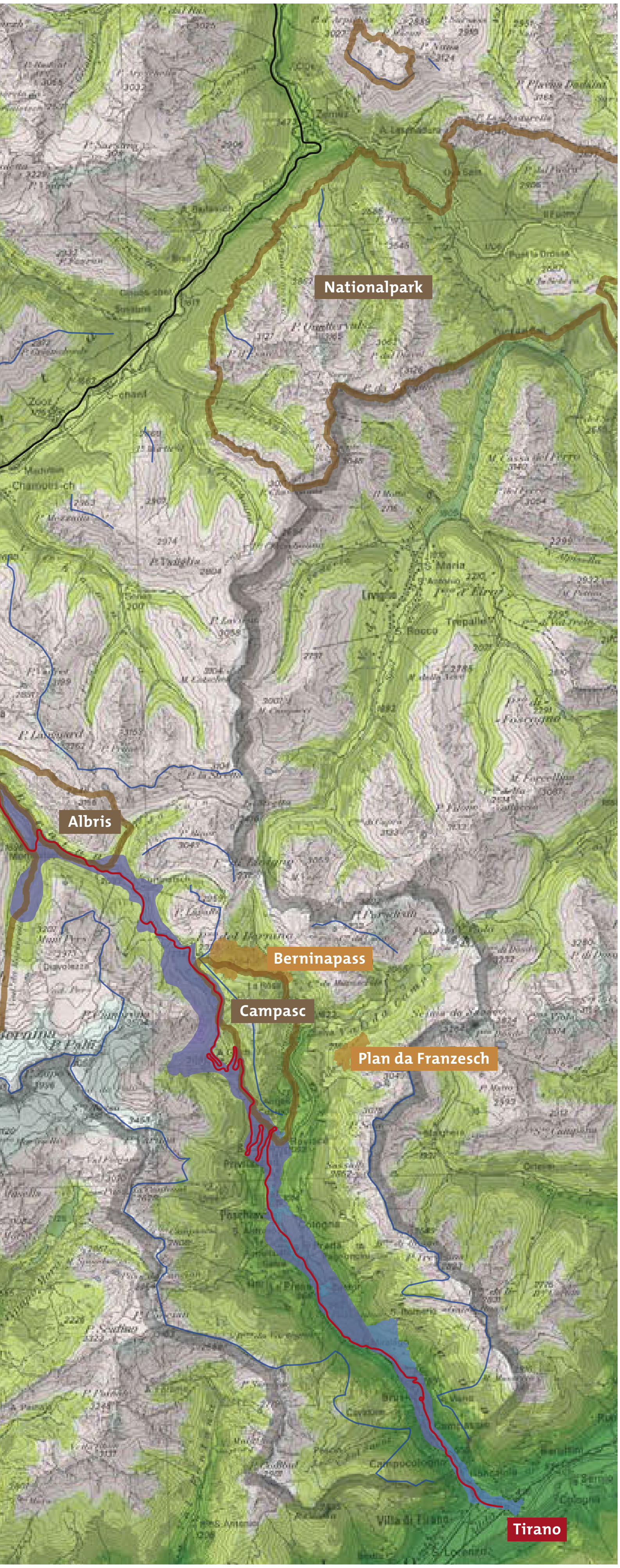
made use of the sulphur springs; the bathing facilities were luxurious by the standards of the day. After a period of stagnation, the spa hotel was sold to Kraftwerke Brusio AG (now Rätia Energie AG). Today it is once again run as a hotel. There are various sizable businesses in Brusio specialising in the vegetable and wine trades.

Veltlin

The climate in the Veltlin is varied: the air currents from Lake Como bank up against the mountains causing frequent rainfall; the region becomes progressively drier to the east. There is even a sharp contrast in conditions between the two sides of the valley. Thanks to almost continuous exposure to the sun, temperatures on the south flank are relatively high, even in winter, and snow does not accumulate as it does on the north flank. This encourages agriculture and in particular vine growing up to a relatively high altitude. The north side of the valley is colder, has fewer buildings and is characterised by extensive forests and pastures. Precipitation is unevenly distributed as the mountains to the south fend off the humid air currents from the plain. The wind blows from two directions: the south wind coming from Lake Como and the "Föhn" from the north.
The region's terrain and climate determined its settlement patterns. The centres of settlement were localised in the lower and central Veltlin valley. The villages are strung out on the southern flank, at an altitude of 500 to 800 m in a west-east direction, surrounded by vineyards. The farms below these preferred locations are mostly devoted to stock farming. The situation of the villages on the northern flank is quite different to those on the southern flank: stock farming predominates here and there is little vine growing, while farming has largely become a part-time occupation. Vine and fruit growing (18% and 10% respectively) are highly specialised in the Veltlin. The varieties of apples grown are "Delicious", "Stark" and "Golden Apples". Key focus is on the production of quality wines bearing the D.O.C. and D.O.C.G. labels (Denominazione di Origine Controllata and Denominazione di Origine Controllata e Garantita respectively). The principal varieties are "Rosso di Valtellina", "Valtellina Superiore", "Sassella" "Grumello" "Inferno", "Vagella", "Maroggia" and "Sforzato".
The valley runs from west to east: the tectonic formation is referred as the "linea insubrica". Alpine folding along this plane has created an unstable zone which was subjected to further pressure by pronounced glacial activity during the Ice Age. Consequently, the valley developed a typical open U-shape, although its floor is concealed by a thick sedimentary deposit. During the Quaternary period, the entire valley was remoulded by glacial advances with the consequent deposit of moraines indicating the course of the old glaciers. The tributary streams formed alluvial fans and cones on the flanks of the valleys.

Alpine ibex > The heraldic beast of Canton Graubünden.
K. Gansner

Thusis
Piz Beverin
Alp da Stierva
Piz Ela
St.Moritz
Stazerwald
Bernina
0 1 2 3 4 5 km
N
CH
FL
A
GRAUBÜNDEN
Thusis (CH)
St.Moritz (CH)
Tirano (I)
I



Flora and fauna

Altitude levels

3,000 – 4,000 m

2,400 – 3,000 m

1,600 – 2,400 m

1,000 – 1,600 m

400 – 1,000 m

Moor landscapes of outstanding beauty and national importance

Federal no-hunting zones

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
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Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: RIP 2000
Design: Süsskind, SGD, Chur
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2.a.8 Flora and fauna either side of the Alps

The profile of the flora and fauna along the railway line from Thusis to Tirano is unique. Besides the close-to-nature cultural landscape that has been formed and influenced by man over thousands of years, the railway also runs through intact natural landscapes. It was even the scene of a pioneer achievement in the conservation of endangered species with the re-introduction of the ibex – enthusiastically supported by the Rhaetian Railway.

The Albula/Bernina line of the Rhaetian Railway crosses the arc of the Alps near its centre. Geology and climate change continually along the stretch. The central Alpine, dry valleys of the Domleschg and Albula are under the rain shield of the northern ridge of the Alps and enjoy a characteristic continental climate. The continental aspect of the climate is even more pronounced in the Upper Engadin, for example in Val Bever, with low precipitation and low temperatures in winter. In contrast, precipitation on the Bernina Pass is more than double that in Samedan. As one moves south, the volume of precipitation decreases sharply; The lower section of the Poschiavo Valley and the Veltlin enjoy a markedly southern, dry Alpine climate.

This stretch of railway also exhibits an exceptional variety of flora, as it covers the entire range of Alpine vegetation zones. The Domleschg valley, the starting point of the railway, with its mountain sycamore forests lies in a colline-montane zone. In the Albula and Upper Engadin valleys deciduous trees occur only as pioneer growth and in the wetland forests along the rivers. This region lies mostly in the montane and sub-Alpine zone. Forests of larch and Swiss stone pine are characteristic of the Upper Engadin. Around the Bernina Pass, the climatic tree line is at an altitude of virtually 2,300 m, a limit that is only rarely exceeded in the Alps. From the Bernina Pass the view into the nival zone is unimpaired, yet only 25 km further, the route returns to the colline zone with mixed forests dominated by linden trees.

High biodiversity

No specific studies of the biodiversity of plants and animals have been made to date for the area along the Albula/Bernina line. One of the few systematic surveys of the biodiversity in the Alps has been in progress on Alp Flix, in the valley of Oberhalbstein, since 2000. So far some 3,000 different species of plants and animals have been identified there including some that were previously unknown. This confirms the assumption that high biodiversity is to be expected in sub-Alpine and Alpine cultural landscapes and there are many treasures waiting to be discovered. The preconditions for them are excellent in the Albula and Bernina regions due to the variety of geological formations and climatic zones. In the 1900s, a study of nesting birds revealed a density of 110 per 100 km^2 grid square around Thusis and 90–100 in both the Upper Engadin and lower Poschiavo valleys. In the lower-lying parts of the Poschiavo valley, over 1,000 plant species were identified in the same area. So the Poschiavo valley has one of the highest levels of plant diversity in Switzerland.

Golden eagle > The railway crosses nine golden eagle territories between Thusis and Tirano.
K. Gansner

Stazerwald in the Upper Engadin > The largest raised bog region in Graubünden.
Amt für Umwelt und Natur

Bernina Pass > Alpine grass land and patches of low-growing bushes.
Amt für Umwelt und Natur

Constancy and change of species

Various animal or plant species may change, mix or dominate along the railway line. Among the butterflies, the Blues are a case in point: Plebiscula escheri can be observed in the Albula valley, a variety that prefers the French Alpine milk vetch, widespread in sub-Mediterranean zones, and is only found on warm, dry slopes. The Magnificent Blue (Pseudiaricia nicias) is found in the Engadin and the Chequered Blue (Scolitantides orion) in the Poschiavo valley. Each of these similar types has found its ecological niche. Another interesting example is a very common species that can be seen at every station: the sparrow. The familiar house sparrow (Passer domesticus) – the male is distinguished by a grey patch on its head – lives in the north; in contrast, in the south we find the relatively little-known Italian house sparrow (Passer hispaniolensis italiae), a sub-species of the Spanish sparrow, which has a brown patch on its head. Both types are found in the Upper Engadin, at times they even mix; the highest nesting places for the house sparrow and the Italian house sparrow in Europe are found on the Bernina Pass. The various salamander subspecies react differently to the varied ecological conditions along the railway line. Salamanders have a preference for worms and must have a certain degree of humidity in their habitat. In the north we find the Alpine salamander (Salamandra atra), which is live-bearing. This species is not found in the Engadin, probably because the climate is too dry. But in the Poschiavo valley we find the spotted fire salamander (Salamandra salamandra salamandra). However, some animal species that can be observed along this stretch belong to the same species both in the north and in the south, for example the golden eagle, chamois, red deer and the fieldfare. The trip from Thusis to Campocologno crosses nine different golden-eagle territories. With a little luck the traveller may catch a glimpse of this majestic bird of prey from the train.

Striking features along the railway line

Lake of Constance Return

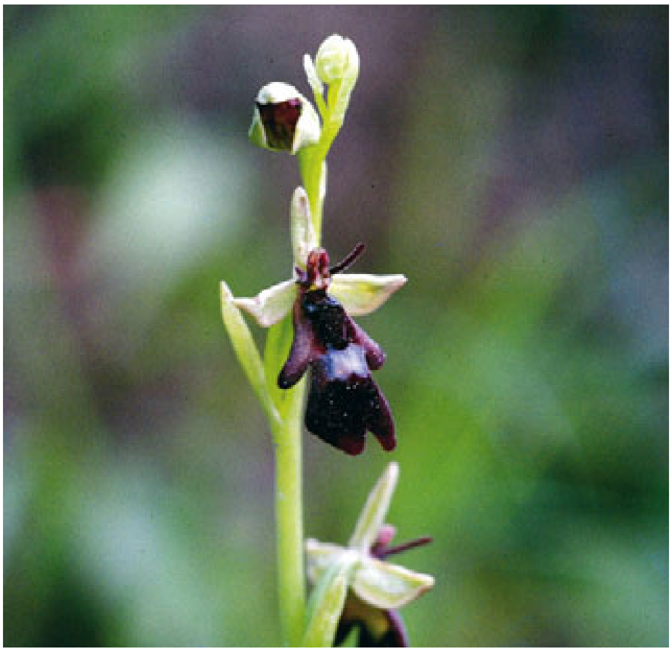
Immediately after leaving Thusis station, the train crosses the Hinterrhein (a headwater of the Rhine) and with it the most southerly spawning place of the Lake of Constance trout (Salmo trutta). The trout which hatch here make their way to the Lake of Constance in their first year, where they grow to the imposing 12 kg and 90 cm long Rheinlanken and then return – like salmon – to their birthplace to spawn. The Rheinlanken were once an important staple food for the common otter, which is no longer found in Graubünden.
Migratory birds have their own ‘international timetable’; they make a regular stopover in the Munté nature reserve, below Thusis, a wetland of trans-regional importance. Over 7,000 songbirds were ringed here at the end of the 1980s. Those that have been found again show the extent of these avian ‘international connections’: from southern Sweden, Lithuania via the Czech Republic to Algeria and Tunisia.

Hedgerow landscapes and extensive forests

Between the Schin Gorge and the Albula Pass we find a cultural landscape that is close to nature with extensive dry habitats. The field hare, butcher bird, yellow hammer, whinchat and, in southern exposures, even the zilpzalp all live here.
The zone gives way to extensive heaths of erica dotted with pine forests, though these are often shaped by man. In the late Middle Ages large

Butcher bird > The close-to-nature cultural landscape of the Albula Valley is an excellent habitat for the butcher bird.
C. Meier-Zwicky

Yellow hammer > A species found frequently in the Albula Valley.
C. Meier-Zwicky



Fly orchid (Orphys insectifera) > An orchid that attracts its prey with pheromes.
C. Meier-Zwicky

Wallcreeper > This colourful bird likes a rocky habitat - for example between Bergün and Preda.
C. Meier-Zwicky

areas of forest were often felled and used to fire the iron-ore smelting furnaces. In spring, during the flowering period, the expanses of heather look like a pink carpet. The rare capercaillie still lives in the heather-carpeted pine forests today. These forests are also the habitat for numerous varieties of orchid such as the pleasantly scented short spurred fragrant orchid (Gymnadenia odoratissima), ladies tresses (Goodyera repens) and the reddish brown dark-red helleborine (Epipactis atrorubens); the latter often grows next to the tracks. One orchid that grows alongside Filisur station attracts its pollinators with pheromones, namely the fly orchid (Ophrys insectifera).
On the shady side of the Albula valley, the predominant species in the forests are spruces and firs. The highest altitude for firs is reached behind Filisur. They are not encountered again until the descent into the Poschiavo valley.
The Alpine wall creeper (Tichodroma muraria), a strikingly colourful bird, is found in the previously inaccessible rocky slopes between Filisur and Preda that were opened up by the Rhaetian Railway.

Stopover for migratory birds

The Upper Engadin has a pronounced valley-floor character, despite the sole altitude of some 1,700 m. This is the highest nesting place in Europe for various species of bird. These include water birds like the little ringed plover, little grebe, common coot and great crested grebe, but other species are also found in the cultural landscape that is so close to nature such as the wood warbler, hoopoe, wryneck, fieldfare and collared dove. The ash is another species that does not grow anywhere in Europe at such a high altitude as in the Upper Engadin. This was taken into account recently when the Flaz stream, that flows through the flat land at Samedan, was re-routed (cf. 4.a.2). In this way the migratory birds were saved from losing their important Alpine stopover in the Engadin.
The laurel willow-wetland forests along the tributaries of the Inn are a special feature of the Upper Engadin. The laurel willow is rarely found in Switzerland apart from the small stands in the Upper Engadin. In spring, the male plants produce the characteristic fat yellow catkins (pussy willows).
The Stazerwald sustains a bog landscape of national importance; the most extensive raised bog in Graubünden where a large number of northern plant species are found, e.g. various peat mosses, innumerable sedges and carnivorous sundews (Drosera rotundifolia and Drosera intermedia). There are also extensive stretches of dry grass with continental varieties like feather grasses (Stipa sp.) and the northerly dragon’s head (Dracocephalum ruyschiana).

Pioneer conservation

The “Berninahäuser” station (today “Bernina Suot”) on the Bernina line is of historic importance in the conservation of zoological species: it was here that the successful reintroduction of the ibex began with the founding of the Albris ibex colony. The first ibex arrived by train on 14th July 1922, where they were welcomed by an enthusiastic crowd. The animals were then carried up to the high-altitude release area in woven baskets. The ibex thrived in the continental climate of the central Alps; within 40 years some 2,000 of them could be resettled to other mountain areas as the nucleus for new colonies. Once most of the formerly populated regions had been resettled, the colonies continued to flourish so that other forms of population control had to be adopted. Above all, the important protected forests above Pontresina could not sustain more

Alpine ibex > The founding of the Alpine ibex colony in 1922 marked the start of the successful resettlement of the ibex in the Alps.
Graubünden Ferien

European Star-of-seven (Trientalis europaea) > a glacial relict found near the Bernina Pass.
Amt für Umwelt und Natur

Chestnut orchard > The sweet chestnut, a species that is widespread in Mediterranean countries, flourishes around Brusio.
Amt für Umwelt und Natur

than a certain number of ibex. The introduction of the Alpine ibex in 1977 meant the beginning of sustainable management of this nationwide protected species; Graubünden's traditional hunting-by-permit system proved that it could also cope with this challenge. The ibex can even be observed from the train, above all in spring when the meadows begin to acquire their lush green appearance.

The area between Pontresina and the Bernina Pass, where the first ibex were released, was already declared a federal no-hunting zone ("Bernina-Albris") in the 1920s. Together with "Piz Ela" and "Piz Campasc", half of the no-hunting zones in Graubünden are in the Albula/Bernina region; they also constitute fundamental elements of animal diversity protection in Graubünden.

Express through the biodiversity of the south side of the Alps

From the Bernina pass as far as the Italian border at Campocologno, a stretch of only 25 km, the Rhaetian Railway runs from the Alpine grass and low bush vegetation zone through the larch and Swiss stone pine stands near the crest of the pass to the colline zone at the edge of the vine-growing region of Veltlin. The star-of-seven (Trientalis europaea) that grows in a few places on either side of the Bernina Pass is an otherwise rare glacial relict; one of a number to be found here. Several species thrive at Brusio, for example the sweet chestnut (Castanea sativa), the downy oak (Quercus pubescens), the hop hornbeam (Ostrya carpinifolia), the Mediterranean hackberry (Celtis australis), the Mahaleb cherry (Prunus mahaleb) and the fig which are found primarily in the Mediterranean zone. The numerous grass patches on the rock terraces along the railway line, supporting very few species, are particularly striking. They are built up by tussocks of Festuca varia. In between, tawny fire lilies (Lilium bulbiferum croceum) may occasionally be seen and there are also a number of species of house leek (Sempervivum sp.). Similarly, in the animal world, we also find species from the southern or eastern Alps, for example the scorpion (Euscorpius alpha) and the barred warbler (Sylvia nisoria). In contrast, the Postsolenobia thomanni, a small butterfly and one of the genuine bagworms, found in the lower Poschiavo valley has not been identified anywhere else to date. It is found on the rocks, walls and dykes that are so abundant along the Bernina line and often owe their existence to the railway itself.

The birds and bats also have their own 'trans-regional connections' here, and so do the few offspring of the marbled trout (Trutta marmorata) that used to migrate as far as the Adriatic.

Veltlin Valley

The original vegetation of the Veltlin Valley has been radically changed by settlement patterns that brought agriculture and forestry as well as livestock grazing. The region's varied geology and morphology determine the diversity of its flora. Deciduous trees, namely sweet chestnuts, beeches, sycamores, oaks and limes grow on the valley floor, while coniferous forests dominate the landscape at higher altitudes. Low bushes such as alpine rhododendron, juniper and myrtle predominate over 2,000 m.

The terraced vineyards along the stretch from Ardenno to Tirano are striking. They present a well-tended, impressive cultural landscape that has been created and looked after by the people of the valley over hundreds of years. There are extensive orchards on the valley floor.

The mountain region of the province of Sondrio with its diverse climatic zones is an ideal habitat

Veltlin > Vineyards have sketched out the cultural landscape pattern.
Fondazione Provinea

Veltlin > Terraced vineyard near Montagna.
Fondazione Provinea

Veltlin > Red deer are at home on the southern flank of the valley.
K. Gansner

for a varied Alpine fauna. Alpine ibex and chamois can be observed both on the south and north-facing slopes. Red deer prefer the south-facing slopes, while hares and marmots are found up to an altitude of 2,000 m. Foxes, stoats and squirrels are common. Rare birds can also be observed: capercaillies in the coniferous forests on the north side of the valley along with black grouse, grouse, rock partridge and ptarmigan. Birds of prey like the eagle owl and golden eagle have always been found here, while the bearded vulture was reintroduced in recent decades. Among the factors harmful to the fauna are over-hunting, the widespread use of insecticides, the construction of more and more roads in the mountain regions and the increasing number of winter sport facilities. However, the decrease in pasture and tilled land has expanded the habitat for wild fowl and red deer. The maintenance of fish populations depends on careful management and regular restocking. Various superior table fish like lake and river trout and grayling are found in the Adda and Mera rivers and the various streams in the Veltlin.

The following areas are registered nature reserves or nature parks: the Farggia Waterfalls at Chiavenna, the “Le Marmitte dei Giganti” glacier moulins at Chiavenna, Piuro and Prata Camportaccio, Pian di Spagna and Lake Mezzòla. The regional park of “Orobie Valtellinesi” covers the entire Orobiche Alps, with peaks rising 2,000 to 3,000 metres and including exceptional natural habitats and stretches of countryside. The game park at the entrance to the Parco di Aprica is also notable. Stelvio National Park is one of the oldest national parks in Italy and the largest in the Alps. It lies at the heart of the Central Alps and is flanked by the lofty peaks of the Ortler-Cevedale massif. A hundred years ago, the last ibex survived here: they are the ancestors of the ibex colonies now thriving throughout the Alps. Another important national nature reserve is the “Paluaccio di Oga”. Although these nature reserves are not within the perimeter of the nominated site, they are adjacent to it.

Carschenna near Sils i.D. > Rock drawings mark the site of religious rituals in the Bronze and Iron Ages.
M. Bühler


Thusis
Bever
St.Moritz
0 1 2 3 4 5 km
N
CH
FL
A
GRAUBÜNDEN
Thusis (CH)
St.Moritz (CH)
Tirano (I)
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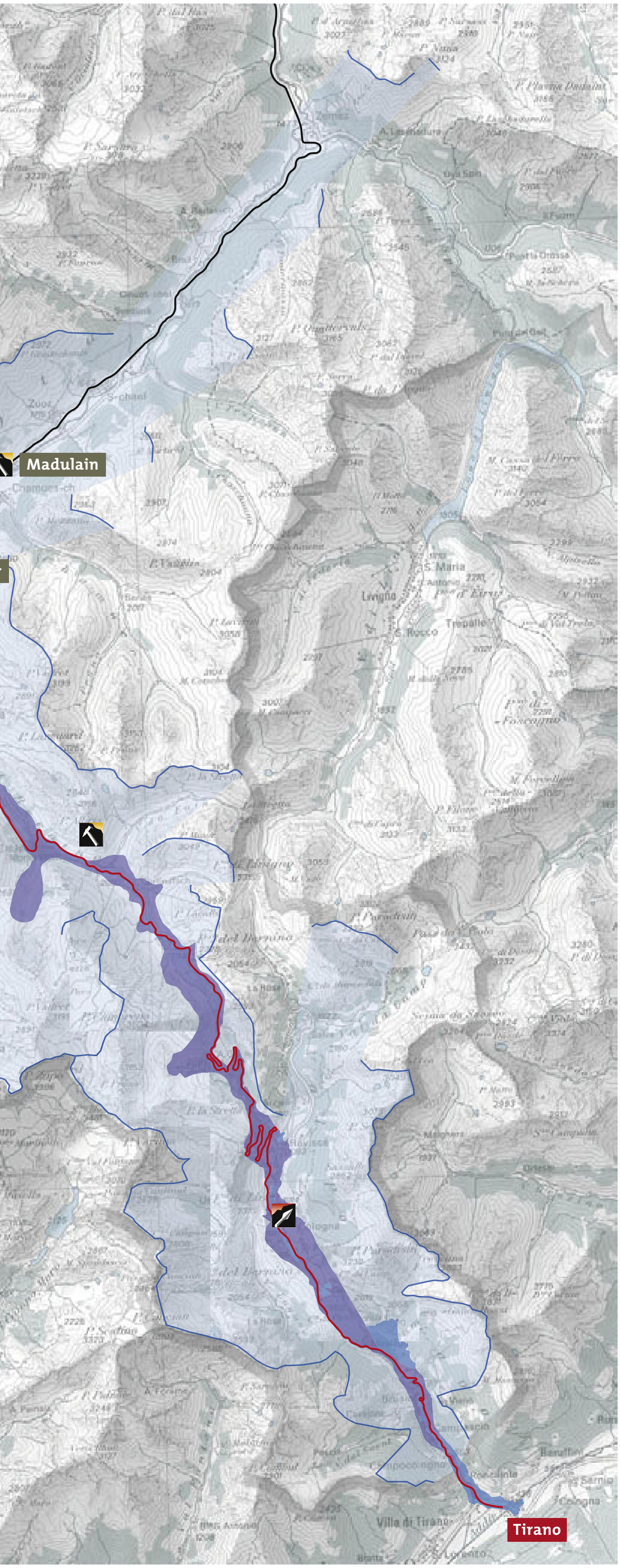


Archaeology along the Albula and Bernina line

- Locations of archaeological finds
- Ore storage sites
- Therapeutic springs

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Mathias Seifert
Design: Süsskind, SGD, Chur

2.b History and Development

2.b.1 Archaeology along the Albula and Bernina line

Archaeological finds in the cultural landscape of the Albula/Bernina date back to the Neolithic. Thanks to the routes across the passes and the resources of ores, these mountain valleys retained their importance as settlement locations through the Bronze Age, Iron Age and Roman period until the threshold of the Middle Ages. Despite the cultural links with the north and south, the regional independence, due to their remoteness, is striking in all periods of prehistory and early history.

After the end of the last Ice Age, some 19,000 years ago, the Alps of the Graubünden were modelled to form the landscape we know today by the retreat of the glaciers and the erosive effect of the rivers flowing from them. Ranges running from west to east separate the Engadin from the Albula and Poschiavo valleys and are the watersheds for the waters of the Albula, Inn and Poschiavino rivers flowing north, east or south. They also separate the three distinct cultural areas of the Albula, Upper Engadin and Poschiavo Valleys. Due to the remoteness, the regional character of these valleys is usually clearly recognisable in the pattern of archaeological finds. The fundamental cultural orientation to the north is determinant for the Albula Valley, and that to the south for the Upper Engadin and Poschiavo – and this through all periods of pre- and early history.

Palaeolithic and Mesolithic (11,000 – 10,000 BC and 10,000 – 6,000 BC)

The first inhabitants of the alpine region lived towards the end of the Palaeolithic era. As hunters they followed the game to the sparse vegetation of the mountain valleys coming from what is now southern Germany in the north and upper Italy in the south. The Domleschg and Poschiavo valleys were two of the gateways for settlers. To date there have been no finds along the Albula-Bernina route to document this pioneer phase. The subsequent changes to the valleys due to flooding and rockfall have washed away relics of the camps, which were only used for a few days, so that any archaeological finds throughout the alpine region indicating these early settlers are really lucky finds. Similarly there are no known habitation or burials sites from the following Mesolithic period, when the people continued to live as hunters and foragers under changed environmental conditions. However, relevant finds in the neighbouring valleys suggest seasonally used camps in the Albula/Bernina region as well. That the Alps were crossed in both directions even in the Mesolithic era is evidenced by the import of high quality flint to the neighbouring valleys.

Neolithic (6000 – 2200 BC)

There was a fundamental change in the way of living during the Neolithic era. The hunters and foragers started planting crops and raising animals, they settled, built wooden houses and start-

Cazis-Petrushügel > The hill plateau was settled in the Neolithic age (some 2800 BC).
Archäologischer Dienst Graubünden

Neolithic artefacts found in the high Alpine region.
All photos: Archäologischer Dienst Graubünden

Obervaz > Flint blades.

St. Moritz > Flint arrow heads.

Bernina Pass > Hard rock axe blades.

Poschiavo area > Copper axe (some 3000 BC).

ed to make clay vessels. As flooding, rockfall and rockslides are always to be expected in the mountains, the villages are usually built on hills on the flanks of the valleys. The Neolithic Petrushugel high-altitude settlement at Cazis (some 2800 BC) is located on a high terrace on the flank of the Heizenberg. Several archaeological excavations have produced a rich inventory of clay vessels, bone, flint and stone tools. Erosion has wiped out any traces of the settlement on the 1,800 square metre plateau. Specially decorated clay vessels document the connections with south German regions.
According to present findings, the Neolithic people settled in places below 1,000 m; only isolated flint tools and weapons have been found at higher altitudes to date. However, a remarkable flint blade was found by a hiker in the Albula Valley at 2,250 m, above Obervaz. An arrow head was found during building work in St. Moritz, in the Upper Engadin. A stone axe head found high above the Poschiavo valley proves that people did cross the high altitude zone. All these artefacts were probably used by passing traders and hunters or herdsmen who spent the summer on the alps with their livestock. A copper axe was discovered in the Poschiavo area; the same type as the one carried by the "Ice Man" found on the Similaun glacier. This find suggests that the Alpine resources of ores were already sought and exploited 3000 BC.
In view of the proven transfer of raw materials from south to north (flint) and away from the Alps (hard rock for axe heads), we can assume that there was a well used network of paths over the alpine passes already in the Neolithic era. The variety of shapes and decoration on the ceramic vessels and jewellery makes it clear that despite the volume of transit traffic, the Domleschg, as far as the Albula Pass, was culturally oriented to the north, whereas the Poschiavo valley, was rather oriented to the south due to the barrier of the Bernina massif. To date it has not been possible to evidence any Neolithic settlement in the Upper Engadin which lies between them.

Bronze Age (2200 – 800 BC)

With the triumphal advance of bronze (an alloy of copper and tin) as the new tool-making material, the importance of the Alps as a mining area increased. Copper ore is found at various places along the Albula / Bernina route and in the neighbouring valleys. The deposits at Filisur, Bergün / Bravuogn, Madulain and Pontresina deserve special mention. Large slag heaps, the waste dumps from ore processing, have been discovered providing tangible evidence of the prehistoric mining activities. A dump of broken bronze hammers found at Filisur indicates the importance of mining in the Albula Valley during the Bronze Age.
The clear increase of settlements during this period, evidenced by archaeology, was not solely due to the Bronze Age people's search for and exploitation of ore deposits. Progress in planting crops and keeping animals led to an improved economic basis that was reflected by the growth in population. Settlement sites and individual finds at various locations along the Albula/Bernina route prove the existence of Bronze Age villages. The Cazis-Cresta settlement is quite exceptional. It was built in a six metre wide and 100 metre long rock cleft on a hill flanking the Heinzenberg. This site was inhabited throughout the Bronze Age and has provided a unique range of finds in clay, stone, bone and metal. The Bronze Age settlement site on the rocky hilltops of Craistas Pitschna

Filisur > Bronze Age hoard with broken bronze hammers.
Archäologischer Dienst Graubünden

Bergün/Bravuogn-Craistas Pitschna > The Bronze Age settlement in a dominant position on a rocky outcrop.
Archäologischer Dienst Graubünden

Madulain > Today, the Bronze Age waste heap on the Alp Es-Cha is almost completely overgrown.
Archäologischer Dienst Graubünden

Bergün/Bravuogn > Isolated find of a bronze bangle (some 1300 BC).
Archäologischer Dienst Graubünden

Madulain > Isolated find of a Bronze Age dagger blade (some 1400 BC).
Archäologischer Dienst Graubünden

and Craistas Grond at the entrance to the wide Bergün/Bravuogn valley basin protected and controlled the route across the Albula pass.
The proximity of the copper ore deposits in Val Plazbi were probably another reason for establishing a village here. A slag heap discovered on Alp Es-cha near Madulain in the Upper Engadin, from about 900 BC, is linked to a settlement site that has not yet been located; chance finds like a bronze dagger back up this hypothesis. A bronze sickle found in Bever indicates that crops were planted in the Engadin up to an altitude of 1,700 m at this time. Mot la Scera near Poschiavo, to the south of the Bernina Pass, has already been localised as a Bronze Age settlement site. Isolated finds at various points indicate the presence of villages in the Poschiavo valley during the Bronze Age, even if these have not yet been discovered.
Transalpine trade with raw materials and finished products also increased as a result of denser settlement. A well-developed trade and carrier traffic across the across the Bernina and Albula passes in the Bronze Age can be assumed. Tools, weapons and clay vessels from the south German or north Italian regions found their way into the inner recesses of the Alps.
The far-reaching connections are evidenced not only by the goods transported. The unique rock art at Carschenna (at Sils i.D.) is striking as the oldest evidence of cult activities. These Bronze and Iron Age drawings on several slabs of rock along a rock face at the entrance to the Albula valley, 500 metres above the valley floor, are the most important and largest collection of rock drawings in Switzerland. The chiselled drawings – concentric circles, animals, human figures and line systems – can probably be interpreted as symbolic cult representations. It is interesting that comparable images are also found in the Valtellina and Val Camonica, at the southern tip of the Albula/Bernina route.
The holy waters are another focus of religious activity. In the alpine zones with their deposits of ores, warm springs enriched with iron and sulphur rise to the surface in various places. It is probable, though not yet confirmed, that the springs at Rothenbrunnen and Alvaneu, which are still used today, were holy sites in the Bronze Age as bronze artefacts have been found near them. The Bronze Age construction to tap the spring at St. Moritz is unique. This comprises three hollowed out larch trunks as pipes, a log built wooden box frame, four wooden hooks and a sturdy log ladder. They were embedded in moist clay which explains why they have been so well preserved. Dendochronology (tree ring dating) has established that they originate from the 15th century before Christ. Bronze votive offerings were laid at the base of one of the pipes (a dagger, three swords, a needle).
The differentiation of the regional cultural areas Albula, Upper Engadin and Poschiavo valleys, with their relevant orientation to the north and south, continued during the Bronze Age. Nevertheless a mesh of connections across the ridge of the Alps can be assumed. The proportion of foreign forms in the finds makes it clear that not only trade wares found their way across the Alps. Again and again, groups of people from the south and from the north moved to this region contributing to the blending of the various population groups.

Iron Age (800 – 15 B.C.)

Knowledge of how to process iron reached the Alps towards the end of the Bronze Age. Processing copper to make bronze was easier than making iron, but the new metal offered advantages with respect to hardness and elasticity. The switch to making tools and weap-

Bever > Chance find of a bronze sickle (about 1000 BC).
Archäologischer Dienst Graubünden

Poschiavo > Chance find of Bronze axe (about 1500 BC).
Archäologischer Dienst Graubünden

Carschenna at Sils i.D. > Section of a rock slab engraved with signs and symbols (Bronze/Iron Age).
Archäologischer Dienst Graubünden

St. Moritz > The Bronze Age larch wood arrangement to tap the spring.
Archäologischer Dienst Graubünden

Scharans > Bronze fibulae – used to fasten clothes – made in the Celtic tradition, from the Scharans-Spundas settlement (some 200 BC).
Archäologischer Dienst Graubünden

Pontresina > Chance find; Iron Age spearheads (3rd/2nd century BC).
Archäologischer Dienst Graubünden

ons from iron was very rapid in the Iron Age. Bronze was still used, but only for jewellery. Deposits of iron compounds are much more common than copper ore along the Albula/Bernina route. The deposits at Filisur, Bergün/Bravuogn, Madulain and Pontresina deserve special mention. As the resources were exploited on a large scale from the Middle Ages until modern times, hardly any traces are left of mining in the Iron Age. Large slag heaps and charcoal dumps indicate systematic mining by Iron Age standards. The distribution of the few, known settlement sites gives an incomplete picture of the effective situation during the Iron Age; research should fill this gap. In view of the broad distribution of mining and the transalpine exchange of goods between the Celts in the north and the Etruscans in the south, the density of settlements along the Albula/Bernina route must have been considerably higher than in the Bronze Age. To date, village sites have been found only in the Domleschg valley. The settlement near Scharans, built on the steep flank of the Spundas hill at the entrance to the Albula Valley, dates back to the 2nd century BC. The wood and dry stone wall buildings were scattered across the hillside. They were set deep into the slope on the uphill side and supported by columns on the downhill side. Besides regional characteristics, the finds reflect a certain Celtic influence. There was another Iron Age village at Cazis on the Crestas hill already mentioned; this was inhabited throughout the Bronze Age. Iron lance heads have been found in the Upper Engadin and Poschiavo indicating that there were probably settlement sites there.
With the appearance of the Celts in the north and the Etruscans in the south the north-south cultural orientation of the valleys becomes more distinctly visible in the range of finds than in the previous eras.

Roman Era, Early Middle Ages (15 BC – 400 AD, 400 – 800 BC)

In 16 – 14 BC, Drusus and Tiberius, the stepsons of the Emperor Augustus, led the military conquest of the alpine region. Some remarkable finds at the entrance to the Albula Valley document this historic event that has left its mark in Graubünden to the present day.
The campaign, which progressed from Bergell over the Septimer Pass into the Albula Valley and then down the Rhine Valley to the Lake of Constance, met with resistance from the inhabitants. Lead catapult ammunition bearing the sigils of the Roman legions was discovered above Tiefencastel as well as Roman and alpine battle axes and lance heads indicating a battle site. Incorporation in the Roman Empire brought more than military control by Rome across the Alps; the achievements of the highly developed culture from the south rapidly changed the way of life and the settlement landscape of the alpine peoples. The expansion of the road network, the coinage system, the building of stone houses, baths and Roman cuisine are only a few examples. The virtually complete pervasion with Roman culture meant that the regional differences are no longer recognisable in the archaeological pattern; this also applies for the Albula / Bernina region.
To date Roman settlement sites have been discovered in the Domleschg and Albula valleys. There was a Roman hamlet perched on the plateau of the imposing and naturally fortified Hohenrätia crag at Sils i.D. valley.
No Roman village settlements have been definitively localised in the Upper Engadin and Poschiavo valleys to date. But isolated finds along the St. Moritz – Poschiavo stretch do evidence transit traffic, so the existence of Roman villages appears probable.

Tiefencastel > Lead catapult ammunition with the sigils of the Roman legions.
Archäologischer Dienst Graubünden

Tiefencastel > There was a fortified settlement on the present church hill in late Roman times.
Archäologischer Dienst Graubünden

Sils i.D. > The terrain around the Middle Ages fort of Hohenrhätien was settled already in Roman times.
Archäologischer Dienst Graubünden

Pontresina and Poschiavo > Chance finds of Roman spearheads (1st – 4th century BC).
Archäologischer Dienst Graubünden

Mining continued to be an important economic factor in Roman times but, analogous to prehistoric mining, direct proof is rare as ore was mined uninterruptedly until modern times. However, the smithy pits found in some settlements do indicate systematic exploitation.

With the increasing threat from invading Germanic tribes in conjunction with the internal decline of the Roman Empire in the 4th century, security and prosperity fell in the alpine region. Subsequently fortified settlements appear in various places. The striking late Roman complex at Tiefencastel, on the present church hill, marks the important strategic point where the Albula and Julier separate. The remains of several 4th – 5th century pillar dwellings complete with hearths have been excavated here. The modest number of finds – apart from an excellent bronze disc-shaped fibula, for the most part vessels made from alpine soapstone – presage the economic and political decline of the Roman Empire.

According to legend, the Christian faith spread through the alpine region already in the 2nd century; written and archaeological sources, however, can only evidence it from the 5th century. The transition to the Christian religion was gradual and it is not rare for the early churches to be built on Roman religious sites.

The number of finds dwindles towards the end of the Roman era. A few isolated finds and graves along the Albula/Bernina route indicate the continued existence of the settlements in the 5th and 6th centuries. The alpine region did not flourish again until under the sway of the Merovingians and later the Carolingians. The great importance of the passes linking north and south is underlined by the impressive churches and monasteries that were built in Domleschg and along the Albula route between 600 and 800.

Sils i.D. > Fort Campi.
R. Pedetti

2.b.2. From ancient to modern: state, society, economy and culture in the Albula / Bernina region

The Albula/Bernina region shares the destiny of alpine Rhaetia. The entire region was incorporated in the Roman Empire and christianised; later it fell to the emergent Germanic Empire. The feudalisation process led to the dominion of the Bishop of Chur. However, the communities soon became the most important political players: they joined forces in the Drei Bünden, the political predecessor of the Canton Graubünden. Under their auspices traffic flourished on the Albula/Bernina route from the late Middle Ages. In pre-modern times, the autonomy of the communities led to confessional schism in the Albula/Bernina region while maintaining trans-local solidarity. The social order presented a similar pattern: aristocratic families dominated the Drei Bünde, but they always had to seek their power base in several communities.

Late antiquity: Christianisation

The central alpine region was integrated in the Roman Empire relatively late. However, the influence of Roman civilisation was all the more long-lasting. The alpine peoples, primarily the Rhaetians, developed into loyal custodians of the Roman cultural heritage: Christianity and the Latin language.

About 300 AD, Chur was promoted to the capital of the province "Raetia Prima" – the alpine part of the province Raetia – and is already mentioned as a bishopric in 451. The Chur church association of the time remained restricted to the town and its immediate environs; the territorial diocese came later.

The first missionising waves to reach Rhaetia came from within the empire, from the south, gradually building up a network of extensive country parishes. The patron saints help to differentiate the various phases of this process. Dedication to St. Peter indicates papal influence on the founding of the church, particularly in the 5th century. It has been observed that the churches lining the pass routes frequented in Roman times were dedicated to Peter the apostle. This also applies for the Albula/Bernina route. There are churches dedicated to St. Peter in Alvaschein (Mistail), Bergün/Bravuogn, Samedan and Poschiavo.

Early Middle Ages: Regionalisation

After the collapse of the western Roman Empire only the "Raetia Curiensis" or "Churrätien" – significant elements of the provincial organisation – survived in Raetia Prima. Political power was in the hands of the local landowners. The most respected dynasty took charge of government and also filled the office of Bishop of Chur. The church citadels – old retreats that became places of worship – were a characteristic feature in Churrätien. The best known of these retreats and citadels is the "Hohenrätien" on a rocky outcrop overlooking Sils in the Domleschg valley. Its church, a baptistery on the left side of the valley, is dedicated to St. Johannes Baptista [St. John the Baptist]; the bridge over the Rhine at Thusis was used principally for going to church.

Churrätien was semi-autonomous, but subject to various overlords over the years: first the Ravennatic Ostrogoths then, from 536, the Merovingian

Sils i.D. > Ehrenfels Castle. Built in the first half of the 13th century. Renovated as a youth hostel in 1934.
Ch. Meisser / Staatsarchiv, Chur

Sils i.D. > The Campi fort. Founded around 1200 by the von Campell lords. Given up around 1740.
Ch. Meisser / Staatsarchiv, Chur

Brienz/Brinzauls > Belfort fortress. Built in 1228. Expanded to a noble residence in several stages. Destroyed 1499.
Ch. Meisser / Staatsarchiv, Chur

Pontresina > The Spaniola tower. Pentagonal residential tower, built 1210 under the lords of Pontresina. Given up around the end of the 14th century.
Ch. Meisser / Staatsarchiv, Chur

Franks. The bishopric of Chur – the diocese was now identical with the territory of Churrätien – was able to shake off the close ties with Milan; the Bishop even attended the Frankish imperial synod in Paris as early as 614. With the introduction of the regional constitution of 806, Churrätien fell to the Carolingian regency and the territory was divided into two districts or counties: Oberrätien and Unterrätien or Upper and Lower Rhaetia. The districts were broken down into several "ministeria", fiscal-military administrative areas. The district count (Gaugraf) assumed the secular rule in Churrätien on this basis, together with the administration of most of the churches. However, the bishop lost almost all his possessions by this move.

How were things organised now, particularly in the Albula/Bernina region? The Upper Engadin, the "ministerium de Endena", the Albula the "ministerium de Impetinis" were now administrative districts in Oberrätia. Centre of the latter was "Castellum Impitinis", Tiefencastel/Casti. The local churches were part of the royal possessions; there were others in the upper Albula valley.

With the end of the Ostrogoth hegemony over the alpine region, the Lombards had moved into Upper Italy in the 6th century; the start of the Frankish era in Churrätien. This cut off the southern link to the Albula route. Only with Charlemagne's victory over the Lombards in 774, did the Veltlin and Poschiavo valleys open up again to influence from the north. Charlemagne placed his possessions in these valleys at the disposition of St. Denis abbey near Paris. In 824, his grandson Lothar I, ceded the parish churches in the upper Veltlin to St. Denis; these included the church in Poschiavo which is mentioned as "postclave" or "post lacum": the area "behind" the Lake of Poschiavo. The fact that the name given has a Latinate derivation, indicates that the valley was developed under southern influence.

High Middle Ages: Feudalisation

At the partition of the Carolingian empire in 843, Churrätien fell to the east Frankish or "German" Carolingians and the bishopric of Chur was allocated to the archbishopric of Mainz. From the 10th century, Churrätien belonged to the German Empire that had developed from the east Frankish empire. Emperor Otto and his successor rescinded the Carolingian measures. They again vested the Bishop of Chur with goods and privileges. The county of Oberrätia was not formally abolished but lapsed in the course of the 11th century. This shift in authority laid the foundation for episcopal power.

The feudalisation process started at the same time: the exercise of power by a prince of the church was always indirect and had to be implemented by vassals; but the feudal lords craved independence and set up their own rule. Vice versa, the bishop managed to force free noble families into dependence. The castles of Ehrenfels and Campi above Sils in the Domleschg valley were at first the seats of two independent lords; by the 14th century they were part of the Bishop's retinue. Hohenrätia had been feudalised: the citadel now had a residential tower housing the bishop's bailiffs.

The Albula valley was ruled first by the lords of Greifenstein and then by their heirs, the Wildenbergs: Rhaetian branches of noble families from Swabia. Their residence was Greifenstein castle at Filisur, their bailiffs occupied the tower at Bergün/Bravuogn where they held the patronage rights of the parish church. By 1400 the Bishop of Chur had managed to acquire all these offices. On the lower reaches of the Albula river, the

Samedan > "La Tuor" village tower. Formerly a residential tower. The seat of the lords of Samedan in the 13th century. Also used as a prison.
Denkmalpflege Graubünden, Chur

Poschiavo > Torre di Municipio. Built as a defence tower for the episcopal bailiff in the first half of the 13th century. Later the seat of the Olgiati family. Converted for use as the Rathaus in the mid 16th century. The belfry was added in 1651.
Denkmalpflege Graubünden, Chur

Poschiavo court flag > (Comun grande di Poschiavo).
Rhätisches Museum, Chur

Bergün/Bravuogn > The "Platz" or "Roman Tower". Built in the 13th century as official seat of the lords of Greifenstein. Converted to a bell tower in the early 17th century.
Denkmalpflege Graubünden, Chur

episcopal overlordship was interrupted by the power base of the lords of Vaz. The latter had achieved independence by building the stronghold of Belfort at Brienz/Brinzauls; from there they organised the colonisation of the Landwasser valley (Davos). They also held the patron rights to Alvaneu. Tensions escalated in 1323: the Bishops vassals and the Vaz retainers feuded at Davos and Bergün/Bravuogn; the latter was burned to the ground.

Relics of the county of Oberrätia were preserved in the Upper Engadin. The Swabian heirs of the counts sold these possessions – including the parish churches of Zuoz, Samedan and St. Moritz – to the Bishop of Chur in 1139 and the source of the Albula river was defined as the most northerly limit of the entire region. The office of the episcopal magistrate (judge throughout the valley) had been in the hands of the von Planta family since 1300; the Planta's had ousted the noble families who had previously resided in the towers of Samedan and Pontresina. The Bishop of Chur claimed dominion over the Poschiavo valley as well, although the valleys south of the Bernina were actually part of the diocese of Como. Citizens of Como owned land in the Veltlin and Poschiavo valleys. Nevertheless, it was a vassal of the Bishop of Chur, who leased the silver mines on the Bernina Pass in 1200; Poschiavo took one half and a private citizen of Como the other.

Late Middle Ages: Communalisation

In 1367, the Chur cathedral chapter, the noble retainers of the bishop and valley communities joined forces. Their association – the "Gotteshaus" (House of God) or "Chadè" – was to control episcopal policy and administration. In the 15th century the Gotteshausbund (House of God Union) linked up with the two other Bünde that had formed alongside it: with the upper or Grauen Bund (Grey Union) and the Bund der Zehn Gerichte (Union of Ten Courts). The new political entity, the Drei Bünden (Three Unions) would form a small, but self-assured little republic in early modern times: the predecessor of the Canton Graubünden.

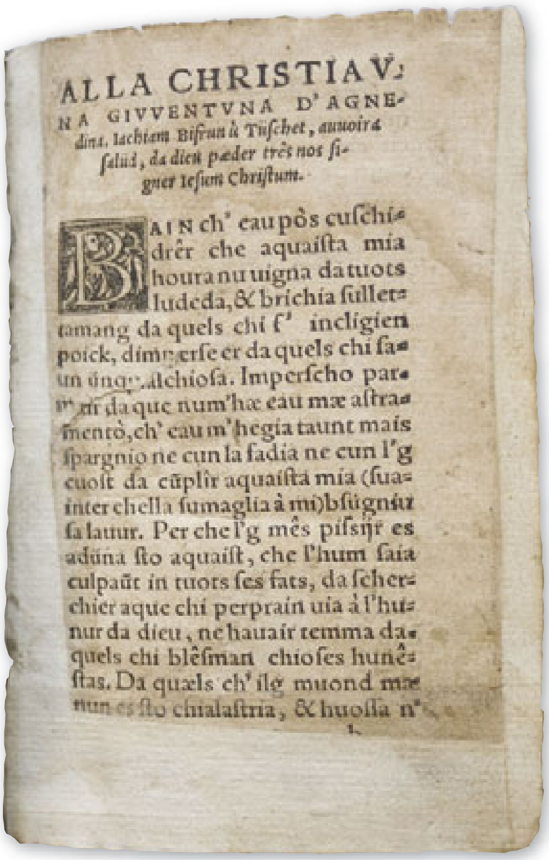
The Gotteshausbund integrated most of the valley communities in the Albula/Bernina region. The community of Belfort (Lantsch, Brienz/Brinzauls, Surava, Alvaneu and the villages in the outer Landwasser valley), which belonged to the Zehngerichtebund was an exception: this was a late consequence of the dominion of the lords of Vaz.

The community of Poschiavo – the "Comun grande" or greater community covering the whole valley – did not join the Gotteshausbund until later. They had long sworn allegiance to the bishop and he had promised protection against Como. But in 1350 the military occupation of Poschiavo by Milan – Como's overlord – severed the connection with the Gotteshaus. Subsequently the Podestà or most important office (president and judge) in Poschiavo was repeatedly filled from Milan or Como.

In 1408, the people of Poschiavo managed to shake off the dominion of Milan. They rose up against the Olgiati family from Como, the Milanese governor, and joined the Gotteshausbund. From then on the community enjoyed extensive autonomy. However, the bishop reserved the right to appoint the Podestà; this right did not revert to the community until the 1540s. The former Palazzo Olgiati in Poschiavo was now taken over as Rathaus or town hall.

The communities in the Upper Engadin also became more powerful and soon broke free from the dominance of the von Planta family. When the Gotteshausbund was founded, three members

The New Testament translated into Rumansh by Jachiam Bifrun.
Fundaziun Not Vital, Ardez



ALLA CHRISTIAV-
NA GIVVENTVNA D'AGNE-
dina. Iachiam Bifrun à Tüſchet, auuoira
ſalüd, da dieu pæder três nos ſi-
gner Ieſum Chriſtum.

BAIN ch' eau pòs cuſchi-
drêr che aquaiſta mia
houra nu uigna da tuots
ludeda, & brichia ſuller-
tamang da quels chi ſ' incligien
poick, dimperſeer da quels chi ſa-
un ünq...alchioſa. Imperſcho par-
... da que num'hæ eau mæ aſtra-
mentò, ch' eau m'hegia taunt mais
ſpargnio ne cun la fadia ne cun l'g
cuoſt da cũplir aquaiſta mia (ſua-
inter chella ſumaglia à mi) bſügniu
ſa lauur. Per che l'g mês piſsijr es
adüna ſto aquaiſt, che l'hum ſaia
culpaũt in tuots ſes fats, da ſcher-
chier aque chi perprain uia à l'hu-
nur da dieu, ne hauair temma da-
quels chi blêſman chioſes hunê-
ſtas. Da quæls ch' ilg muond mæ
nun es ſto chialaſtria, & huoſſa n'

of this family still represented the entire community. After 1460 the dispute over the magistrate's office became open, with the bishop playing a precarious mediating role. In 1526 the community acquired the right to elect their district magistrate independently.

The struggle against the von Planta family also led to the secession of the upper part of the valley. In 1462, the jurisdiction area fell into two independent civil court districts: Samedan with Bever and the other villages in the upper valley took its place with equal rights alongside Zuoz, the von Planta power base. This partition corresponded to the borders between the old parishes or "Pleifs".

The 15th century was not only the time when the political communities in Graubünden were established, but also a peak period for transalpine traffic (cf. 2.b.2). The Dukes of Milan allowed the people of Poschiavo to import certain quantities of Veltliner wine free of duty. Later Veltliner wine was exported, above all over the Bernina Pass. Tirano and Bormio were regional markets. The volume of traffic rose again in 1512, when the Drei Bünde gained power over the Veltlin valley together with Bormio and Chiavenna.

The organisation of transport on the Albula/Bernina route followed the local-focus mentality of the people from Graubünden: haulage and road maintenance were the responsibility of the communities. The carters in each community organised themselves on a cooperative basis; the "Port".

Early Modern Times: Confessionalisation

Establishment of the Drei Bünde on a community basis led to dual confessionalisation. With the advance of the Reformation, every parish was free to go over to the new movement. This principle, pronounced in the 1520s, was followed a generation later by the declaration of protection of minorities: Protestant families were to be tolerated in Catholic communities and vice versa.

Confessionalisation did not start in the Albula/Bernina region until the mid 16th century. The initiative came from the south: Italian faith refugees found a safe haven in Poschiavo. A printing press was soon set up which also supplied the Engadin with Protestant texts. Even by 1600 both Poschiavo religious communities lived together, virtually unseparated: parish churches and cemeteries were used by both faiths, priests and pastors were both paid from community funds.

The Upper Engadin communities also acknowledged their allegiance to the Reformation about the middle of the century. Besides the Italian exiles, Jachiam Bifrun from Samedan – the author of a protestant catechism (first printed in Romansh 1552) and translator of the New Testament, also worked here. Gian Travers, the district magistrate of the Upper Engadin for many years and episcopal bailiff was also active as a Protestant preacher. He was the author of a verse epos and bible dramas in the vernacular.

Bergün / Bravuogn was entirely under the influence of the Upper Engadin; Gian Travers was one of the last episcopal bailiffs at Greifenstein castle. But the change of religious confession remained uncertain here for many years. The decision was not taken until 1601. The last two Catholics moved away of their own free will and the parish church was "cleansed" of images and an altar was sold to Brienz / Brinzauls.

The counter-reformation began to take effect at the beginning of the 17th century. The first Baroque churches were built at that time in the Poschiavo valley, in the spirit of the Council of Trent; they were dedicated to St. Borromeo. The council programme stipulated that the "heresy" in the diocese of Como was to be stamped out. This Catholic hegemony became the motive force of the 1620 revolt in Veltlin, which was again under the dominion of the Bündner. The massacre of the Protestants spread from Tirano into the Poschiavo valley where about a hundred people were murdered.

It was not until 1642, that the Drei Bünde, rent by confessional and party political strife and oppressed by foreign powers, were able to patch up an internal peace. A confessional distribution key for the utilisation of community possessions was drawn up in Poschiavo. All the church wealth went to the Catholics while the Protestants built their own parish churches in Poschiavo and Brusio. The coexistence of both "Religioni" or "Corpi" in the valley of Poschiavo even entailed the development of two distinct forms of dialect. The people's schools, introduced in the 19th century, remained confessionally distinct until 1969.

Virtually all the parishes in the lower Albula valley remained loyal to the old faith. The Capuchin monks from Brescia missionised here from 1635. Their regional base was at Tiefencastel; from there they went out to preach in Mon and Stierva. The somewhat remote German-speaking community of Mutten had been the only village in the lower Albula valley to go over to the Reformation (1582); it remained Protestant.

Alvaneu was particularly devoted to the Capuchin monks, retaining their services until 1890. However, Wiesen, the sole Protestant village in Belfort, broke away from the union with Alvaneu and attached itself to the Protestant parish of Filisur.

Ancien Régime: Social and economic differentiation

A new leadership group emerged gradually in Drei Bünden. The prominent families came partly from the noble retainers of the Bishop of Chur, and in part they were social climbers from the farming classes. Their financial resources had been amassed during military service as mercenaries for European princes, from landholdings or from trade and also from holding community offices. The communities granted the high offices for the administration of Veltlin to the citizens, or rather: they sold them.

The new elite distinguished itself from the "common man" solely by financial clout and lifestyle, not by formal privileges. The aristocratic families were able to increase their influence as they moved into various communities. From the late 16th century the Jecklin, Planta and Juvalta families from Zuoz moved to Bergün/Bravuogn, whereas the Buol family (originally from the Bergell) from the Zehngerichtebund, moved to Salis. However, there were limits to the freedom of movement. When the Protestant Sprecher family from Davos, who owned Bad Alvaneu, wanted to settle in Alvaneu, the village community reacted with a ban on the settlement of "heretics".

The aristocrats liked to engage in mining. The bishop had granted the prospecting rights for the Upper Engadin to the Planta family in 1295. In the mid 15th century the overlord and the vassal were in dispute on this issue but it was the community which carried the day. The contested mines were located on the Bernina Pass. Subsequently, the centre of mining in Graubünden shifted to the Albula valley. Capitalists from Ulm and Bergamo were interested in the Bergün iron mines; the mines were taken over by Johann von Salis-Samedana, a grandson of Gian Travers, in 1576. The charcoal stacks and smelting sheds were concentrated in Filisur (where the electricity works are today); ores from the Landwasser valley, Schmitten and the Davos "Silver Mountain" (Silberberg) were smelted here.

In return Johann von Salis supplied the communities with salt, which he imported from the Tyrol and had brought over the Albula Pass to Thusis. However, all his undertakings eventually failed. Later mining ventures were based on the Bellaluna (a typical mining name) smelting works on the floor of the valley between Bergün/Bravuogn and Filisur; this continued until about 1850. Since early modern times, people from Graubünden have gone abroad to work. Occupational emigration became the most important branch of the economy in old Graubünden. It was not only mercenary service that called for seasonal or prolonged emigration. Until the mid 18th century, people from Graubünden were active as shoe makers, spirits dealers, pastry cooks and innkeepers in Venice and on the mainland. Later they exercised their craft as confectioners and kept coffee houses throughout Europe. Traders from Graubünden operated primarily in northern Italy. One of the most important enterprises was founded in Samedan, in 1789, by Tosio and Giuliani from Poschiavo.

Modern Times: Modernisation

In the 1780s the definitive defection of the Veltlin, a subject state, seemed imminent. In an attempt to fend off the loss, the people of Graubünden proposed to grant the Veltlin communities equal rights, or at least to relocate the Graubünden capitals to the south, to Samedan. But it was too late: in 1797, under the aegis of Bonaparte, the people of Veltlin allied themselves to Cisalpine Republic, to Lombardy. They put up a blockade against Poschiavo – and encouraged the people of Poschiavo to follow them to “liberty”. However, Poschiavo which had received military reinforcements from Samedan and Bergün/Bravuogn, countered that as citizens of Graubünden, they had long been free.

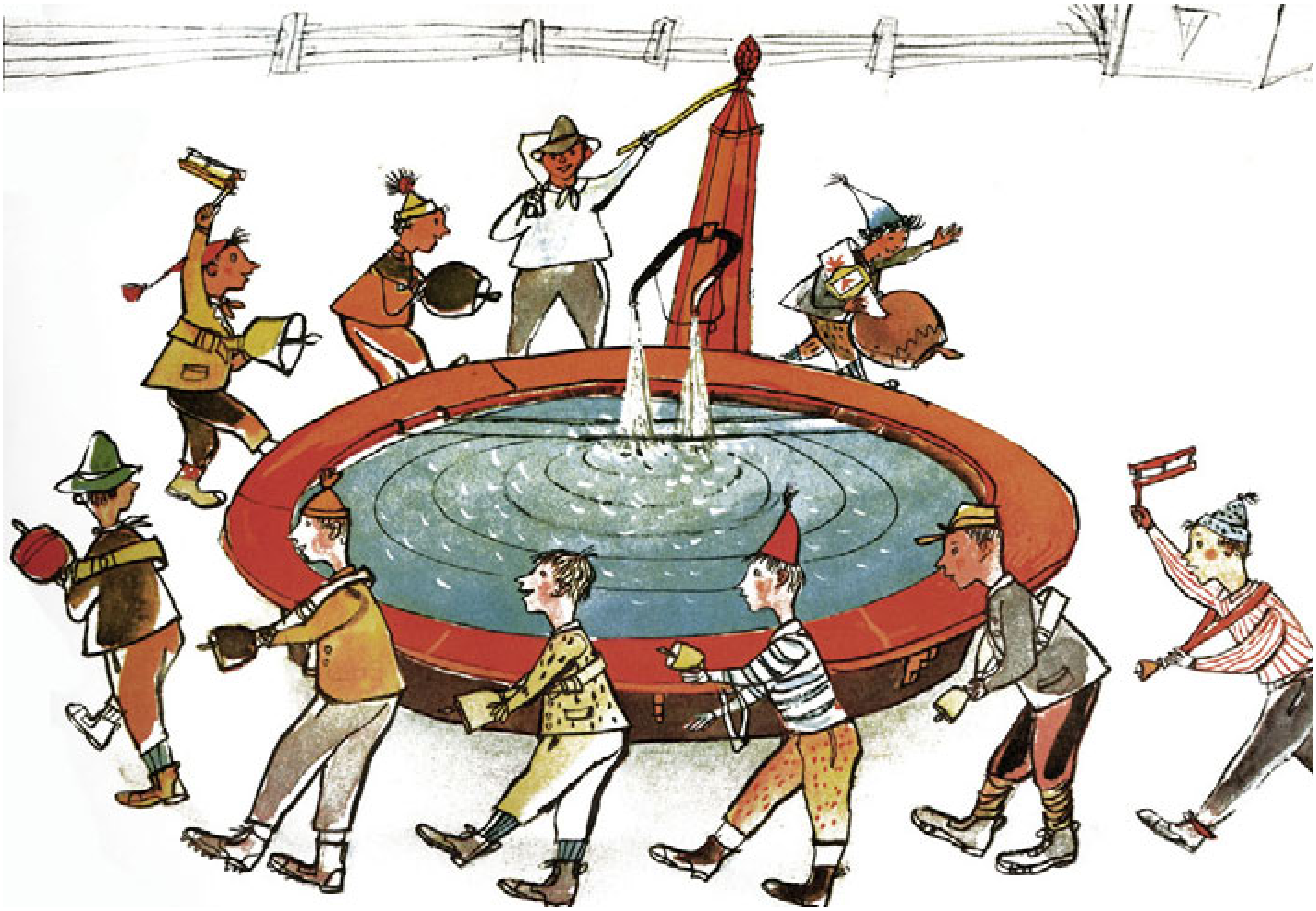
However, the defection of the Veltlin valley hit Graubünden hard; 130 families lost private possessions and the loss of customs and excise revenue from the Veltlin wiped out a large part of the income of the Drei Bünde. The balance of power situation also spoke against the continuation of Graubünden as an independent state. The outcome was the transformation into the Swiss Canton Graubünden in 1803.

But, the old decentralised structure continued in a new guise. The quasi-sovereign communities, the Bünde, remained. The definitive end of the Dreibünde state came in 1851. The valley communities were declared jurisdiction districts and the village communities were promoted to autonomous political units. However, now even the most modest hamlets wanted to be recognised as political communities; Cavaione, for example, a tiny village in the Poschiavo valley, clinging to the mountainside 800 m above the valley floor craved autonomy but it was attributed to Brusio in 1874.

Customs and traditions

The life style of broad sections of the people underwent a radical change during the 19th and 20th centuries. The seasonally dictated rhythms of everyday life vanished with the declining importance of farming. Religious customs continued, above all the number of feast days and the way they were celebrated differing according to confession, but the once universal, even obligatory, participation declined.

Of the cyclic-seasonal customs, above all those celebrated from Christmas to Epiphany are still observed: performances of Christmas, New Year and Twelfth Night carols, traditional drinking and feasting, giving and returning visits, sometimes unwelcome, particularly on New Year’s Eve. In contrast the Protestant moral court



"Chalandamarz" in the Engadin > Drawing by Alois Carigiet from the much loved children's book "Schellen-Ursli".
Orell Füssli Verlag AG, Zurich

Schlitteda > The young lads, dressed in the Sunday traditional dress, would take their sweethearts, in horse-drawn sledges with the horses also decked out for the occasion, to the lakes or the foot of the Albula Pass. Picture painted by Anny Vonzun.

largely repressed the carnival customs and carnival tomfoolery. Ball-hitting games associated with winter fire customs ("Scheibenschlagen" – whispering the beloved's name and making a wish as you hit a burning disc of wood into the night, "Mazza" a form of "Hornissen or Hornets") are well documented but have died out.
There was a gradual change in the groups behind the customs practised by young people: the exclusively male youth fraternity (Societad da mats), which specialised in begging and 'shaming' customs, was displaced by the 'young and single' groups of both sexes (la Giuventetgna) who enjoyed dancing; these were joined by the choir and music societies about 1850.
More recently, some of the old customs have been reintroduced and revitalised. Above all the schoolchildren's spring procession "Chalandamarz" in the Engadin, "al Popocc da marz" in Poschiavo (when a straw 'guy' is burned). The procession to the accompaniment of large and small bells and cracking whips, is intended to drive off the winter; along the way the participants are rewarded with goodies. This custom was not reintroduced in Bergün / Bravuogn, where it had been banned as heathen in 1760.
The 20th century saw the reintroduction of the "Schlittedas" in the Upper Engadin; the lively sledge parties which had been so popular in the 18th century. The party starts and ends in a centrally situated village, usually Samedan; the horse-drawn sledges then drive up the valley to the lakes or down the valley to the end of the Albula Pass. The "Schlittedas" are followed by dances.

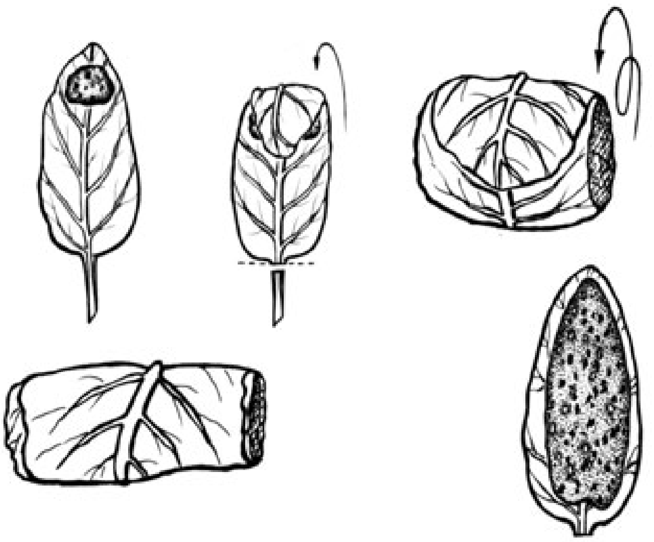
Eating and drinking

The customary eating habits are oriented to the needs and resources of an alpine rural population. This is expressed in Rhaeto Romansh sayings like "Mincha trat ha sia saschun" (Every food has its season) or "Tut dil nies; dalla vacca e da noss èrs" (It is all our own; from our cow and from our fields). The need to keep stores and preserve them determined the form of most of the foods, and therefore the eating habits in the broadest sense.
The energy required for the heavy work of mountain farming is reflected in the high nutritional value of the traditional dishes like Capuns (little 'parcels' wrapped in Swiss chard leaves) with a buttery filling containing bacon and egg; the Romansh name "capun/chapun" also means a plump, stocky man. Several sayings reflect a certain disregard for salad, for example: "Chi chi mangia erba, dvainta bescha" (If you eat grass, you'll turn into a sheep).
Meat, accompanied by barley broth ("schoppa da giutta"), was eaten as the Sunday roast or as boiled beef (in soup). It was also made into sausages (Salsiz) or preserved by air-drying or smoking. This was the origin of the Graubünden dried beef speciality of "Bindenfleisch" ("puolpa"). Milk and flour based foods and high calorie recipes using cream, butter or cheese were part of the traditional every day menu. The cream brose "put in gromma" even gave its name to the Upper Engadin dialect of "puter". Eggs come to the table in every form from "tatsch" (similar to the Austrian Kaiserschmarrn) or as "bizzocals"; maize as "polenta"; maize or semolina as "maluns"; semolina also as "gnocs" (gnocchi); potatoes which were introduced in the 18th century, as "maluns" (in the Engadin also called "micluns") or, with the addition of bacon or sausage as oven-baked "plain in pigna". Egg pasta prepared with savoy or Swiss chard leaves or leek, but also with a little dried meat and bacon become "bizoccals cun ravitscha" ("with leaves") dark "pizzoccheri" – dark because

Pizzoccheri > This pasta speciality made from buckwheat flour is typical of the Poschiavo and Veltlin valleys.
Tourismusverein Valposchiavo

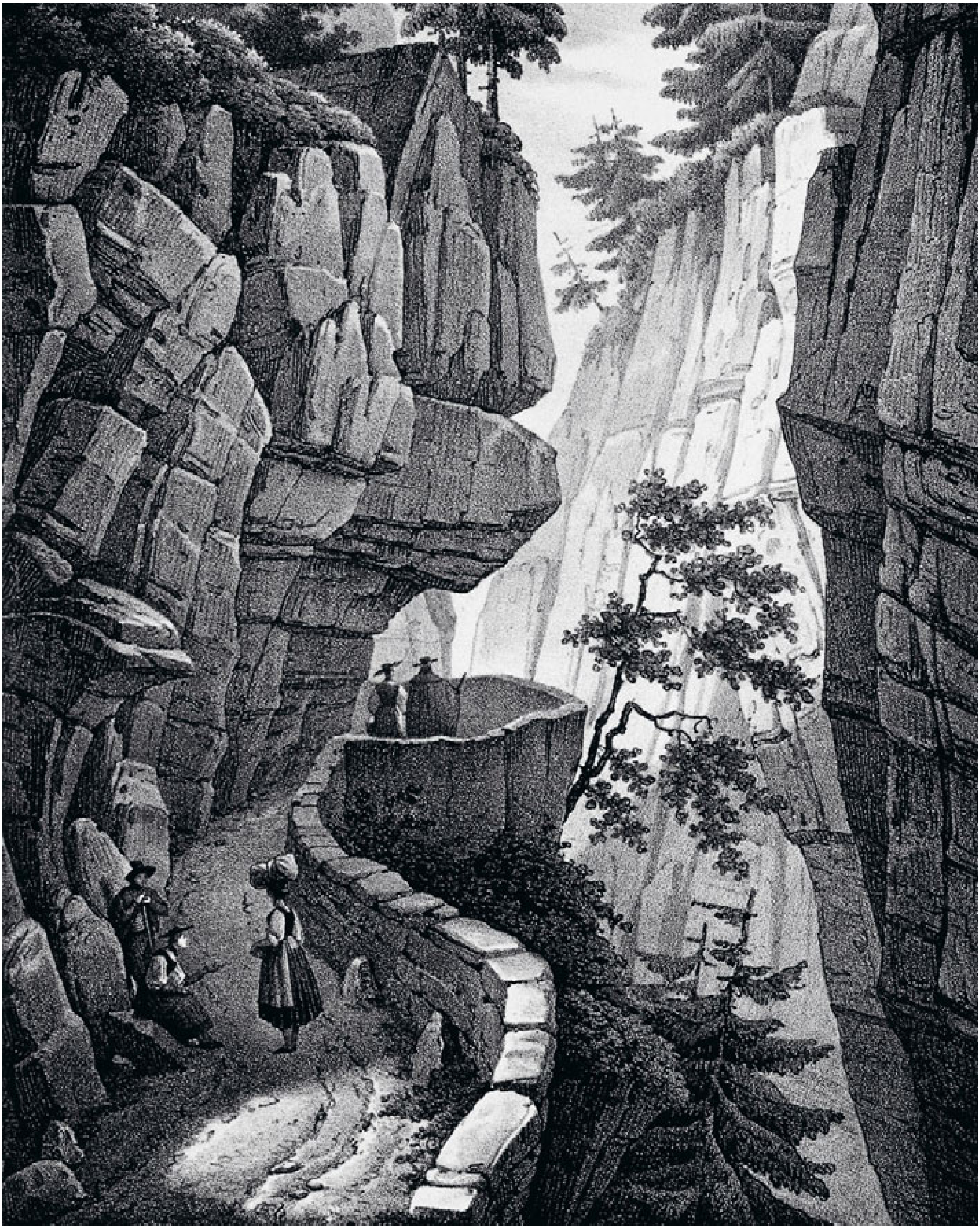
Brasciadella > The bread speciality from Poschiavo is shaped into a ring.
Tourismusverein Valposchiavo

Capuns > These little 'parcels' wrapped in Swiss chard are a typical Graubünden dish; there are numerous variations.
S. Eberle

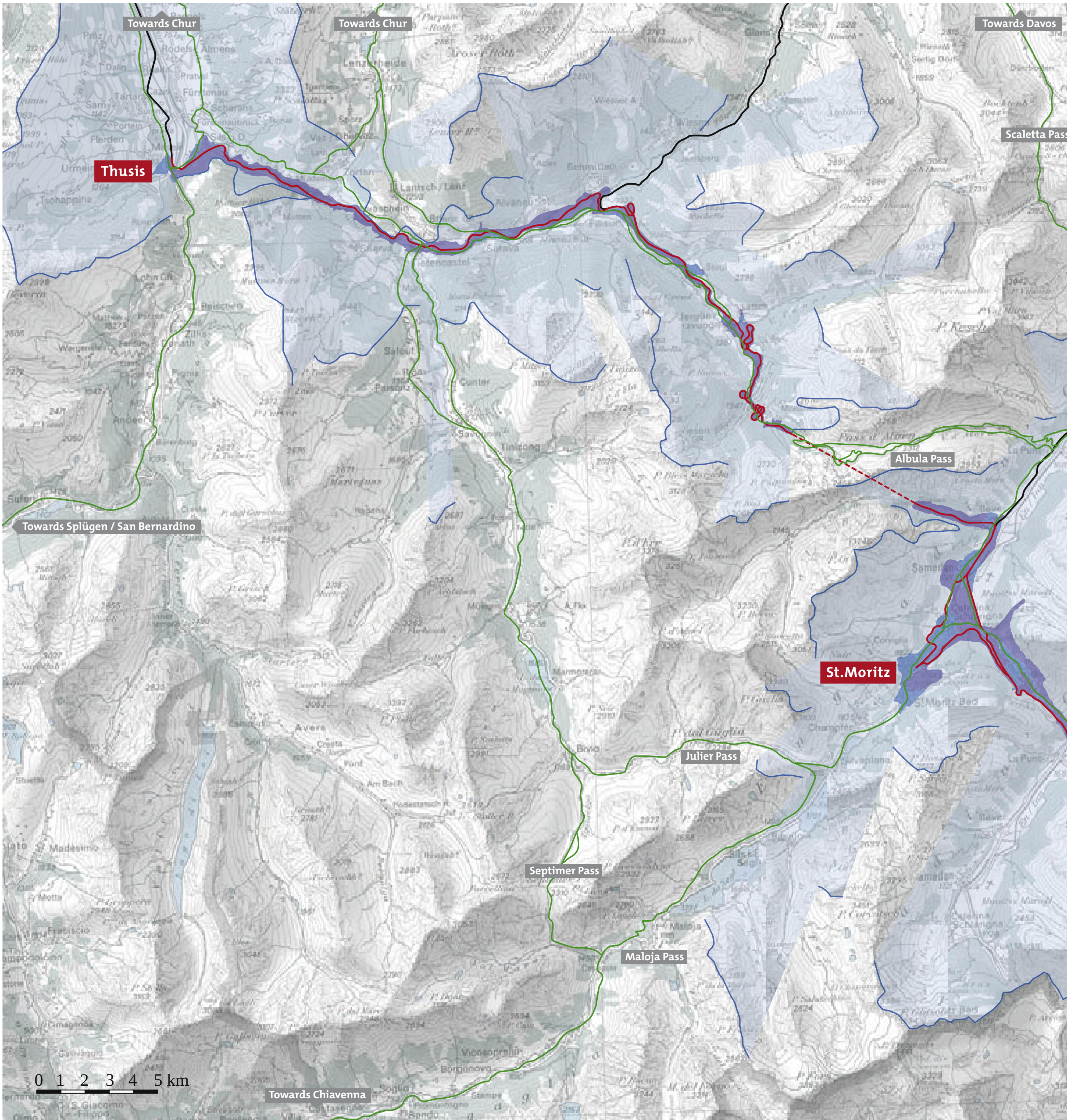


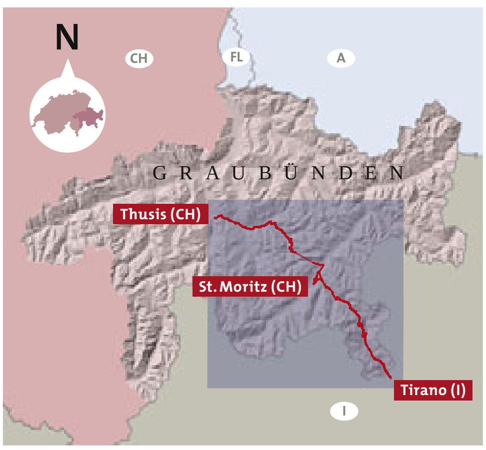
Capuns > There are various different ways of wrapping up the chard parcels 'properly'.
E. Lengler

they are made from buckwheat flour – are a speciality of the Poschiavo valley.
A talent for culinary art and inventive flair were a prerequisite for the success of the emigrants from Graubünden who established themselves as confectioners in the European capitals. After their return they enriched the menus of the valleys of their homeland with their successful creations, for example the Engadin nut tart ("tuorta da nusch engiadinaisa"). Traditional sweet dishes were made with almost as much butter as flour like the "fuatschas grassas" (literally "fat pancakes"), "grassins" and "grassets". In Poschiavio there are deserts made from sweet chestnuts (chestnut pudding). Liquid specialities include the traditional Kirsch liqueur ("Röteli") or the hazel nut liqueur.
Despite all these delicacies, one must not forget the daily bread. In Poschiavio this is usually made from rye flour and is traditionally ring shaped. For many centuries the most popular and most widespread drink was wine from the Veltlin.
Eating together has always encouraged bonding, either within the family, for example a sausage meal or the "bacharia" (after the family pig had been slaughtered), or in the extended family or village community context on the occasion of church rites like christenings or weddings but also at a wake – the "palorma" ("per l'orma" – for the soul).



Bergün/Bravuogn > The passengers were astounded and terrified by the road across the Bergünerstein. Lithograph by Edouard Pingret and Henry Gaugain, predates 1826.


Towards Chur
Towards Chur
Towards Davos
Scaletta Pass
Thusis
Albula Pass
St.Moritz
Towards Splügen / San Bernardino
Julier Pass
Septimer Pass
Maloja Pass
Towards Chiavenna
0 1 2 3 4 5 km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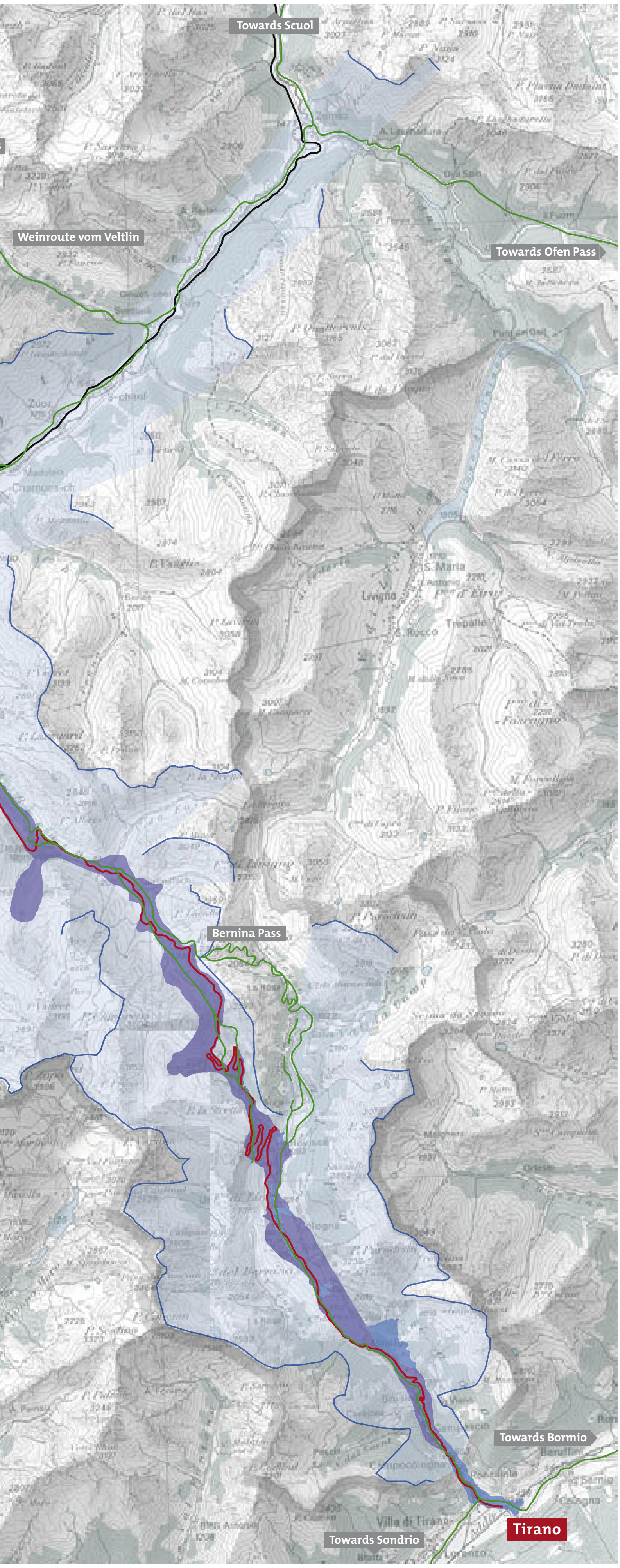

Historic routes

Historic route guide

Important passes and connections

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Hansjürg Gredig
Design: Süsskind, SGD, Chur
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2.b.3 The quickest way to Venice: historic routes in the Albula / Bernina region

The historic Albula/Bernina route – in contrast to the railway line – did not go via Thusis but ran from Chur via the Lenzerheide to Tiefencastel or direct to Filisur. The way continued over the Albula Pass into the Engadin and over the Bernina Pass to Tirano following a similar route to the railway, many years later, though with certain differences (Albula Pass, southern side of the Bernina). The Albula/Bernina route was valued as the shortest link between northern Graubünden and its subject states and to Venice, particularly after the beginning of Graubünden's dominion in the Veltlin valley (1512). Historical milestones were the building of a road across the sheer face of the Bergünerstein (1696) and the changing routes on the southern side of the Bernina Pass. The construction of the pass roads for horse-drawn coaches in the 19th century and then the construction of the railway a few decades later brought another fundamental shift in the distribution of traffic.

The Bergünerstein – "overcome by fear and trembling"

In Roman times the routes over the Julier and Septimer passes, together with the Splügen and San Bernardino passes, were among the most important links between southern Germania and northern Italy. Cart tracks, ruts in the rock, along the Julier Pass show that carts were used to transport goods. In the Middle Ages, the Septimer Pass was one of the most important transit routes for the carriers, who were responsible for the transportation of goods, as well as for travellers and pilgrims. The Albula route, in contrast, is not mentioned until the High Middle Ages when Bishop Berthold of Chur set up a toll station at Guardaval near Madulain, where the Albula pass route reaches the floor of the Engadin valley. The Albula Pass was also used occasionally when the Septimer was impassable for one reason or another. Use of the Albula/Bernina-Route peaked in the 16th century when France established a post system between Chur and Aprica, with posts at Lantsch, Bergün/Bravuogn, La Punt-Chamues-ch, Pontresina, Poschiavo and Tirano. The route lost its transit function towards the end of the 16th century when the San Marco road was built between Bergamo and Morbegno in the Veltlin. The current route from Thusis through the Schin to Tiefencastel did not come about until the boom in road and railway building in the 19th and the beginning of the 20th centuries. Until then the Albula route ran from Chur across the Lenzerheide to Lantsch, Filisur and Bergün/Bravuogn. Anyone who started from Thusis, had to cross the "Moir", a precipitous rock face on the right bank of the river, to reach Tiefencastel. In Tiefencastel, first mentioned in 840 as "Castellum Impitinis", the Albula road crosses the Julier/Septimer route. The greatest impediment between Tiefencastel and Bergün/Bravuogn was a vertical rock face called the "Bergünerstein" that forced travellers and pack animals to make a tedious detour. Consequently, in 1600, the people of Bergün/Bravuogn decided to blast a way through the rock but the daring idea was not realised until 1696. This was the first time that explosives were used on a large scale in road building. The comfortable, gently rising Bergünerstein road along the rim of the abyss

Albula Pass > Steep climb below the "Val digl Diavel" (Devil's Valley); new paths were laid several times.
H.J. Gredig

Bernina Pass > Transporting wine from the Veltlin over the Bernina Pass to the north was a centuries old tradition; photograph about 1900).
Unknown

did not fail to amaze travellers for one and a half centuries. The “Schweitzer Geographie” printed in 1770 recounts: “[…] on the left hand is a perpendicular rock face and on the right is a solid wall, so the traveller thinks he is walking along a nice even road, but if he stands on the wall then he is overcome by fear and trembling”. Below the crest of the pass, the carriers and travellers found themselves in a virtually impassable scree in the “Val digl Diavel” or Devil’s Valley, which the travel writer David Crantz described as “primeval chaos”. The descent to the village of La Punt and the continuation of the road towards the Bernina Pass was less problematic.

Wine, salt and corn

In the 16th century, the Bernina Pass was part of the much frequented route from Chur via the Engadin to Tirano. Traffic between the two allies Venice and France could pass through the territory of the “neutral” Confederation and Dreibünden and did not have to touch the lands of Milan. However, prehistoric finds and Roman coins from the times of Claudius, Marcus Aurelius and Philippus show that the pass was already used much earlier and probably without interruption since earliest times. This is backed up by the silver mines on the Bernina Pass that were exploited from 15th century. However, until 1500 the Bernina Pass was overshadowed as a trade route by the those via Bormio (Passo di Fraele and Passo di Foscagno) and over the Muretto pass between Val Malenco and Maloja.

The export of wine from the Veltlin valley over the Bernina Pass is mentioned for the first time in 1452. The Duke of Milan, Francesco Sforza Visconti, confirmed to the men of Poschiavo their right to take 80 cart loads of wine from his lands and to import them to Poschiavo without having to pay any duties. Tirano was the regional centre of vine growing and the Veltlin carrier trade; the transport of wine by mules or horses from Veltlin to Graubünden effectively made the Bernina Pass into a ‘wine road’ in autumn and winter. The valuable freight took the wine carriers from the Engadin over the Scaletta Pass to Davos and across the Schlappiner Joch on to Montafon in Austria.

A “Tariff Order”, issued by the Upper Engadin court of jurisdiction dated 1734, shows which goods were transported over the Albula Pass. Besides wine, corn and salt, rice, iron and sundries were also transported. However, salt was no doubt the most important product transported after wine. This was obtained from the Tyrolean saline at Hall, below Innsbruck. In the 16th and 17th centuries the salt transports over the Albula were sometimes taken not only to Bergün/Bravuogn but also on to northern Graubünden and to eastern Switzerland.

The best choice of route for the Bernina Pass was always an issue. The terrain permitted two alternatives on the southern side: via Cavaglia, later the alignment of the railway line, or via Val Laguné, the route taken by the pass road today. Both variations were used, either alternately or at the same time, and the preference for the one or the other appears to have changed several times. In 1522 the people of Poschiavo decided to improve the “strada regalis” via Cavaglia. Traders were no longer allowed to use the old road. This somewhat shorter way remained the principal route for some 200 years. After an avalanche disaster in the precipitous Val Pila in 1729, the road was rerouted through the less dangerous Val Laguné. But this did not prevent the people from Poschiavo from rebuilding and improving the road via Cavaglia, as recounted

Bernina Pass > Lago Bianco and Bernina-Hospiz from the east. Coloured aquatint by Johan Rudolf Dikenmann, around 1880.
Rhätisches Museum, Chur

Albula Pass > Pass road. Lithograph by Albert Benninger, before 1882.
Rhätisches Museum, Chur

The opening of the Albula Railway in 1903 marked the end of the post coach era.
Rhätisches Museum, Chur

in an 1830 travel journal: “two roads leading to Poschiavo separate to the north of Lago Bianco. The road to the west runs along the lake to the little mountain village of Cavaglia. It is the older and shorter route and has been passable for small carriages for a few years, but it is dangerous in the avalanche season. The other winds south eastwards past the Lago Nero, in the Engadin, as far as the crest at the Scheideck, by the cross (à la Croce). It is longer but safer than the first and built for pack horses”.

Building the pass roads

The dispute on the layout continued when the carriage road was being planned. In the 19th century, the young Canton Graubünden was starting to realise a network of standardised roads 5 – 6 m wide: the “new roads”. They replaced the narrow, bumpy bridle paths and were used by the post coaches rather than pack animals. The first was the lower or Italian Road (1818 – 1823), from Chur over the Splügen and San Bernardino passes, followed in 1820 – 1840 by the upper road across the Julier and Maloja passes into the Bergell valley. Work started on the first section of the new road over the Bernina Pass in 1842; the last valley section between Poschiavo and Campocologno was completed in 1865.

In the meantime work had already begun on the Albula stretch between Tiefencastel and Bergün / Bravuogn while the Albula Pass had its own carriage road by 1864 – 1866. Construction of the 23 km long and 4.2 m wide pass section between Bergün/Bravuogn and La Punt cost 350,000 CHF.

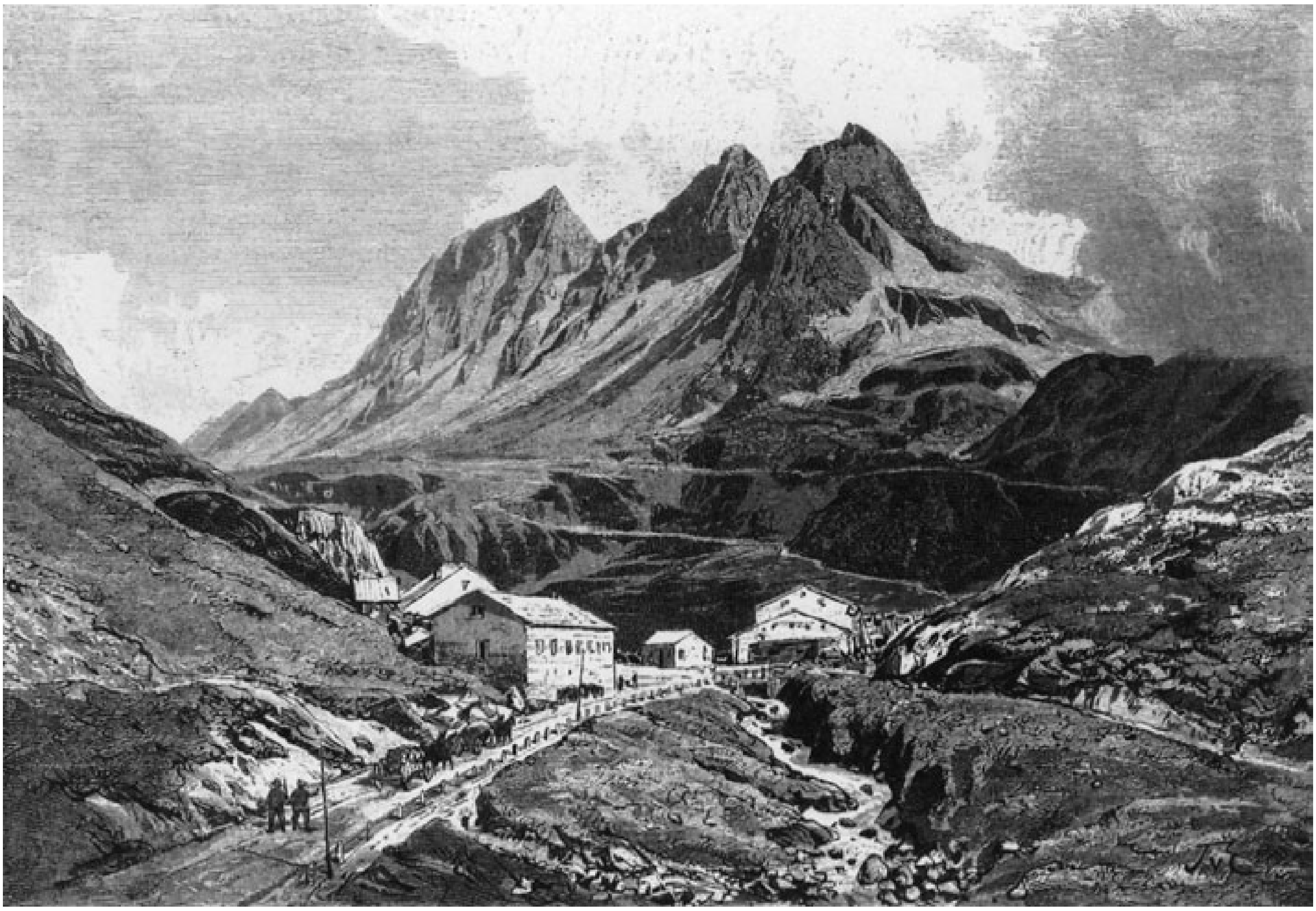
The construction of the new roads fundamentally changed the entire concept of transport. In effect it ousted the centuries old tradition of carriers and pack animals that was organised on a cooperative basis; in contrast the post system boomed. The post coaches plied four-in-hand from Chur to Bergün/Bravuogn and five-in-hand across the pass to Samedan. In 1900, the official post coach contractor in Samedan kept 150 horses. The winter service was run with sledges. The post coaches transported numerous famous people across the Albula and Bernina passes. Giosuè Carducci, Emile Zola and Lord Curzon, Viceroy of India, signed their names in the guest book at the Ospizio del Bernina.

The opening of the Albula line in 1903 brought the post coach era to an abrupt end. After the railway came into operation the Albula and Bernina roads remained closed in winter. It was only with the spread of ski tourism from the Engadin towards the Bernina Pass that the Bernina road was again opened all the year round, in 1965.

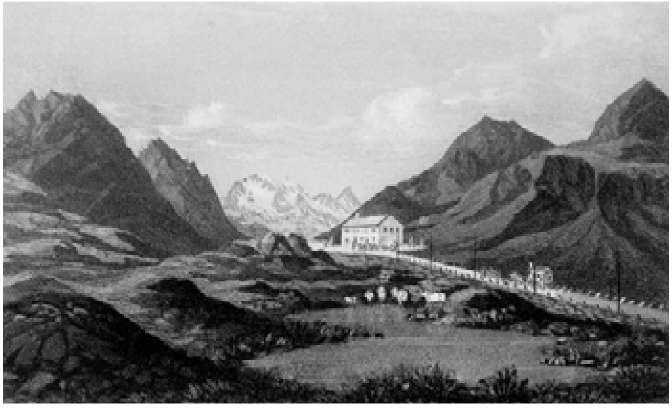
Dangerous travelling

Travelling in pre-post coach days was anything but comfortable; complaints about the state of the roads run interruptedly through the history of transport. The travellers were often not accustomed to the hardships, nor to the cold and snow.

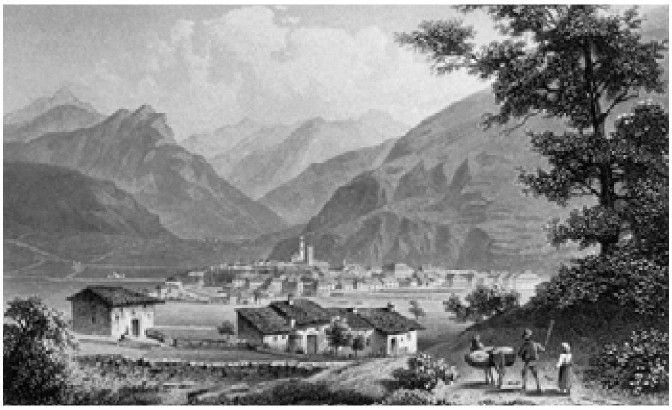
In the 17th century the Albula/Bernina route was still important for transit between Italy and the Graubünden and German trade centres, but the complaints about the poor condition of the roads continued unabated. The general tenor was that the way was difficult and dangerous, rough and tough. Of the many tales of avalanche disasters, one that occurred in 1741 acquired tragic fame: the train of pack animals and carriers was caught by the Scunflo avalanche as they crossed back over the Albula and nine men were lost.



Albula Pass > The guest house at Crap Alv offered accommodation to travellers. Xylography by Themistocles von Eckenbrecher and Adolf Closs, around 1865.
Rhätisches Museum, Chur



Albula Pass > The Hospiz was built at the same time as the pass road, in 1871. Anonymous aquatint, about 1870.
Rhätisches Museum, Chur



Poschiavo > A carrier on the way north. Steel engraving by Ludwig Rohbock and Georg Michael, from before 1861.
Rhätisches Museum, Chur

One problem was the lack of shelters. In contrast to the Septimer, where there is evidence of a hospice already in the 12th century, there was no emergency shelter on the Bernina Pass until 1519. In 1654 a guest house was built on the northern side of the Albula Pass but it was 1817 before a modest shelter was built on the crest of the pass; there was no real hospice until the pass road was built in 1871.

The shelter on the Bernina Pass also had room for ten horses. The "Bernina Häuser", on the northern side of the pass, provided the principal accommodation: this was a small settlement, occupied throughout the year, with stabling for 25 horses. Accommodation for man and beast was also provided in Cavaglia or – on the eastern route – in Pisciadel, Zarera, Lereit and La Motta. The volume of carrier traffic over the Bernina Pass was considerable; this is clear from the extensive stabling facilities in Tirano, Poschiavo or Pontresina that could accommodate some 200 horses.

Despite the danger of avalanches, goods transport in winter was very popular as one could put a heavier load on a sledge than a mule could carry and also because the local farmers had more time for transport services in winter than in summer when they were busy with the haymaking. On the Bernina Pass, the two neighbouring communities of Pontresina and Poschiavo saw to it that the road in their parish was passable in winter. The local farmers took over the job of clearing a way through the snow, stamping it down with their oxen. In 1544 the community of Chamues-ch, for example, engaged to clear the mountain road, keep it in good condition and mark the edges of the road properly with long poles. In return, the community was allowed to levy a toll from the travellers: four schillings for every head of cattle and for every load per pack animal. In Poschiavo every parishioner could be called on to work on repairs to bridges, roads and churches. The maintenance duties were the most difficult. In 1410, the Upper Engadin communities together with Poschiavo and Brusio engaged to maintain the Bernina road as far as Piattamala at the end of the Puschlav valley.

Historic tracks in the landscape

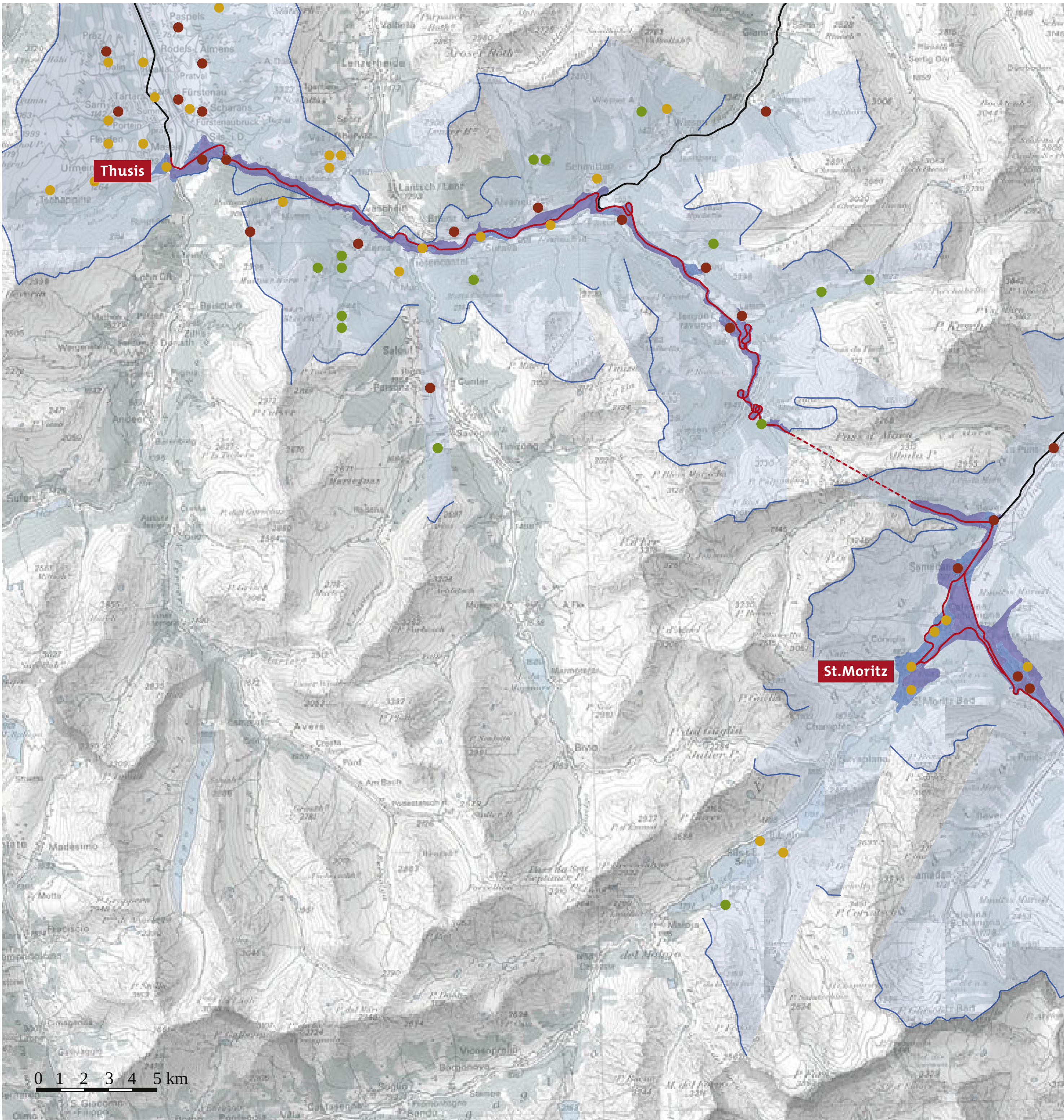
Traces of former routes and tracks are not always visible; frequently they have been built over by modern farm tracks or roads as between Tiefencastel and Filisur. On the way over the Pentsch, that goes round the Bergünerstein, an inscription dated 1688 indicates that this road was improved shortly before the new road was blasted across the sheer rock face. Numerous traces of historic tracks are still visible on the Albula Pass, mostly as deep ruts in the surface worn away by the passage of pack animals. On the way from La Punt to the top of the Bernina Pass there are hardly any signs of traditional road building except for a small stretch of paved road at Morteratsch. There are few topographic difficulties at this point and there is no call for complicated road building. The situation is quite different on the southern side of the Bernina Pass: on the eastern alternative, below La Rösa and in the Bosch da la Turiglia, the historic road is paved and lined with dry stone walls at several points (La Motta or Lereit). The historic sections of the road are even more marked to the west over Cavaglia, in particular the four metre wide paved road between Cavaglia and Cadera that runs into a dead straight lane with dry stone walls both sides. Not only the bridle paths, but also the younger generation of roads, those built in the 19th century, have lost a great deal of their traditional

Albula Pass > Deep ruts above La Punt recall the old mule train traffic.
H.J. Gredig

Bernina Pass > The old mule track in Val Pila is now a popular hiking trail.
H.J. Gredig

substance on the Bernina Pass. The increasingly heavy traffic has entailed massive improvements. The interventions on the Albula Pass were not so marked, primarily as in contrast to the vastly improved Julier Pass, it is merely a secondary road that remains closed in winter.

Bergün/Bravuogn > Village with Piz Ela. Historic photograph from the first quarter of the 20th century.
Collection Wehrli, Eidgenössisches Archiv für Denkmalpflege, Berne


Thusis
St.Moritz
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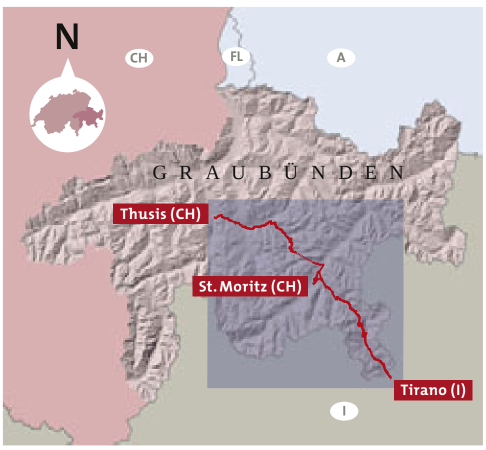
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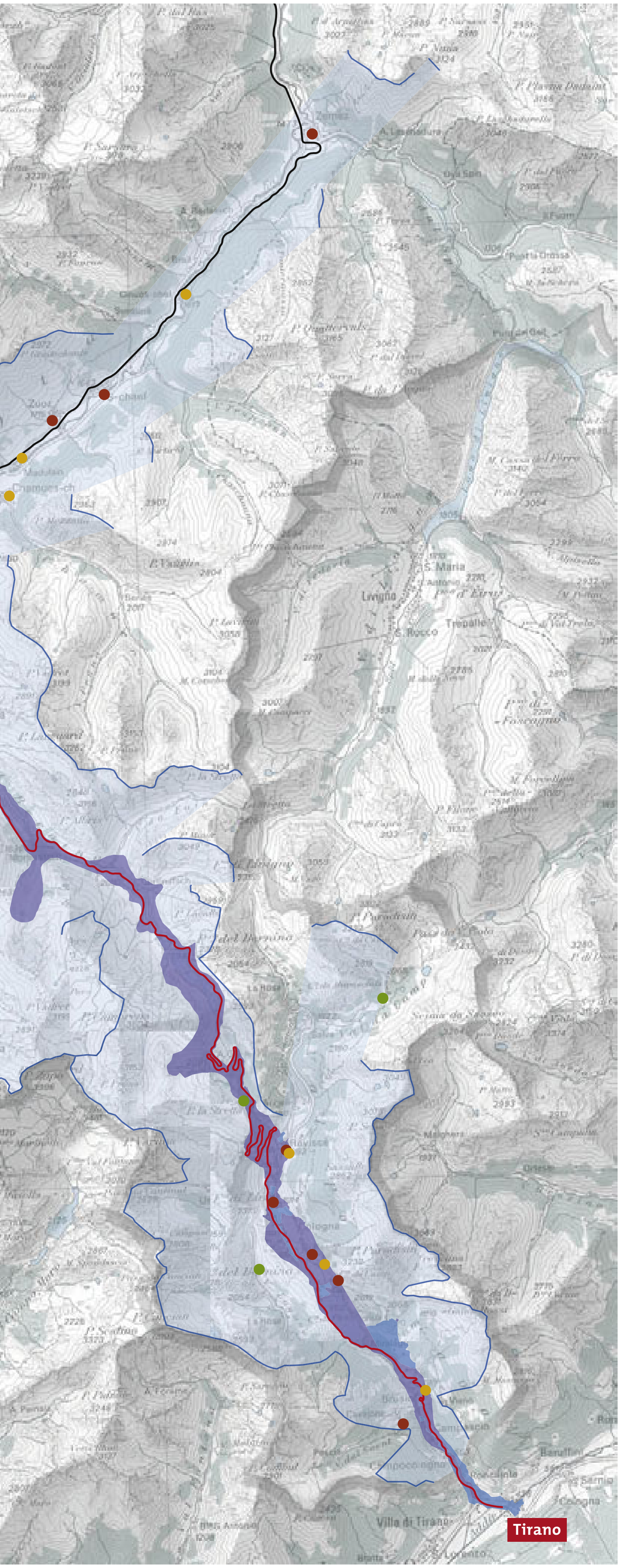

Settlement structures and history

- Cultural assets of national importance
- Cultural assets of regional importance
- Maiensässe (selection)

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: ISOS, Diego Giovanoli
Design: Süsskind, SGD, Chur
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2.b.4 Villages, hamlets, scattered settlements, alps and "Maiensässe" along the Albula and Bernina line

The settlement models of the various valley communities either side of the Albula and Bernina railways are quite distinct. Until the 19th century, the type of settlement was dictated by the prevalent form and mode of the agriculture of the time. The distribution pattern of buildings for homes and animals between village and alp reflects the degree to which the farms were centralised and the geographic distribution of the autonomous farming cooperatives. Like the settlement structures, the building style of the houses also differed from valley to valley. The cultural processes active from the late Middle Ages until 1800 in the various regions of the nominated property were hardly conducive to change. Local customs and habits were not superseded until the 19th century, with the surge of tourism and the rapid increase in mobility bringing the desire for new routes. The foreign, urban architectural styles of the new branch of the economy overlaid the traditional settlement pattern in many places.

A trip up to the high Alps and then down again within a few hours, as is possible on the Albula/Bernina line, not only accelerates the passage through the vegetation zones and even the seasons, it also takes the traveller through a number of different cultural landscapes with a wide variety of building styles. That is why, according to current understanding, the type and density of settlement in the countryside either side of the railway are as much part of the cultural heritage of a rail system as the modelling of the landscape by previous and more recent farming systems.

Since earliest times, the scarcity of usable arable land in the Alpine valleys has forced the people to practise vertical transhumance. As summer comes late and winter early, due to the high altitude, the land farmed – in line with the climatic conditions – was divided into several levels or steps. The lowest – village – level, which was inhabited all year round, was only viable in conjunction with the Maiensässe (small farm dwellings at the intermediate level) and the highest level – the alpine pastures – used only in summer. The temporary area was managed according to a simple principle: either one took the animals up to the fodder or one carried the fodder down to the animals. In the first case, one speaks of a decentralised system, in the second of a centralised one. The decentralised system generated numerous buildings between village and alp, but with a village-centralised system there were no buildings scattered across the pastures. The limitations of the surfaces usable for farming also determined the work rhythm, the size of the villages and hamlets, and their distribution pattern in the valley, on the slopes and at high altitude.

Changes in settlement pattern along the Albula/Bernina line were the outcome of two periods with contradictory dynamics: the new era from 1500 to 1860 and the subsequent modern period. The cultural traditions of the older period, generated by village-centralised and rather static farming communities with locally effective regulators, are being progressively eroded and absorbed into the new reference systems, particularly on the valley floor. Formerly, business was

Thusis > Plan dating from 1876. The 'old village' ❶ that has grown organically is a complex confusion of buildings. In contrast, the 'new village' which was planned on the drawing board, looks very orderly. ❷
Amt für Raumentwicklung Graubünden

Thusis > Historical postcard with a view of the village of Thusis seen from Hohenrhätien. Thusis railway station is in the foreground, to the right.
Private Collection

Thusis > An aerial view taken in 2002.
D. Enz, Comet

only culturally effective up to some 2,000 m; however, in more recent times, the trend is literally to aim high – for the peaks. The present promotion of agriculture in conjunction with strict building regulations will soothe the battered image of settlement and landscape.

Settlement patterns in the northern section of the Albula line

The northern section of the Albula line touches three sharply differentiated settlement areas: the region around Thusis, the starting place, with its gentle topography, is relatively densely populated, while the higher altitude Landwasser valley beyond the Schin gorge and particularly the Albula valley are sparsely populated. In the Albula valley, where the mighty conifer forests reach down to the valley floor, the villages are surrounded by well-tended meadows.

Settlement structures

Domleschg and Heinzenberg

Not only do the flanks of the valley between Rothenbrunnen and Thusis have different names – the eastern slope is called Domleschg, the western slope Heinzenberg – they differ significantly in cultural-geographic respects. On the gently rising Heinzenberg, there are both valley and mountainside villages; and at the highest level there is the Walser enclave of Tschappina. The broad expanse of the Domleschg, in contrast, has valley and mountain villages at only two levels.
On both sides of the valley, the villages and hamlets are more open and surrounded by fruit trees. Farming was organised differently in the mountain and village settlements. The farmed area of all the communities in the valley is not subdivided into levels or steps and there are no buildings of any kind on the meadows. The valley farmers had to rely on extra-territorial summering i.e. renting Maiensässe and pasturing rights in other communities to summer their livestock. In contrast, the farmers in the communities up on the slopes farmed at three levels: the village, Maiensäss and high alp. The farmers had their individual dairies and cowsheds in the Maiensässe that were occupied in spring and autumn; the high alpine pastures were used in summer, often in conjunction with the valley farmers, on a cooperative basis. The pastures around the highest villages – Feldis, Scheid, Trans and Tschappina – have a dense scattering of fodder barns and hay sheds. In contrast, the village pastures of the communities half way up between mountain and valley – Urmein, Flerden, Sarn, Portein, Tartar and Präz – have only a few isolated fodder barns.

Landwasser and Albula Valleys

The villages are more closely structured in these valley communities than in the Heinzenberg/Domleschg. There are no buildings in the countryside around the settlements, as farming is centralised in the valley. The Walser villages, high up above the Landwasser valley – Mutten in the west, Schmitten, Wiesen and Jenisberg in the east – are an exception. The village pastures are dotted with fodder, hay and storage barns. In the Landwasser and Albula valleys, traditional farming usually operates at three levels: village farm, Maiensäss and alp. The Maiensäss level was particularly well developed in the communities of Vaz/Obervaz, Bergün/Bravuogn, Filisur and Alvaneu and the system was practised particularly late; in contrast, it was only fragmentary in Brienz/Brinzauls. There is no Maiensäss level in the Alvaschein, Tiefencastel and Surava communities; the farmers

Maiensäss Naz at Preda > Photograph taken in 1912.
Ch. Meisser / Staatsarchiv, Chur

Tiefencastel > Taken in 1907.
Ch. Meisser / Staatsarchiv, Chur

Filisur > The village street is lined with "Engadin houses"; where farm vehicles can drive straight in to the stables and barns.
Ch. Meisser / Staatsarchiv, Chur

Filisur > Village street. Taken in 1912.
Ch. Meisser / Staatsarchiv, Chur

there farmed only at village level and at an – extra-territorial – alp level.

The Maiensäss farms were owned privately by the farmers and the buildings were usually grouped together. As a rule, the alps in both valleys were used on a cooperative basis; the buildings on the alp – with one dairy hut or two jointly-used milk processing buildings with living quarters and fifteen or more private sheds for livestock – were grouped in hamlets of varying sizes; even today there are still large, homogeneous groups of buildings on the alps. On the alps of the Walser enclaves in the Landwasser valley – Wiesen and Jenisberg – the farms were run individually, and the buildings were the private property of the individual farming families; on the Wiesner alp, there are a total of 36 farms arranged like hamlets. Every privately owned dairy had its own living accommodation and stable. As they were not far from the village, these alp farms assumed the Maiensäss or intermediate altitude functions.

The part of the Albula valley that is occupied all the year round is closely related to the Engadin with respect to architecture and settlement patterns. In contrast, the - two level - farming system of the area occupied for only part of the year is similar to that in central Graubünden. In the Landwasser valley, the temporary buildings are made of wood; in the Albula valley, they are mostly made of stone.

Changes in settlement patterns

Thusis and the Rhine Plain

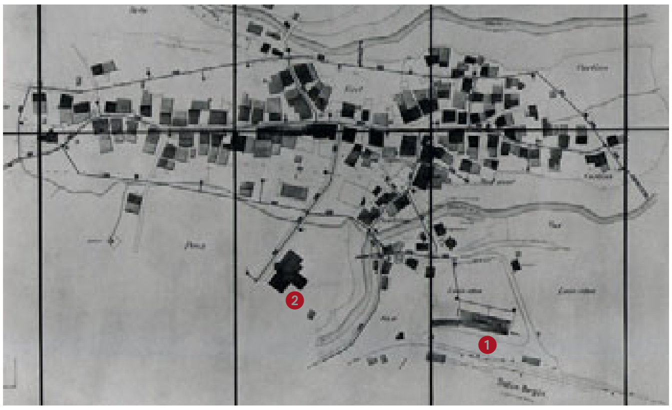
Thusis station, the starting point of the Albula line, is at the southern end of a plain that was created in the decades following 1836, when the Rhine dams were built, from the man-made alluvial deposits on the former flood area. The village itself lies somewhat higher than the railway line. It comprises a historic nucleus and the "new village", which is slightly apart. The latter is a 19th-century rarity in the settlement building pattern: a built-to-plan settlement constructed immediately after the village was destroyed by fire in 1845 to the plans of Richard La Nicca (1794 – 1883), the canton's civil engineer. The cantonal building plan took traffic regulation and economic questions into account, as well as fire safety and sanitation. It stipulated the following:

1. A village road (to be built by the canton): 1,070 m long, virtually flat, 13.2 m wide including a space of 3 m from the houses on either side.
2. Two rows of houses, 10.5 m deep, massively built and with fireproof roofs, separated from one another by side lanes 3.6 m wide.
3. A parallel 'stable road' for the utility buildings, built in a line and separate from the houses.
4. The houses should be two or three storeys high with a classic façade facing the street.

With its clear-cut, orthogonal building pattern and the uniform design of the houses 'New Thusis' reflects the urban visions so much in vogue at the time. This is the only 'new settlement mile' (cf. 2.b.3) in the network of new roads built in Canton Graubünden between 1818 and 1942 that was built strictly according to theory. The "old village" of Thusis was not rebuilt until decades after the fire.

Eight of the twenty-one historic villages around Thusis, including the little market town of Fürstenau, are of national importance. Numerous cultural monuments – all in all, there are seven castles and six churches together with the imposing Hohenrhätien citadel above Sils and the Cazis monastery – round off the picture

Bergün/Bravuogn > View of the village with the Hotel Kurhaus. Taken in the first quarter of the 20th century.
Collection Wehrli, Eidgenössisches Archiv für Denkmalpflege, Berne



Bergün/Bravuogn > Historic plan of the village showing the railway station ❶ and the Hotel Kurhaus ❷. The living accommodation is shown in black, the stables are shaded in grey.
Denkmalpflege Graubünden, Chur

Bergün/Bravuogn > Typical "Engadin House" with painted façade (1554), photograph taken in 1907.
Ch. Meisser/ Staatsarchiv, Chur

of an incomparable complex of historic settlements at the centre of Graubünden.

Tiefencastel

The overall architectural impression in Tiefencastel is reminiscent of the Italian style, partly due to the baroque pomp of the Stephanskirche (St. Stephen's), built in the mid-17th century, partly to the rational building structure and symmetric form of the houses, both these features resulting from the complete reconstruction of the village after it was destroyed by fire in 1890. The encounter with Italianate, sacral architecture is not fortuitous: the village was the centre of the "Missione retica" for Oberhalbstein, the Counter-Reformation movement in Graubünden organised by the Capuchin monks (cf. 2.b.2).

Filisur

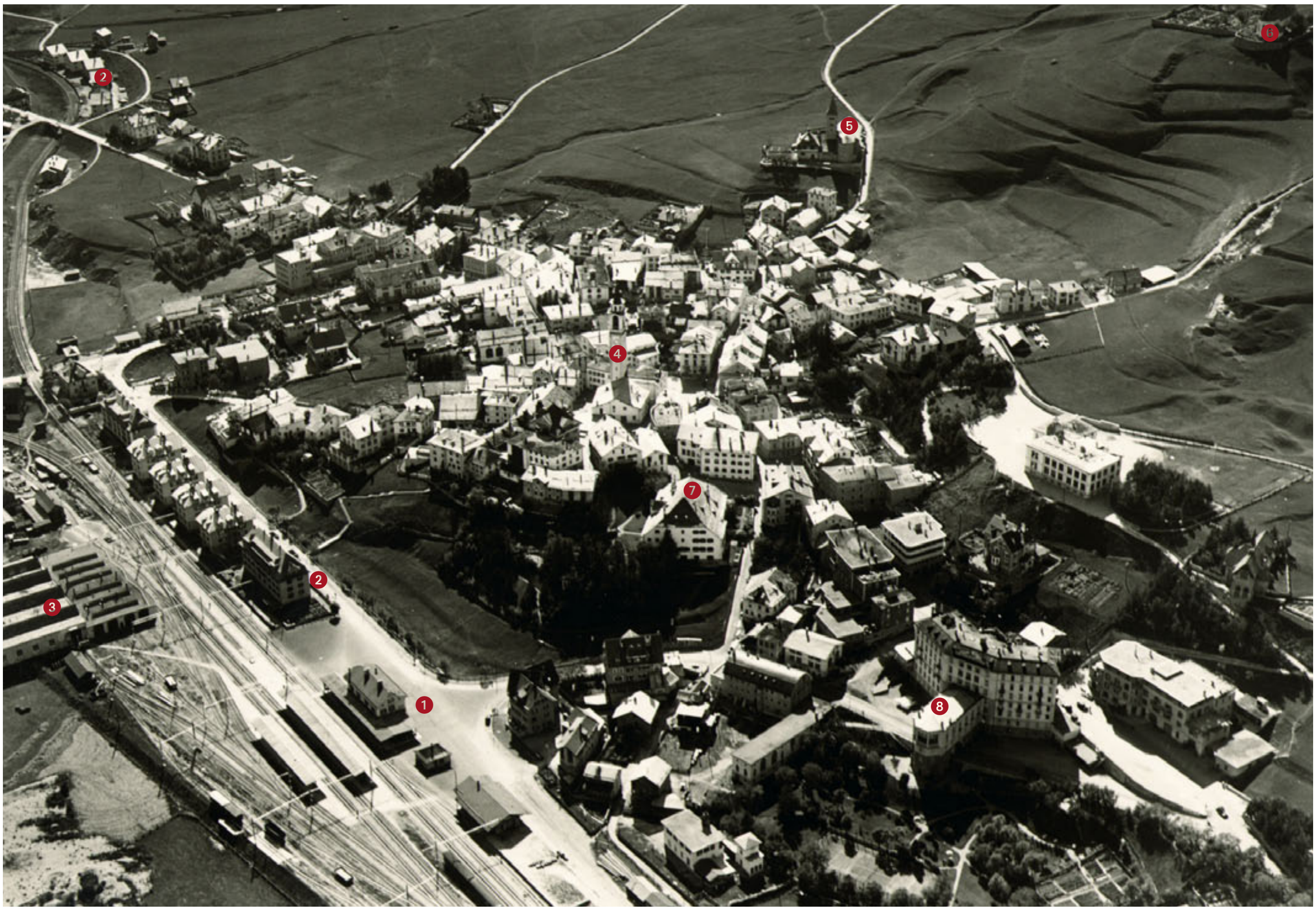
In the Albula valley, the layout of the villages is based on organic, agricultural structures and determined by the complex topography – there are hardly any linear or even symmetric elements to be found here. In Filisur, the connection between the nucleus of the old village and the station on the slope to the north was created by extending the old cemetery road, which was planted like an avenue with mountain sycamore and linden trees at the same time as the station was built. The compact settlement follows the valley road; on the downhill side, the road is bordered by an uninterrupted line of imposing houses with decorated façades. Filisur is recognised as one of the most attractive villages in central Graubünden.

Bergün/Bravuogn

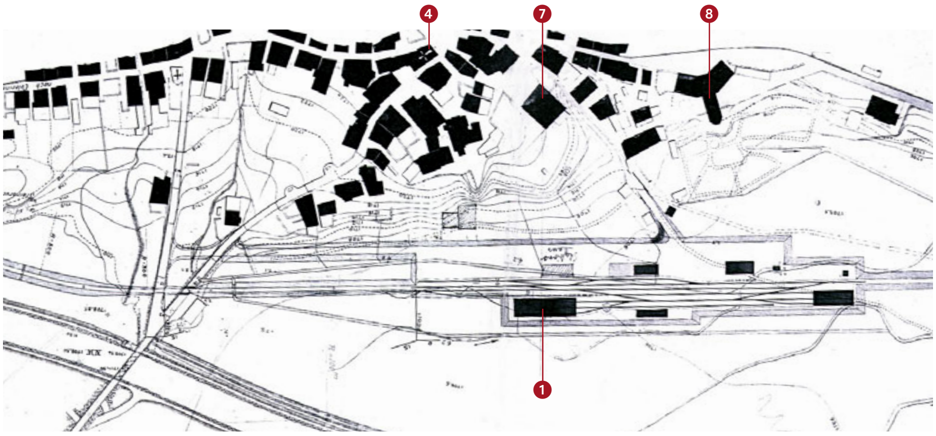
In 1925, the village of Bergün/Bravuogn comprised some 80, in part very imposing, farmsteads, a station area with a few new shops and restaurants, the federal arsenal (1917), and the Kurhaus, opened in 1906, with its gardens and contemporary sports facilities. A stone bridge, built in 1903, leads from the old village to the mountain sycamore and birch-lined avenue of the station road. Since the Middle Ages, the historic nucleus has developed either side of a long road with short lanes branching off to the sides. Two important planning rules define the appearance of the village: the buildings stand close together flush with the edge of the road, their plastered decorated façades facing outwards; the utility buildings are built on to the houses at the back so that the edge of the village shows an uninterrupted, close-knit row of livestock sheds with stone-built corner posts and wooden walls in between.
The railway line starts the climb to the Albula pass in two open loops across the winter-safe mountainside meadow to the east of the village. It is a pleasant surprise for the passengers to discover that the view of the village and its church, together with the hamlet of Latsch above it, is repeated several times.

Maiensäss Naz

In general, all building at the Maiensäss level in the Albula valley is in the same style. On the gentle slopes of the Naz meadows, there are 18 Maiensäss farmsteads, at regular distances and all built with the same materials and facing the same direction. They are seasonal dwellings with living and farm sections of the same size. The livestock and hay barn tracts are on the sunny side; the conditions on the shady living side are ideal for processing and storing milk and cheese.



Samedan > The historic village is set on a hill, the railway installations are on the valley floor. Taken in 1933.
1 = Reception building
2 = Staff houses
3 = Repair workshop
4 = Protestant church
5 = Catholic Sacred Heart church
6 = St. Peter's church of the Holy Sepulchre
7 = Chesa Planta
8 = Hotel Bernina
Swissair



Samedan > Original plan for the construction of the railway station, dating from 1903.
Rhaetian Railway

Settlement pattern in the Upper Engadin

The rolling topography of the landscape, together with the airy larch forests, the lakes and the flat meadows where the rivers used to meander at will, provides an unmistakable stage for the historic settlement nuclei pattern of the Upper Engadin. The open, high altitude valley, virtually free of farm outbuildings, allows an unimpaired view of the formerly farming villages and also underscores the two most recent phases of building development generated by the surge of tourism. The first phase, with the castle-like hotel buildings in the old centres of the villages and the palatial residences in the midst of elaborately landscaped hotel parks near the villages, started about 1850 and was interrupted abruptly in 1914. In the meantime, the extensive residential quarter of St. Moritz, with its landscaped parks individualised by successive additions to the hotel complexes, has acquired rarity value as a new tourist settlement. From the architectural- and tourism-historic viewpoint, the once farming villages dotted with large hotel complexes are also important; these include the former village of St. Moritz as well as Pontresina, Celerina and Samedan. In the last few decades, large holiday home developments have grown up around the historic villages.

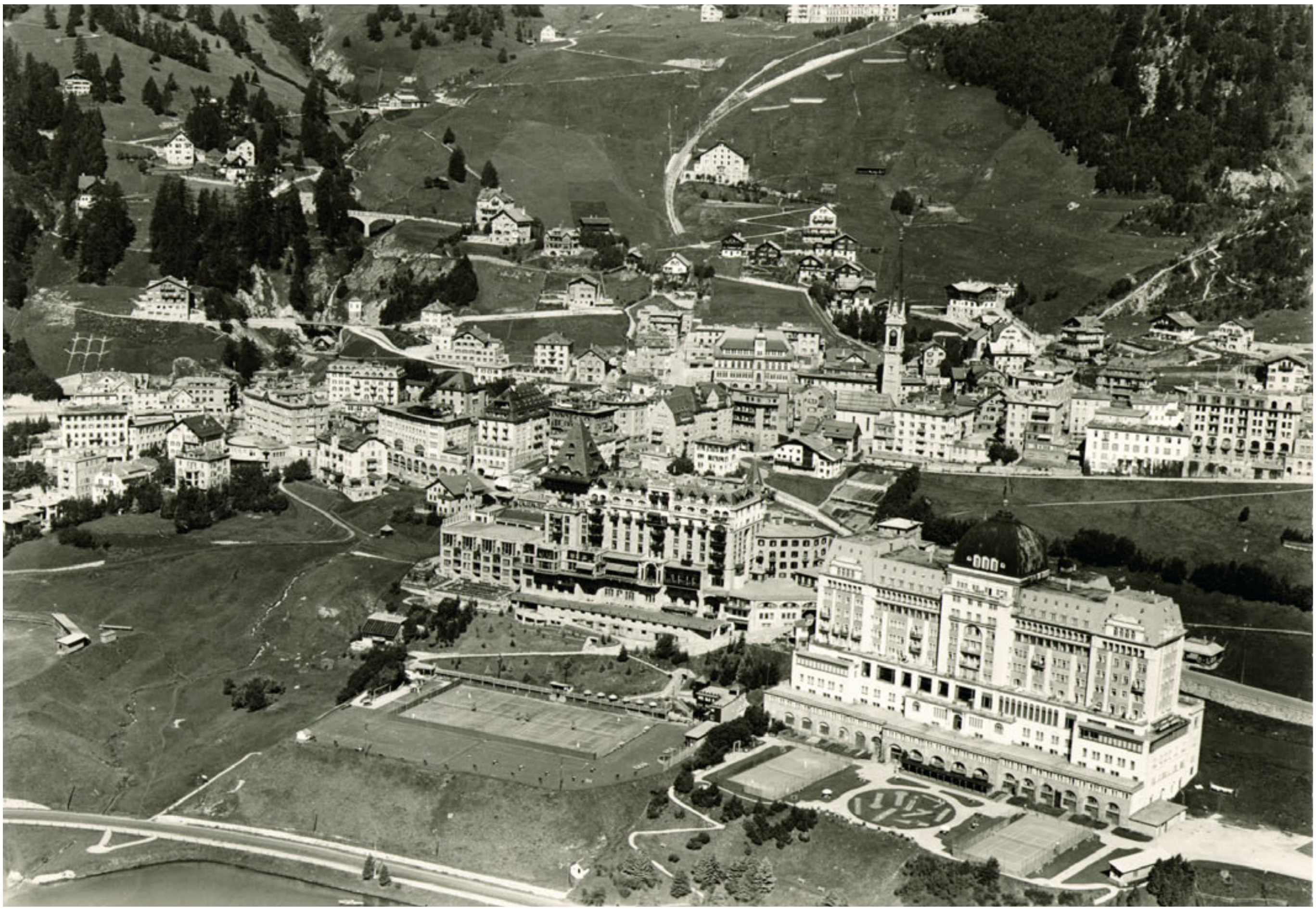
Settlement structures

The gently sloping valley floor of the Upper Engadin lies between 1,600 and 1,800 m and is therefore at about the same altitude as the alp-grazing regions elsewhere. Consequently, the alpine pastures in this part of the valley are only slightly higher than the villages. The historic farms here were organised and centralised at two levels and farmed from the villages, which, despite the high altitude, were inhabited all year round. Winter fodder was stored exclusively in the massive barns built in one unit with the houses (cf. 2.a.6). There were, and still are, more than enough pastures, but only a restricted area of meadows. The lower slopes were terraced for arable farming; these old terraces are still very impressive today (cf. 2.a.7).
The historic village nuclei were built up according to strict planning regulations on the location of the buildings and their architecture. Geometric or symmetric positioning of façades and repetition of the same forms were foreign to the local building pattern until about 1800. In view of the concentration of buildings, the prescriptions for private and collective objects are very strict. Agricultural wheeled vehicles are allowed to enter and pass through the historic farm complexes. The rows of buildings, flush with the street, face on to the curving lanes. The valley road forms the spine of the villages and, here and there, short side lanes branch off with rows of houses on both sides. The appearance of the lanes and open spaces is characterised by the decorated house façades, the edge of the village by the livestock sheds built on to the back of the living quarters. This gives the settlement nucleus a very compact and architecturally uniform appearance. The settlement landscape has few towers or defences dating from the Middle Ages; in contrast, there are many, mostly small, sacral buildings from the Middle Ages and the Baroque period, which define entire passages of the landscape or are the focus of the closely structured villages.

Changes in settlement patterns

Bever

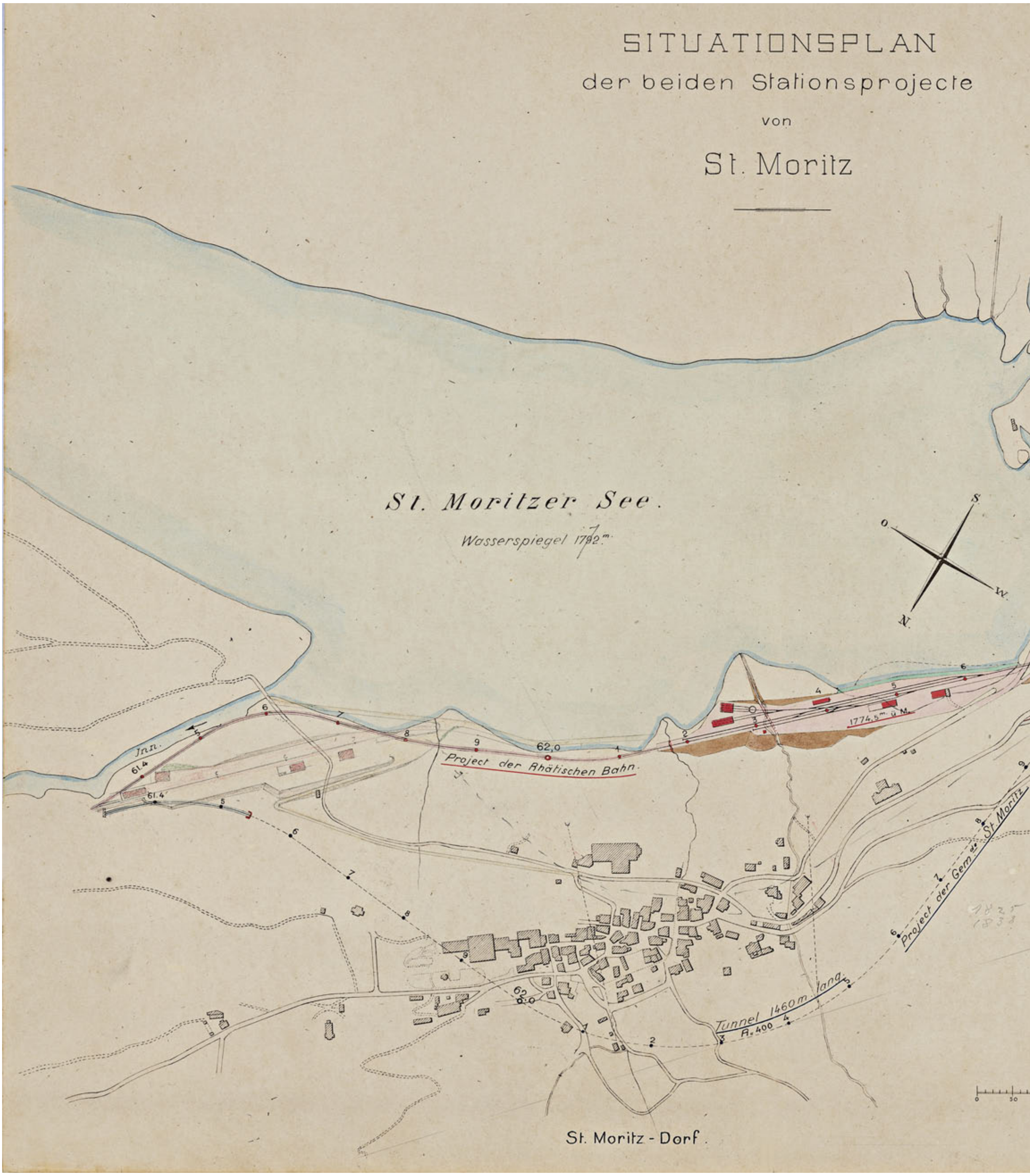
The Albula railway makes a sharp bend round Bever and stops to the west, outside the village. Since 1955, this farming village has morphed

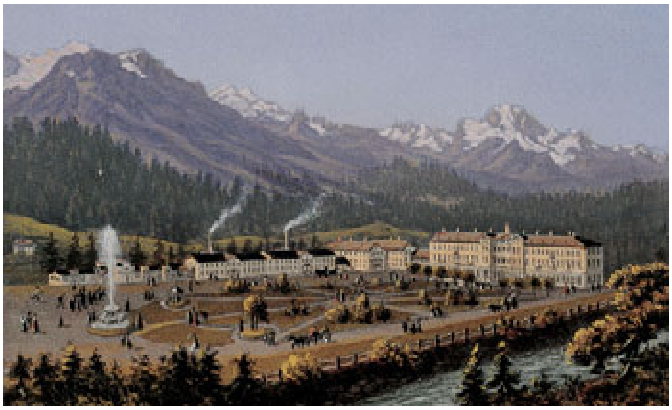


St. Moritz Dorf > View of the village from the south in 1934. The Grand Hotel and the Hotel Palace in the foreground.
Swissair

St. Moritz Dorf > View of the old farming village from the west, about 1850.
Denkmalpflege Graubünden, Chur

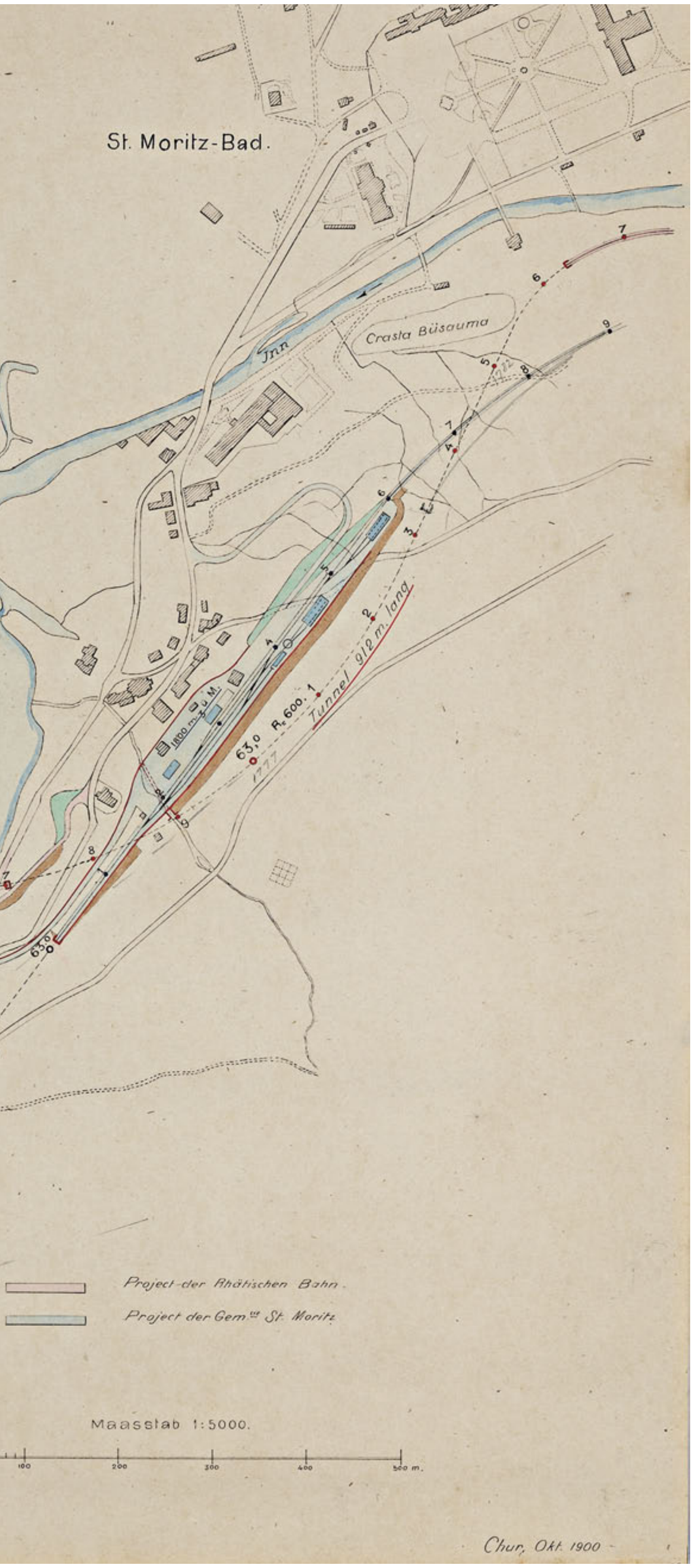
St. Moritz Bad > Construction of the Hotel Stahlbad, 1891/92.
Dokumentationsbibliothek, St. Moritz


SITUATIONSPLAN
der beiden Stationsprojecte
von
St. Moritz
St. Moritzer See.
Wasserspiegel 1772m
Inn.
Project der Rhätischen Bahn.
Project der Gemde St. Moritz
Tunnel 1460 m lang.
St. Moritz - Dorf.



St. Moritz Bad > The Neue Kurhaus built in 1864. Coloured aquatint by Johan Rudolf Dikenmann, around 1870.
Rhätisches Museum, Chur

St. Moritz > The spa district in the foreground and St. Moritz Dorf across the lake in 1900.
Denkmalpflege Graubünden, Chur



St. Moritz > Overview project plan for the location of the railway station, about 1900 (reduced in size).
Rhaetian Railway

into a tourist resort, but the authorities have taken care to preserve the old farm houses in their original form; the decorated façades, for example, have been renovated in the authentic manner.

Samedan

Samedan is the principal base of the Albula and Bernina line, with its own railway installations and residential area for the staff. The railway district is a settlement focus on the flat land below the historic village and provided the impulse to expand and upgrade the village as a regional centre with a regional hospital (1914), the Academia Engiadina secondary school, apprentice workshops (1965), and a vocational college (1980).

St. Moritz

When the Albula railway was opened, the transformation of St. Moritz into a world resort was already in progress. The development of tourism had begun only some fifty years earlier (cf. 2.b.9), not so long after the first guests had been put up in its patrician houses. The pioneer hotels – Kulm (1857), Steffani (1869 – 70), Palace (1892 – 96) and Schweizerhof (1897 – 98) – had developed their imposing architectural lines without losing sight of the old farming village on the meadows high above the lake. After the advent of the railway, more representative residences were built between the village and the station some distance away: for example, the Grand Hotel (1905, destroyed 1944), the Hotel La Margna (1906 – 07), the Neue Posthotel (1907 – 08) and the Hotel Carlton (1912 – 13). The Engadin Museum (1905 – 06) and the Segantini Museum (1908), both built by Nikolaus Hartmann the younger, belong to the same period (cf. 2.a.5).
The previously undeveloped flat land to the west of the lake was built over in the 19th century with luxury bathing and hotel establishments. The first was the Neue Kurhaus (1860 – 1864, a few storeys were added in 1905), a castle-like edifice surrounded by extensive landscaped gardens. More recent complexes were built on the same principle – Hotel Victoria (1874 – 81), Hotel du Lac (1875, demolished 1974) Hotel Hof (1875), Hotel Stahlbad (1891 – 92, destroyed by fire 1971) – so that the space between the River Inn and the forested southern slope gradually developed into a residential area with alpine gardens and delicate fountains on the lines of a Baroque palace. Various new sacral buildings tended to the spiritual needs of the guests: the Evangelical Badkirche (about 1870), the Catholic St. Charles church (1885 – 89) and the French-Calvinist church (1875 – 77). The footpath to the old hall where the guests 'took the waters' was rebuilt as a carriageway and lined with shops, giving the hotel district its dominance in the settlement pattern; a tram also ran on this road. There is only one villa worth mentioning that belongs to this period; this was built 1883 for the industrial magnate, Jacques Ambrosius von Planta, who lived in Chur.
After prolonged discussion about the location, the station for the Rhaetian Railway was built at the eastern end of the lake, directly after the River Inn runs through a gorge – away from St. Moritz-Dorf (St. Moritz-Village) and even further from St. Moritz-Bad (St. Moritz-Spa). The local council had demanded that the station be located to the west of the lake with a tunnel to underpass the village; at all events, the "connection to the lake and the picturesque bay" as well as the unimpaired "vista of the lake and the mountains" had to be preserved. Although the liberally-minded railway engineers insisted on "one station for spa and village" and the "sur-

Pontresina > Looking towards Val Roseg. The station of the Rhaetian Railway can be seen mid-right. Before 1930.
Ch. Meisser, Staatsarchiv, Chur

Bernina-Suot > Row of farm houses. The drawing is from before 1930.
Denkmalpflege Graubünden, Chur

Poschiavo (parish) > Maiensäss Pairol. Photograph from before 1930.
Denkmalpflege Graubünden, Chur

prising view of the lake and the broad valley on emerging from the tunnel", they were largely guided by topographic and economic factors. The definitive, peripheral location was eventually determined by the Swiss government.

Settlement pattern along the Bernina line (Swiss section)

The north ramp of the Bernina railway climbs from Samedan or St. Moritz to the Ospizio Bernina station across treeless alpine pastures and past community alp buildings. There is a steep descent to Poschiavo after the crest, with the line curving lazily from Alp Grüm to Cavaglia past numerous scattered one-herdsman alps; from there to Cadera, it crosses the Maiensass belt with its numerous scattered buildings several times. In the lowest section, shortly before Poschiavo, the mountain line repeatedly presents vistas of the closely structured villages and the 'Borgo', as the nucleus of Poschiavo is called; this was urbanised in the 19th century. The view of the landscape – populated only part of the year in the higher section, all year round in the lower section – is irresistibly dramatised by the low speed of the train and the repeated loops and traverses.

Settlement structure

The floor of the Poschiavo valley is at medium altitude, between 500 and 1,200 m, favouring the organisation of the farms at the various altitude levels: valley, Maiensäss and high alp. The entire hay harvest from the village meadows was stored in barns in the village, so there are no fodder barns on the meadows themselves. The Maiensäss belt falls into two sections between 1,100 and 1,800 m: the lower Maiensässe (monti maggesi), which are occupied in the autumn, and the upper areas (monti alti), which are used by the farmers, each working for himself, in the spring. As a rule, the farms comprise a house with integrated stable for the livestock, a hay loft above it, and a separate, mostly domed, cellar. The older farms are built partly in stone and partly in wood, usually facing south; the more recent buildings face the same direction, but are built of stone throughout.
In summer, the farmers from Poschiavo go up to the single herdsman alps (monte alpivo). The alp level here is far more extensive than most and, in the past, provided more than enough room for the local farmers' cattle and small animals as well as other animals from Lombardy, particularly sheep but some cattle as well. According to the position, the alp farms differ considerably with respect to the size of the buildings and the length of time they are occupied (three to eight months). Normally, there are larger or smaller lofts above the stable; these are used for alp and mountain hay and partly as living quarters. Freestanding barns, without stabling, for intermediate storage of the mountain hay are the exception on the Poschiavo alp.

Changes in settlement pattern

Pontresina and Muottas Muragl

By the time the railway was built, Pontresina, originally a farming village in two separate parts, had merged into a hotel village offering travellers an impressive alpine-urban prospect, an effect accentuated by the hotel park gardens between the village and the stream. The Muottas Muragl funicular railway was built at the same time as the Bernina line; it has a notable valley station, acting as a link to the new (1906/07) mountain hotel with a panoramic terrace at an altitude of 1,453 m.

Poschiavo > Aerial view of the Borgo taken in 1955.
Comet

Poschiavo > The row of "Palazzi" on the southern rim of the village.
Riccardo Tognina, Romerio Zala: *Das Puschlav* (Schweizer Heimatbücher, Bündner Reihe, vol. 3, 53/53A), Berne 1974.

Bernina Suot

The three farmsteads at Bernina Suot, standing in a row alongside the old pass road with their living quarters and stabling tracts built together and interconnected lie at an altitude of 2,046 m; the highest settlement in Europe lived in all year round. The compact row of buildings is a rare settlement pattern in view of the high altitude and the structure, which is reminiscent of mediaeval architecture.

Poschiavo Borgo

Similar to the villages in the northern part of Graubünden and particularly in the Engadin, the historic settlement structures in Poschiavo did not welcome a novel form of transport forced on them from outside; until then, the village had always developed autonomously, from the inside. Building in Poschiavo is slightly denser than in the other villages along the Bernina line. The houses stand close together, bordering the narrow streets. The village was architecturally modernised in the decades before the railway was built and urbanisation extended on a linear axis in a row of buildings along the southern edge of the village (known as the "Palazzi" row, cf. 2.a.6).
As it reaches Poschiavo, the Bernina line follows the foot of the western slope, so the station had to be located outside the historic settlement nucleus. The free area between the old village and the station provided generous space for the subsequent extension of the settlement on either side of the road as far as the station. The latter was not planned as an extension of the Palazzi road, although the famous row of buildings at the south of the 'Borgo', an eminent ottocento urbanisation feature, had just been completed, accentuating the impact of the connection between the station and the historic centre of the village. The railway builders did not continue the orthogonal settlement pattern as classicism was no longer fashionable.

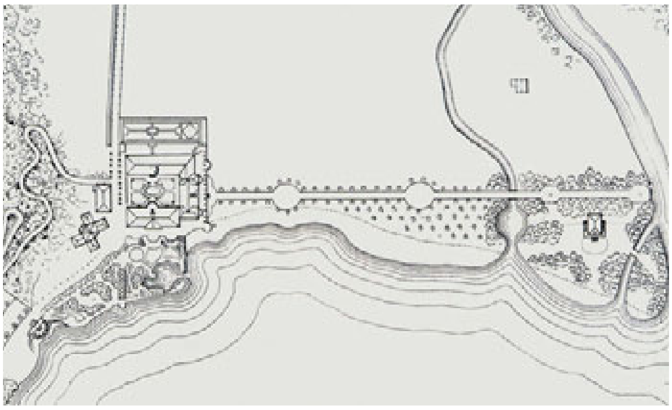
Le Prese

Fifty years before the Bernina line was built, the quiet little village by the Lake of Poschiavo had been redesigned and idyllically developed in the classicist manner; the luxurious Albergo Bagni Le Prese, a new hotel complex with mineral baths built in 1857, is particularly impressive. The laying out of the hotel park gardens was the first example of landscaping a natural environment in Graubünden. The contemporary project drawing shows a straight avenue of trees, at right angles to the valley floor, with a bridge over the mouth of the river. The avenue connects the hotel with the English-style gardens, complete with a small marina on the shore of the lake. It was not until 1884 – with the laying out of the Maloja Palace hotel grounds at the head of the Upper Engadin – that a lake shore was integrated in the landscaping of a garden in Graubünden; with this sole exception, the Upper Engadin lake shores remained intact until recent times.

Brusio

Close to the railway line, to the north of the Brusio reverse curve viaduct, a group of nine domed buildings attracts the attention of passengers. Known in the valley as "scélé" or "crott", these are single-chamber domed cellars to keep food and wine cool; their location is explained by the currents of particularly cool, fresh air that circulate there. These artefacts, unique in Switzerland, are built of dry stone; the corbelled or beehive domes cover a single perfectly circular chamber. This stylistic rarity is found throughout the Poschiavo valley at all farming levels, from village to alp.

Le Prese > Albergo Bagni, Le Prese from the south. Steel engraving by Ludwig Rohbock and Friedrich Theodor Müller, from before 1861.
Rhätisches Museum, Chur



Le Prese > Project sketch by Giovanni Sottovia for the landscaping of the shore area, drawn in 1864.
Silva Semadeni, Robert Obrist and Diego Giovanoli: *Bauen. Construir. Costruire 1830 – 1980*, Zurich 1986.

Brusio > A “crott” or “scéle”, an air cooled domed cellar below the railway embankment.
D. Giovanoli

Campocologno

In the years after 1907, Campocologno, till then a modest, single-alley hamlet close to the frontier, was overwhelmed by the technological age. The most important "hydroelectric power station in Europe" was built to the south of the village with an above-earth penstock, machine hall (since replaced) and transformer, with the Bernina line station to the north and rail tracks behind a row of houses. Soon afterwards came the school building, a Catholic church (1910 – 12), and the buildings, offices and living quarters of the Federal Customs and Excise authorities.

Tirano: settlement construction and history

The settlement history of Tirano can be broken down into four phases: the Middle Ages, the beginning of the 19th century, the beginning of the 20th century and today. The medieval settlement nuclei are found at outstanding sites overlooking the valley, but above all providing protection from flood waters. Examples include St. Perpetua pilgrims' hospice, the fort of Dosso and the little village of Visoli. The population increased sharply in the 19th century when settlement took place largely in the valley on the left bank of the Adda. The walled city of Tirano was already playing an import role in the region at that time. The nearby settlement of La Rascia, with the pilgrimage church of Madonna di Tirano, had been growing steadily since the 16th century.
In the early 19th century, houses were built along the right bank of the river; this was made possible by the river embankments built around 1800 under Austrian rule. These new elements and the buildings around the pilgrimage church mark the start of a surge in building activity in the 19th century. The advent of the railway – from Sondrino in 1902 and across the Bernina in 1909 – launched a building boom that continued until the beginning of the First World War. The specific location of the two railway stations, built next to one another, speeded up the merging of the two districts of Madonna di Tirano and Tirano to the south of the link road.
In appearance, the new buildings somewhat resemble northern Alpine architecture while incorporating the influence of Art Nouveau. The new bridges across the Adda determined the principal axis of the town along the Viale Italia and the Via della Republica. So the medieval nucleus with its historic walls and gates progressively lost importance and started to fall into decay.
Building activity increased considerably during the 1950s and 1960s. Trades, crafts and small industries flourished in Tirano. The rapid growth of the town could partly be attributed to the influx of villagers from Roncaiola, Baruffini, Serio and Pervio. Houses began to soar several storeys high: the first notable example is the Marelli building in the Via Italia. In only 50 years the town has spread out into the surrounding countryside. Madonna di Tirano and Tirano grew together to form a single town due to extensive developments of detached houses, but the historic nucleus of Tirano has hardly changed. The most marked expansion of the settlement was in the area between the right bank of the Adda and the railway line from Tirano to Sondrio.

Albula line > The first train steams into Samedan.
On board, all the members of the Swiss government.
Engadin Press

2.b.5 History of the Rhaetian Railway

The origins of the Rhaetian Railway go back to 1888, when the "Landquart-Davos Narrow-Gauge Railway Company" was established in Davos. The foundation of this enterprise had been preceded by years of arguments about whether a rail transport system for Graubünden should take the form of standard-gauge transit lines or narrow-gauge valley lines. The narrow-gauge railway between Landquart and Davos was opened in 1889/90. After a further six years or so of heated discussions, the remaining lines making up the main network of the Rhaetian Railway were finally put into service within just 18 years (between 1896 and 1914). This period also saw the inauguration of the three legally autonomous lines in the Mesocco, Poschiavo (Bernina line) and Schanfigg valleys, which were later to be incorporated into the Rhaetian Railway network. Today, the Rhaetian Railway offers a wide range of passenger and freight services, including high-capacity car transport facilities on the Vereina line since 1999.

Transit or valley lines?

The history of the Rhaetian Railway is intimately linked with the special topographical features of Graubünden, Switzerland's largest canton. Graubünden had always managed to turn its central position in the heart of the Alps to its advantage. With the emergence of the railway as a new means of transport in the 1840s, the question of the canton's importance for transport policy was seen in an entirely new light. Enormous efforts were made to ensure that the new European alpine rail transit routes would not bypass the territory of Graubünden – but to no avail. The completion of the Brenner line (1876) – and even more so the opening of the lines through the Gotthard (1882) and the Arlberg (1884) – had direct economic repercussions in Graubünden, particularly in the traditional transit valleys such as Schams and Rheinwald (Splügen Pass and San Bernardino route) and Oberhalbstein (Julier route, cf. 2.b.3). In just 20 years (from 1880 to 1900), the population of these valleys declined by almost 14 %, whereas Switzerland's total population increased by 17 %!

Graubünden's unceasing efforts to secure a link to the international railway system had dire consequences in the sense that vital resources were tied up over the long term. Not only was a great deal of time and money invested in projects like the Splügen, Septimer, Greina and Lukmanier lines, none of which came to fruition; the fact is that this preoccupation with the idea of a great alternative alpine transit route through Graubünden also delayed the development of a rail network built around so-called valley lines within the canton. Most major European railway lines were laid out with a "normal" track width, or gauge, of 1435 mm, the curve radius was seldom less than 190 m und the maximum gradient was 25 ‰ (Semmeringbahn) or 27 ‰ (Gotthardbahn). By their very nature, such routing parameters were badly suited to the construction of a comprehensive rail network in a mountainous canton; on the Bernina line, for example, the minimum radius is 45 m and there are many sections with a gradient of 70 ‰. But anyone in Graubünden who favoured a narrow-gauge railway with a track

Landquart-Davos line > A passenger train on the Landquart – Davos narrow gauge line passing the through the narrow gorge (Klus) at the entrance to the Prättigau valley. Photograph from 1891.
Rhaetian Railway

Willem Jan Holsboer (1834 – 1898) > Energetic initiator and promoter of railway building in Graubünden, about 1885.
Rhaetian Railway

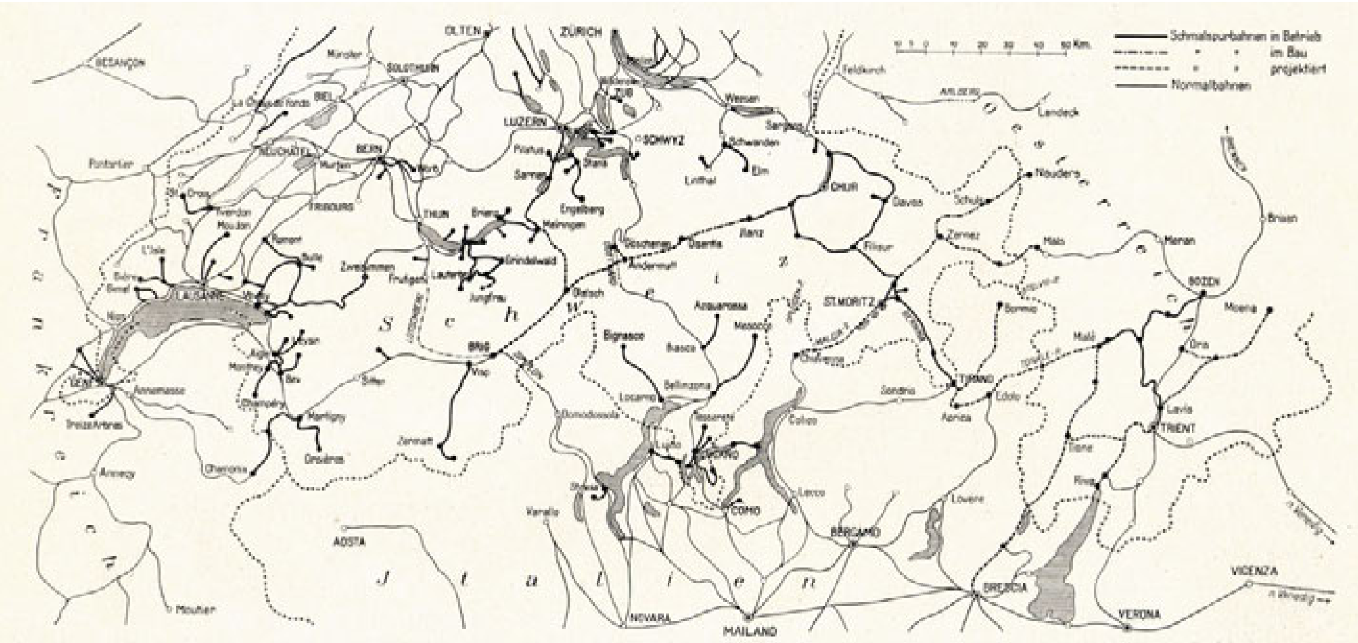
width of only 1,000 mm and parameters better adapted to mountainous terrain was accused by the political establishment of undermining the efforts to build international lines on the canton's territory. Nor was the considerably lower cost of a narrow-gauge railway an argument that counted for much in those days. Small-mindedness and parochial attitudes in some quarters also contributed to the deadlock: in the capital, Chur, for instance, which already had a rail link to cities in Northern Switzerland such as St. Gallen (since 1858) and Zurich (since 1859), people were still adamantly opposed to extending the standard-gauge line to Thusis and the Engadin in the 1880s for fear of losing the monopoly position as the terminus of a national railway!

Willem Jan Holsboer – Graubünden's Alfred Escher

A solution to the canton's railway problem was found eventually, thanks to various far-sighted local people including the future Federal Councillor Simon Bavier, the lawyer Sebastian Hunger and the engineers Robert Moser and Martin Versell. However, the most important contribution was made by a Dutchman, Willem Jan Holsboer. A former captain, and vice president of an international bank, Holsboer first came to Davos with his wife in 1867 for a cure. After his wife died the same year, he decided to make his home in Davos, where he would later play a major role in turning the village into a world-famous resort. Holsboer realised that a connection to the greater European railway network was essential for Davos' future development. In the mid-1880s, together with Peter Bühler, a member of the Swiss parliament, he presented a project for a narrow-gauge railway from Landquart to Davos. The budget of 5 million Swiss Francs for this project was to be less than half the estimated cost of the standard-gauge railway mooted ten years earlier, on condition that the municipalities concerned undertook to supply the land and all the necessary building materials – gravel, sand, stones and wood – free of charge. After a sizable majority of the people of the Prättigau Valley and District of Davos voted in favour of the project, the Landquart – Davos Narrow-Gauge Railway Company was founded on 7th February 1888 with its registered office in Davos; this company was the forerunner of today's Rhaetian Railway. The section as far as Klosters was put into operation in 1889 and Davos, the (provisional) terminus, was reached in the summer of 1890.

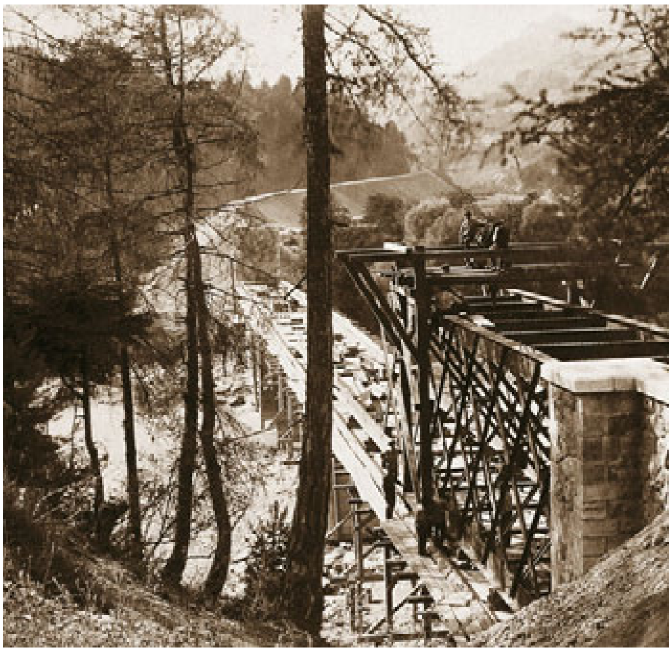
From the "Landquart-Davos Narrow-Gauge Railway" to the "Rhaetian Railway"

Alongside all this, the discussions about the "right" type of technical railway equipment for Graubünden were continuing at the political level and among the population. At the end of 1889, the people of Graubünden agreed to a cantonal contribution for a standard-gauge line (!) from Chur to Filisur via Thusis, but the project had to be scrapped because the planned core finance from private sector sources did not materialise. This fuelled the increasingly strident demands – to which Holsboer also lent his voice – to abandon standard-gauge "world rail projects" (e.g. Chur – Engadin – Landeck – Merano or Chur – Thusis – Splügen – Chiavenna) for the time being at least, and focus instead on measures that would better serve Graubünden and its fast-growing tourist industry. Accordingly, work was started on a narrow-gauge



Overview of the narrow gauge railways in the Swiss Alps. Plan (reduced in size) taken from: E. Bosshard: ***Die Berninabahn***, Zurich 1912 (***Schweizerische Bauzeitung***, offprint).

Landquart-Davos line > After passing Küblis, the railtrack climbs a gradient of 43 ‰.
Rhaetian Railway



Chur – Thusis line > Construction of the steel bridge across the Hinterrhein at Reichenau. Taken in 1885.
Rhaetian Railway

line from Landquart to Chur and on to Thusis. The Landquart – Davos Narrow-Gauge Railway Company was entrusted with this undertaking, and both lines were up and running in 1896.

This period also saw a change in the Company's name, which no longer reflected its actual sphere of operations. The Landquart – Davos Narrow-Gauge Railway Company was renamed "Rhaetian Railway" in 1894, not least with a view to the new rail projects that were taking shape in the canton. This allusion to the name by which present-day Graubünden was commonly known between the 16th and the early 19th century (Alt Fry Rätien) was a clever move, as it fostered a sense of local identity and certainly helped to defuse the tension surrounding the contentious issue of what constituted the "right" type of railway. The name originally envisaged – Graubündner Bahnen – was rejected, since a possible abbreviation using the initials "GB" might have led to confusion with the Gotthardbahn.

In 1896, the Rhaetian Railway moved its registered office from Davos to Chur.

In 1897, the Canton Graubünden bought the large block of Rhaetian Railway shares held by the "Swiss Railway Bank" (Schweizerische Eisenbahnbank). This bank – another brainchild of Holsboer's – was set up in Basel in 1890 for the purpose of assisting "in particular, rail transport enterprises serving the interests of the Canton Graubünden". Having acquired these shares, the canton became the de facto sole owner of the Rhaetian Railway. It would now have been possible to make the railway company part of the cantonal administration, in line with the policy adopted at federal level: the Swiss government had also bought the shares of the country's five regional railway operators in 1897, and merged them into a single, government-controlled company under the name "Swiss Federal Railways . However, Graubünden did not want to follow suit with "its" railway.

But since the canton was now the majority shareholder of the Rhaetian Railway, it was nevertheless necessary to enact the appropriate cantonal legislation on railways. This was done in 1897, and the draft bill was accepted by a clear majority of voters in a local referendum. The legislation governed the above-mentioned acquisition of shares, support for the construction of new lines by means of graded cantonal contributions, and the mandatory payments in kind by the municipalities involved. In addition, the Rhaetian Railway was exonerated from all cantonal and municipal taxes. The tax exemption still holds good today (see Art. 34 of the Public Transport Act in the Canton Graubünden dated 7th March 1993), whereas the obligations relating to payments in kind could "only" be maintained until 1993. However, during the construction of the Vereina line from Prättigau to the Lower Engadin (from 1990 on), the municipality of Klosters-Serneus – which was particularly strongly affected by this project – was instructed under a Federal Court decision to meet its commitments, notably to make the necessary building land available free of charge.

In 1898, one year after the legislation on railways was approved, Graubünden successfully applied to the federal parliament for a subsidy. The Swiss Confederation agreed to take a stake of 8 million Swiss Francs in the Rhaetian Railway by purchasing so-called subsidy shares. This meant that work could go ahead on the following lines (first year of operation in brackets):

Samedan > The Rhaetian Railway threw a party in Samedan to celebrate the opening of the Albula line, 27th June 1903.
Rhaetian Railway

Davos – Filisur line > Wiesen Viaduct. The imposing framework was constructed by the legendary Richard Coray. Taken in 1908.
Rhaetian Railway

Reichenau – Disentis/Mustér line > The station in Disentis/Mustér decorated to welcome the opening train drawn by the G4/5 Nr. 119 locomotive, 30 June 1912.
Rhaetian Railway

> Albula line from Thusis to St. Moritz (1903 / 04)
> Reichenau – Ilanz line (1903), later extended to Disentis / Mustér (1912)
> Samedan – Pontresina line (1908)
> Davos – Filisur line (1909)
> Bever – Scuol line (1913)

These lines constitute the main network of the Rhaetian Railway, together with Landquart – Davos and Landquart – Chur – Thusis. In addition, three legally autonomous railway lines were built in Graubünden during the same period:

> Bellinzona – Mesocco (1907)
> St. Moritz – Tirano (opened in stages from 1908, all sections open in 1910)
> Chur – Arosa (1914)

Graubünden's narrow-gauge rail network covering a total distance of almost 400 km was completed in an extremely short timespan of 26 years – an absolutely remarkable achievement even (or especially) by today's standards, given the major technical, topographical, climatic, political and financial difficulties involved.

Strong growth in the Belle Epoque

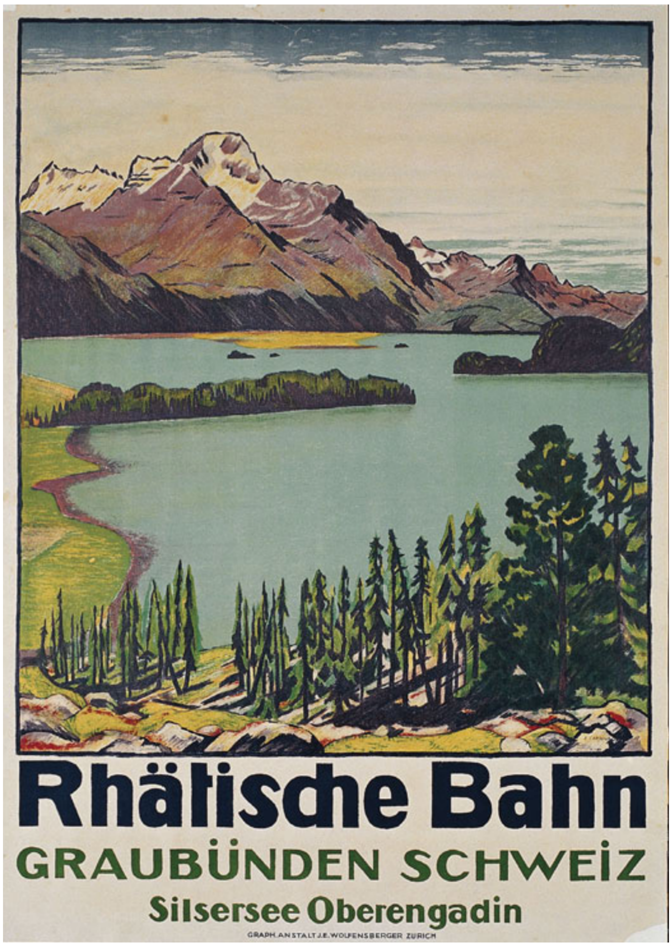
The lines of the Rhaetian Railway and the other rail companies provided access to all the most important valleys of Graubünden. Train frequencies showed a very pleasing trend. Between 1890 (the first full year of operation) and 1913 (the year preceding the war), i.e. the period of network expansion, the Rhaetian Railway registered the following growth in its main network (converted to network kilometres):

> Number of passengers carried – up by a factor of 2.0
> Number of tons transported – up by a factor of 2.0
> Number of passenger kilometres – up by a factor of 2.6
> Number of tonne kilometres – up by a factor of 3.0
> Total transport revenues – up by a factor of 2.5

What should also be noted in this connection is the considerable increase in transport productivity, which is defined as the quotient between the company's transport services and its total staff. This quotient rose from 20.1 in 1890 to 36.5 in 1913.

The increase in train frequencies, of course, was not achieved without a lot of hard work. Very early on, the people who ran the Rhaetian Railway had realised the importance of measures that nowadays come under the heading of marketing. The Bernina Railway's report on its second financial year (1907) emphasised the need to take appropriate steps in this field: "As the area which should be opened up to large-scale tourism by the Bernina Railway is still relatively little known, we consider that extensive but dignified advertising is absolutely essential." Subsequently, renowned artists including Emil Cardinaux, Augusto Giacometti, Rafael de Ochoa and Marcel Lebrun were commissioned to design suitable posters. Advertising between 1910 and 1920 was done by means of posters, which displayed the name of the railway but did not show any trains!

In line with the increase in train frequencies and revenues, financial results were also very encouraging. With the exception of two business years (1891 and 1892), the Rhaetian Railway paid its shareholders regular dividends until 1913. In the post-war period, annual dividend payments only resumed when



Poster for the Rhaetian Railway by Emil Cardinaux, 1916. Surprisingly, the artist chose not to show a train.
Rhaetian Railway / KGMZ

Poster for the Rhaetian Railway by Emil Cardinaux, 1918. Here again, the representation of a train is "missing".
Rhaetian Railway / KGMZ

Postcard for the Bernina Railway, 1920. Artist unknown.
Rhaetian Railway / KGMZ

the Company started making profits again after 1925, but they came to an end once and for all in 1930.
In the euphoric atmosphere generated by the success of the early years, various studies were carried out after 1900 on the feasibility of extending the Lower Engadin line to Pfunds in Austria, where a connection with the projected Vinschgau line from Meran to Landeck was planned. Both the Swiss and the Austrian authorities had already agreed in principle to grant the licence for the construction work. Projects and licences were also available for a rail link to Italy, from St. Moritz via Maloja to Chiavenna. But World War I put an end to all these plans. In view of the limited investment funds available, priorities had to be redefined. What counted was no longer the extension of the network but the optimisation of transport productivity.
In the entire main network of the Rhaetian Railway, only the lines to the Lower Engadin and the section between Samedan und Pontresina were electrified until 1913; roughly 80 % of the network was operated with steam engines. During and after World War I, the price of coal rose six fold within seven years. The Company therefore pressed ahead with electrification of all its other lines, and the process was completed in 1922 (cf. 2.b.6 and 2.b.7).

New challenges and growth through mergers

After carrying out all these investments, the Rhaetian Railway was faced with a threat of barely imaginable proportions when a new means of transport made its debut. The first cars had already appeared on the drivable roads in Graubünden in the closing years of the 19th century (cf. 2.b.3), but a complete ban on cars in 1900 soon put a stop to this. From 1907 on, the people of Graubünden would repeatedly turn down proposals by the cantonal authorities to allow private cars on the roads. Only in 1925 – after eight unsuccessful referendums on the matter – was the ban on cars finally lifted. The car gradually became a powerful competitor of the railway for both passenger and goods traffic. A few years later, the Rhaetian Railway and the canton as a whole were hit by the world economic crisis. Between 1931 and 1936, the handsome profits earned in the six previous years turned into equally substantial losses. This negative trend continued with the outbreak of World War II. International political developments had an even stronger impact on the other rail companies in Graubünden, namely the Bernina, Mesocco and Arosa lines, which were only able to stave off bankruptcy thanks to periodic injections of public funds. In 1939, the Federal Act on Assistance to Private Railway and Shipping Companies entered into force. This was the basis for the restructuring of the Bernina line and its subsequent integration into the Rhaetian Railway, initially by way of a cooperative arrangement, then a full merger in 1944. Of necessity, the Mesocco and Arosa lines had already adopted this solution in 1941.

Developments in recent decades

There have only been two further changes in the network of the Rhaetian Railway since the end of World War II:

a) On the insistence of the Swiss government, the loss-making passenger transport operation on the Mesocco line was replaced by a bus service in 1972; the section between Mesocco and Castione remained open for

Bellinzona– Mesocco line > A train passing through Soazza. Photograph taken in the 1950s.
O. Furter/Rhaetian Railway

Vereina Tunnel > Car loading point for the longest one metre gauge rail tunnel in the world.
P. Donatsch/Rhaetian Railway

the time being, albeit only for goods traffic. Following a violent storm, the highest section of the line (Mesocco-Cama) had to be closed in 1978, and the Rhaetian Railway also discontinued train services on the remaining stretch between Cama and Castione due to a sharp fall in traffic volume. The rail installations were transferred to the Società Esercizio Ferroviario Turistico (SEFT), a private association which now offers a museum train service in the summer months.

b) The demise of the Mesocco line was almost fully offset in kilometre terms by the construction of the Klosters-Lavin line (22 km long) between 1990 and 1999; its centrepiece, the Vereina tunnel, is the world's longest railway tunnel in meter gauge. In the short time since it was put into service, the Vereina line has exceeded all expectations regarding traffic volume. As the second rail connection from Northern Graubünden to the Engadin, it is of crucial operational and economic importance for the Rhaetian Railway and the Lower Engadin/Münstertal region (also as a fall-back in the event of interruptions on the Albula line).

The Rhaetian Railway has existed for more than a hundred years. Although its history has been punctuated by several crises, the Company has never failed to recover from them. The Swiss government and the Graubünden cantonal authorities regard it is an entity of major relevance, not only on national policy grounds but also for economic, transport and military reasons – which is why the Rhaetian Railway has always received generous financial support from the public sector. This commitment manifests itself in non-refundable grants to compensate the Company for operating regular train schedules that do not cover costs, and in the joint financing of railway infrastructure investments, particularly with a view to increasing capacity on certain routes (e.g. by building double-track islands in an overwhelmingly single-track network). The present shareholder structure of the Rhaetian Railway, which has undergone practically no change in recent decades, is as follows:

Swiss Government	43.1 %
Canton Graubünden	51.3 %
Graubünden municipalities	1.0 %
Natural persons, legal entities	4.6 %

Successful alpine-experience railway

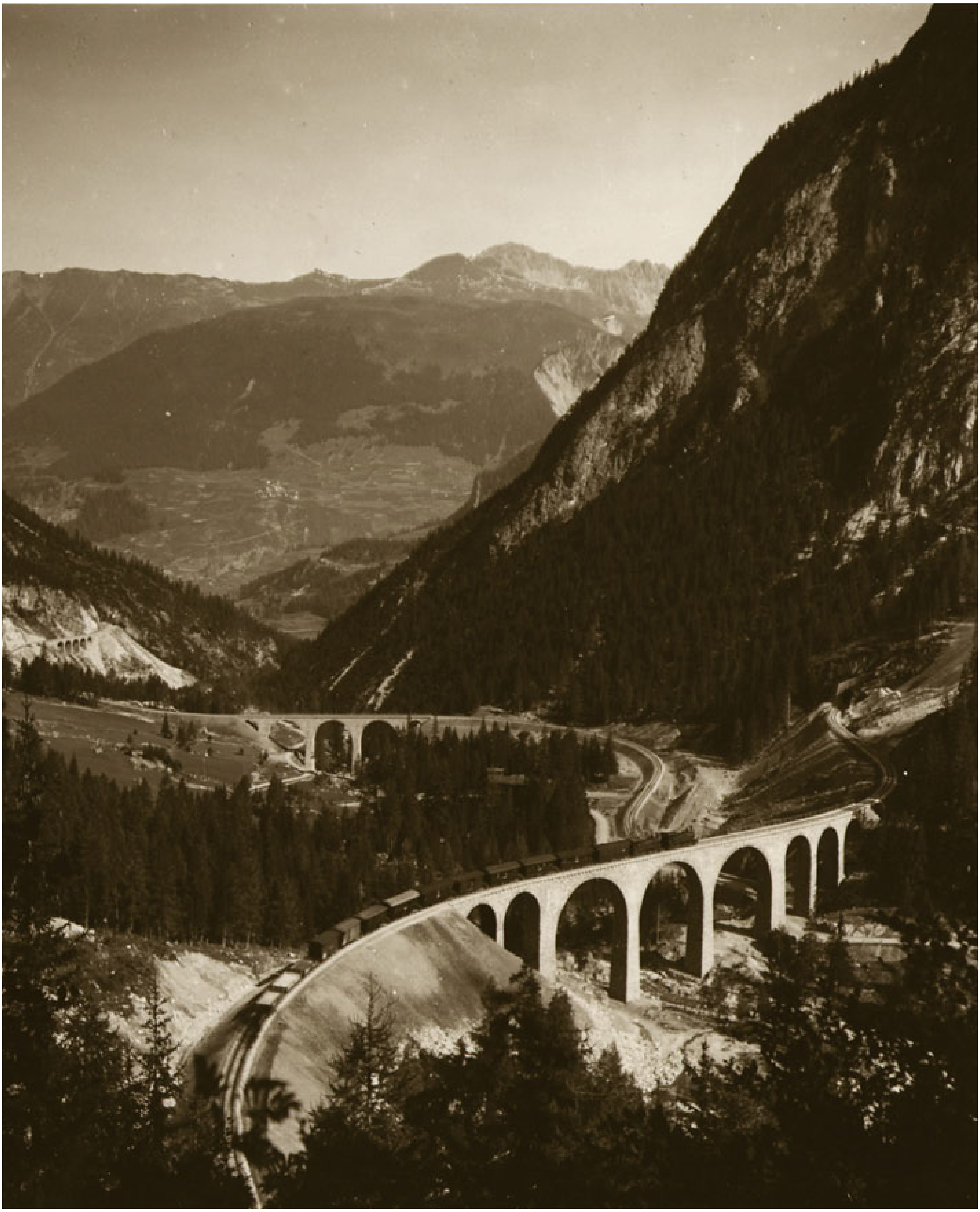
Under its Articles of Association, the Rhaetian Railway's mission is to serve the economy of the Canton Graubünden in its capacity as a company managed in accordance with business administration principles. This also involves responding to new and growing customer needs. For example, the journey time from Chur to St. Moritz has been cut from 3¾ hours when the line was opened in 1904 to 2 hours today, thanks to state-of-the-art train security installations and increasingly efficient locomotives. Furthermore, the Glacier Express (St. Moritz-Zermatt) and Bernina Express (Chur – Tirano) are Rhaetian Railway "products" which enjoy a worldwide reputation and are not just applauded by experts; the National Geographic Traveler rates the Bernina Express as one of the ten most beautiful railway lines in the world.

A 385 km rail network with rolling stock of some 1,500 rail-borne vehicles is currently operated and maintained all year round by a staff of roughly 1,450 people. The latest performance figures show that with a to-

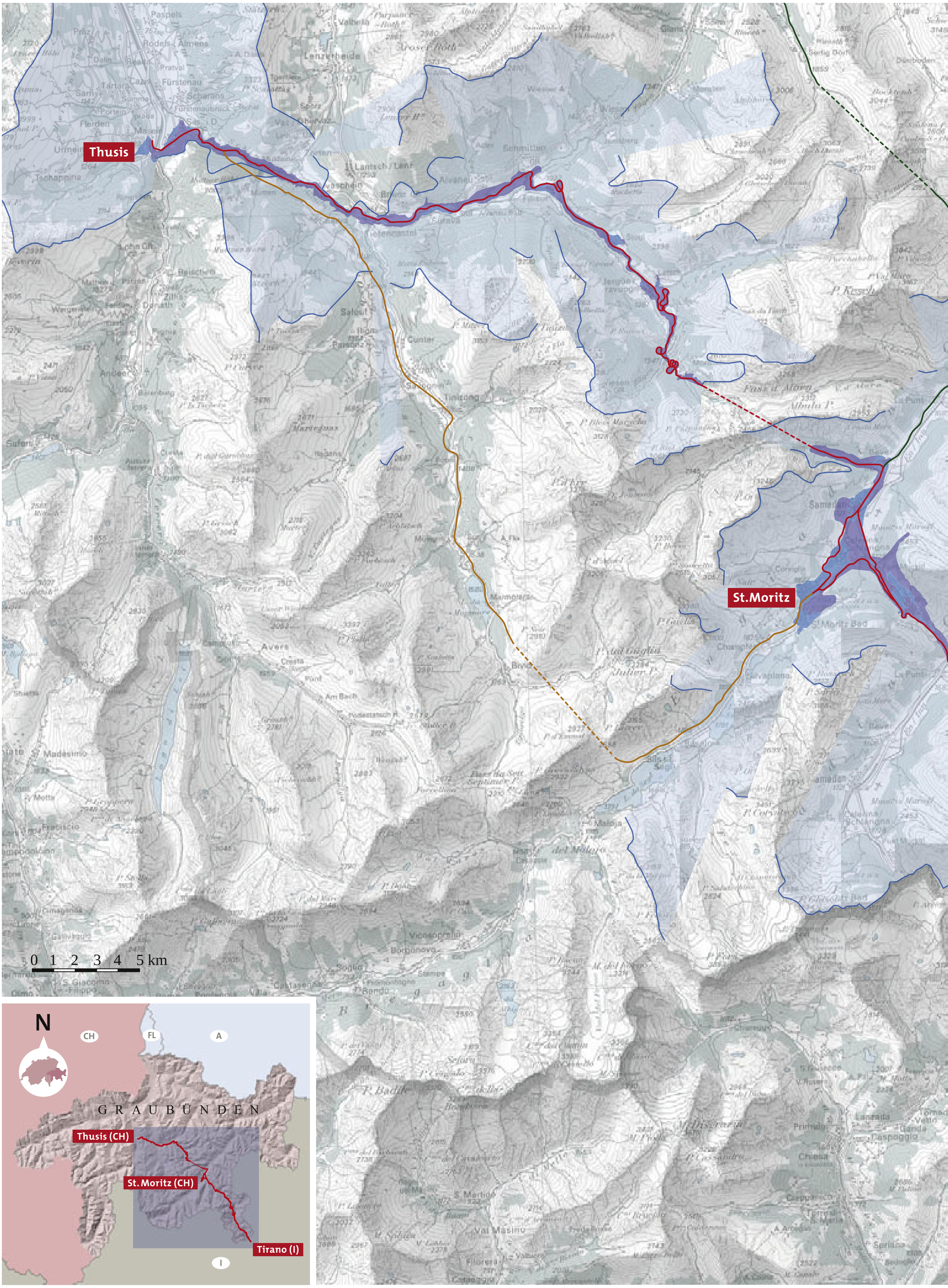
Bernina line > The Bernina Express has contributed significantly to international renommé of the Rhaetian Railway.
T. Keller

Albula line > The Rhaetian Railway also operates goods trains. Timber and foodstuffs transport on the Landwasser Viaduct.
P. Donatsch

tal annual turnover of over 250 million Swiss Francs, approximately 10 million passengers, 700,000 tonnes of freight and 400,000 accompanied motor vehicles a year are transported in an environmentally friendly and energy-saving manner. The Rhaetian Railway has successfully developed from a pure means of transport to a world-class alpine-experience railway, whose fame extends far beyond the borders of Graubünden and which is an inseparable part of the canton's tourism infrastructure.



Albula line > A passenger train crossing the Albula Viaduct III. Taken shortly after the opening in 1903.
Archives Engadin Press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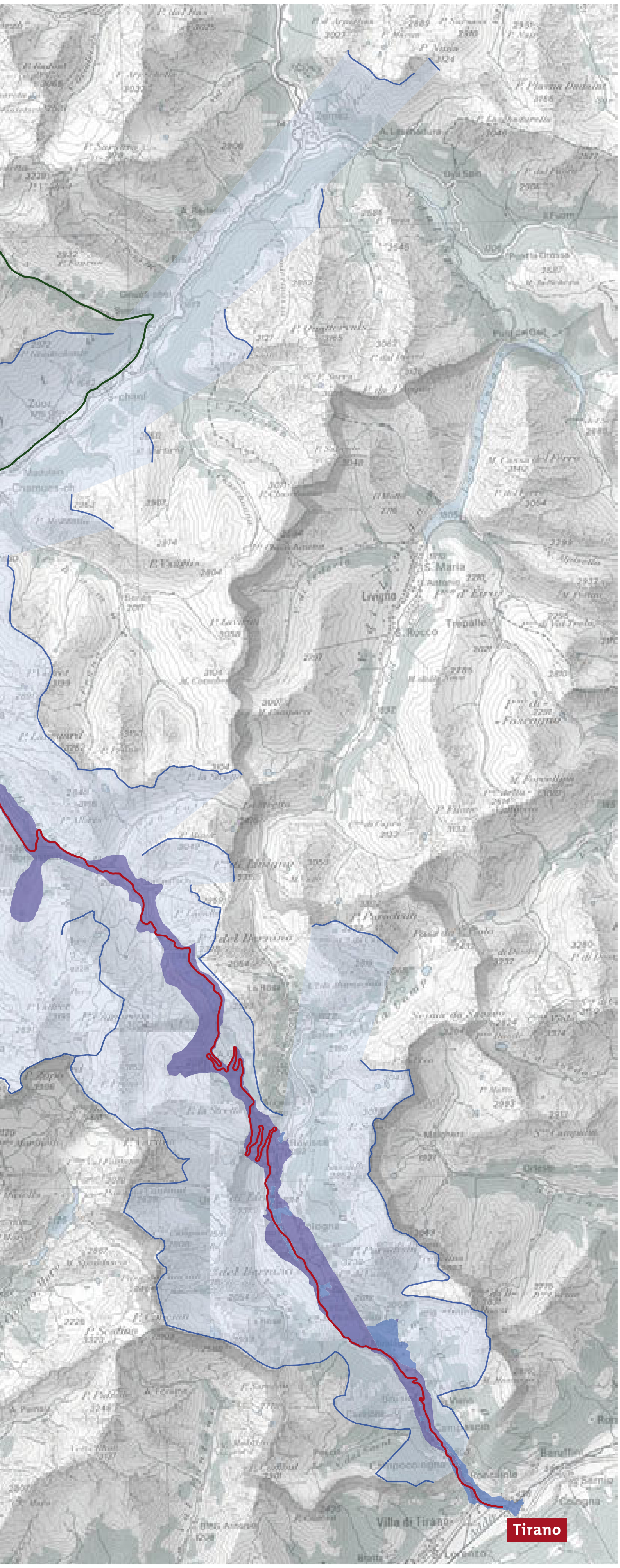

Railway construction projects for the Engadin

Scaletta railway 1890
Scaletta tunnel

Julier railway 1897
Grevasalvas tunnel

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area
Buffer zone in the distant area (backdrop)
Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Gian Brüngger / Gion Rudolf Caprez
Design: Süsskind, SGD, Chur
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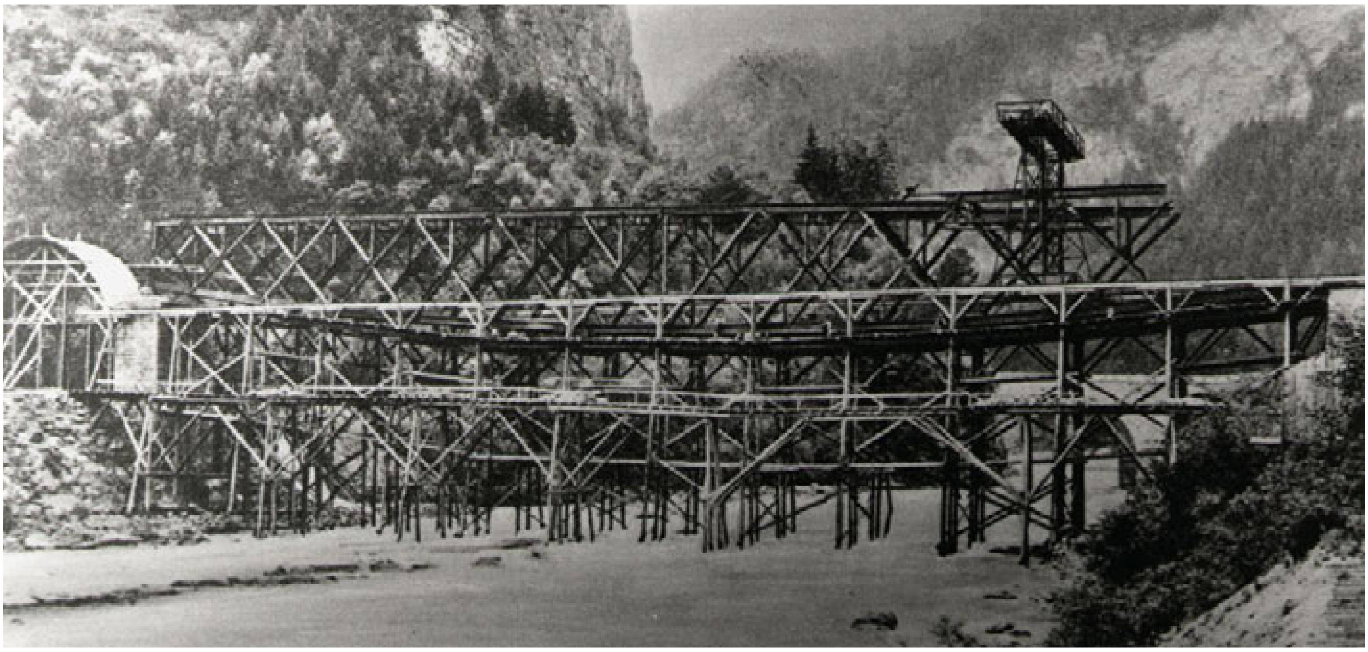
2.b.6 Railway construction and operation

The Albula line was constructed between 1898 and 1904 as a high-capacity, narrow-gauge railway providing access to the renowned holiday resorts of the Upper Engadin. The stretch was originally operated with steam engines but electrified in 1919. Despite continuous adaptations to changing requirements, the original alignment has been preserved virtually throughout and is still used for its original purpose.
The Bernina line was constructed between 1906 and 1910 as an electrified surface railway linked with the power stations on the south side of the Bernina Pass, and for better access to the natural scenery that is so attractive to tourists. However, modifications to the alignment and innovations in terms of snow clearance and protective measures for the track proved necessary to permit services to be operated all the year round.

Albula line

Project development

By 1860 a continuous network of main railway lines had developed in Europe extending as far as the foot of the Alps. This made travel into the Alpine area much simpler, even though the last part of the journey still had to be made by stagecoach or on foot. The use of narrow-gauge lines to open up access to the higher altitude holiday resorts, as provided in Switzerland with the lines to Davos (1890) and to Zermatt (1891), greatly increased the quality of access to the high mountain areas. From then on tourist centres which did not have a railway connection found that they were at a comparative disadvantage and sought to correct this.
The construction of the Albula line from Thusis to St. Moritz should be seen in this context. Since the middle of the 19th century the Upper Engadin had become an increasingly popular holiday destination for international visitors (cf. 2.b.9). Although travellers could use the stagecoach from Chur to reach the area, the railway link connecting Gotthard – Milan – Chiavenna with the onward road link over the Maloja Pass was more expedient for goods such as coal and for the construction material needed for new hotels. The cost of transporting a wagonload of coal over the section from Saarbrücken to Chiavenna was CHF 223.–, while for the section from Chiavenna to St. Moritz it was as much as CHF 250.–.
The decision to run the line along the Albula valley into the Engadin was the result of a lengthy selection process (cf. 2.b.5). Compared with the other options which were being discussed (the Scaletta and the Julier lines), the Albula line offered clear advantages from both geographical and engineering angles. The Scaletta line from Davos met with resistance from the central regions of the canton as well as from the Engadin itself; the primary reason was its peripheral location. What these areas wanted was their own direct connection to the standard gauge railway which, by 1858, had been completed as far as the terminus in Chur. A proposed Julier line running from Tiefencastel through the Oberhalbstein was rejected on financial grounds; the summit tunnel alone, due to its extreme length, would have involved enormous costs.
In 1889, the Graubünden cantonal engineer, Giovanni Gilli, prepared the initial design for a



Albula line > Construction of the bridge over the Hinterrhein at Thusis, 1901.
Rhaetian Railway

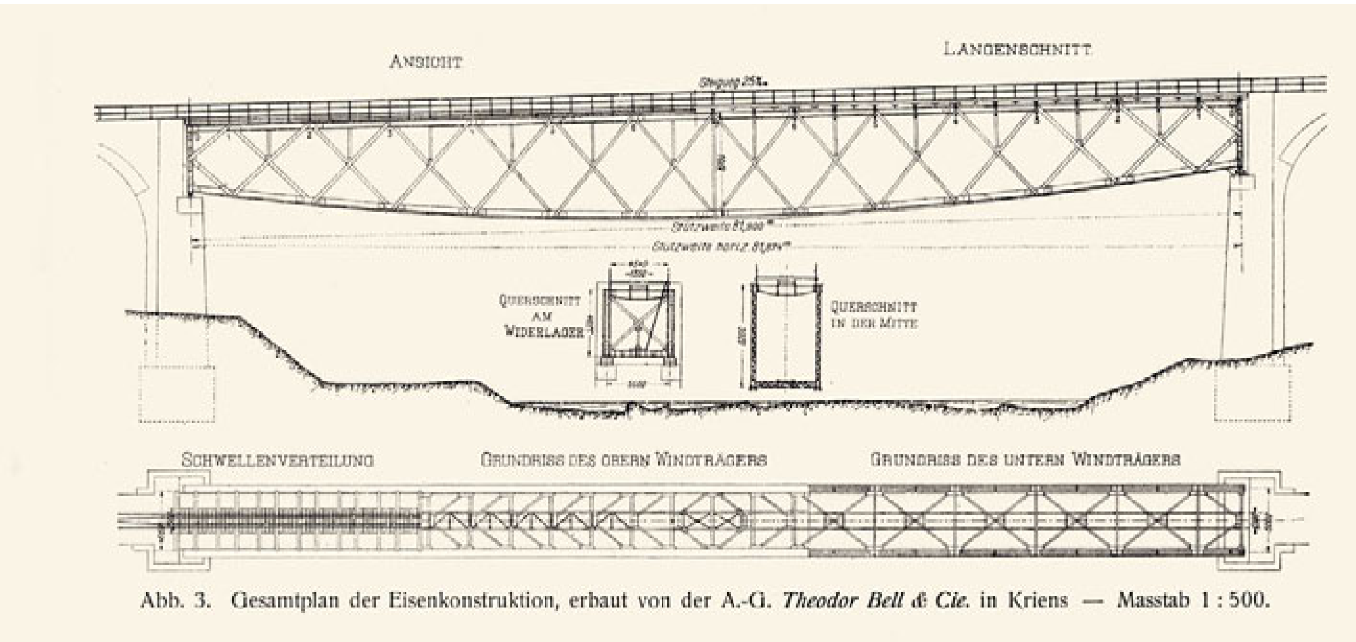


Abb. 3. Gesamtplan der Eisenkonstruktion, erbaut von der A.-G. *Theodor Bell & Cie.* in Kriens — Masstab 1 : 500.

Plan of the iron construction for the bridge over the Hinterrhein at Thusis. Plan (reduced in size) taken from: Friedrich Hennings: *Albulabahn. Denkschrift*, Chur 1908.

line through the Albula valley which would open up railway access to the Engadin. However, his plans for a narrow gauge Albula line between Filisur and Samedan show that it would not have had a high capacity. It would even have involved operating an 11.4 km section of the line as a cog railway with a gradient of 90 ‰ and the summit tunnel would have been so high that winter operation would scarcely have been possible. In 1890, an 'Albula line committee' was set up in Bergün/Bravuogn. Its members included well-known figures from the world of politics and the hotel trade. The committee asked the engineer Robert Moser to prepare a "technical study to investigate the construction of an Albula line and identify the most effective railway connection with the Engadin". In his report, Moser came to the conclusion that an Albula line, as "clearly indicated by the geography", would be preferable to the competing routes. His project proposed a narrow-gauge railway with a 45 ‰ gradient, similar to the line running from Landquart to Davos. Moser later reworked his design and showed that with little additional cost it would be possible to reduce the gradient to 35 ‰ significantly increasing the capacity of the line. In 1897, the Rhaetian Railway decided to go ahead with the construction of a line based on this design. Work on its construction began in 1898 under the direction of engineer Friedrich Hennings.

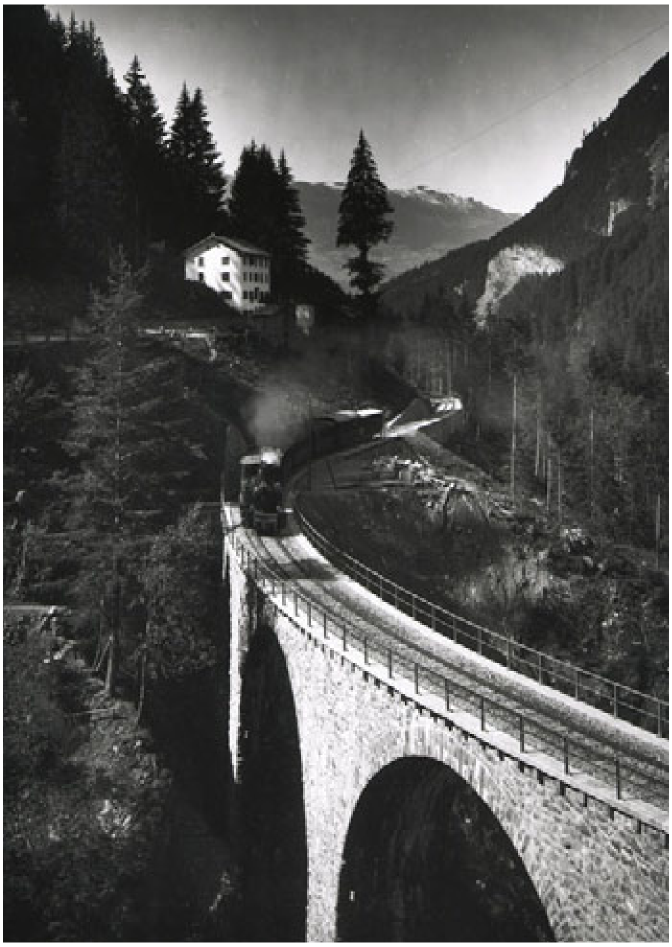
Finance

Graubünden's first narrow-gauge railway, the Landquart – Klosters – Davos line, which opened 1889/90, was mainly financed by the Schweizerische Eisenbahnbank (Swiss Railway Bank) established in Basel for this purpose; the bank held a majority of the relevant shares and bonds (cf. 2.b.5). It can be assumed that the investors expected to make a profit in the form of dividends or interest on bonds, or that they hoped at least to protect existing investments in hotels. In 1895 the application of stricter state regulations resulted in private shareholders threatening to drop out and give up their Graubünden railway shares. With the cantonal railway law of 1897 the canton took over the shares of the Landquart – Davos railway (renamed as the Rhaetian Railway) held by the Railway Bank and regulated the financing of what were called the 'priority lines'; this term referred to those sections of railway line in Graubünden (the lines between Reichenau and Ilanz and between Thusis and the Upper Engadin), which the canton wanted to get started without delay. These were no longer viewed as profitable investments, but rather as a means of implementing commercial and territorial policies.

The estimated costs of CHF 26 million for the construction of the priority lines was covered by share subscriptions: the Swiss government (CHF 8 million), the canton (CHF 4.3 million) and the communities (CHF 3.6 million), together with an issue of bonds for an amount of CHF 10.2 million.

The estimated cost of the Albula line was CHF 21.2 million; the final bill amounted to CHF 25.8 million, or some CHF 418,000.– per kilometre. Compared with the cost of the Gotthard line (completed in 1882 at a cost of CHF 1.1 million / km) and the Lötschberg line (completed in 1913 at a cost of CHF 1.6 million / km), the single track, narrow-gauge line through the Albula valley into the Engadin proved much cheaper to build, both in terms of the approach ramps and the summit tunnel; the narrow-gauge railway line between Landquart and Davos cost a mere CHF 150,000 / km. In terms of cost therefore, the Albula line lay somewhere in the middle between a simple narrow-gauge line and a full mountain railway.

Albula line > Alignment below the fort ruins at Campi near Sils i.D.
Rhaetian Railway



Albula line > Passmal Viaduct, Schin gorge, taken 1903/04.
Collection Wehrli, Eidgenössisches Archiv für Denkmalpflege, Berne

Albula line > Framework for the construction of the Solis Viaduct, erected by Richard Coray. Photograph 1901.
Rhaetian Railway

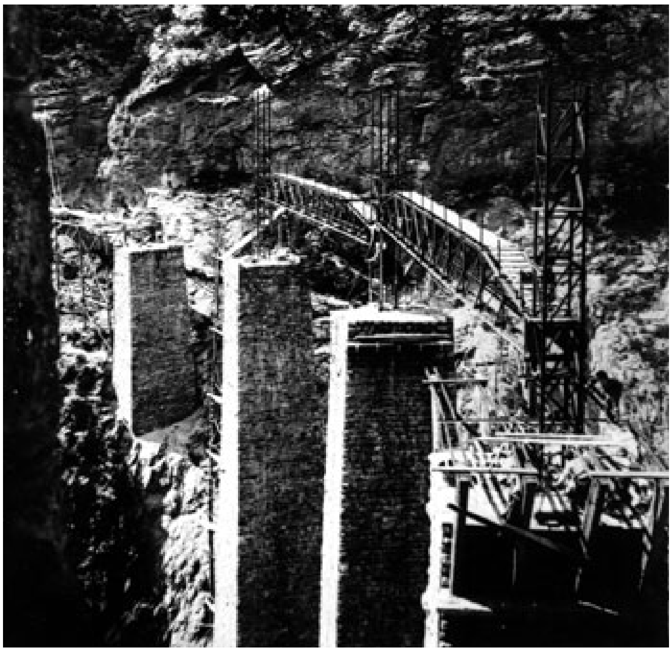
In 1906, chief engineer Friedrich Hennings defended the cost overrun of CHF 4.6 million in a memorandum pointing out the difficulties which arose during the construction of the Albula tunnel (and other cuts) due to the local geology, which gave rise to around CHF 3 million of additional expenditure. He also pointed out the design improvements made during the course of the construction, where the changes were intended to allow the line to cope with a greater volume of traffic and resulted in the final design of the Albula line approaching even more closely that of the large Alpine railways.

The construction of the railway

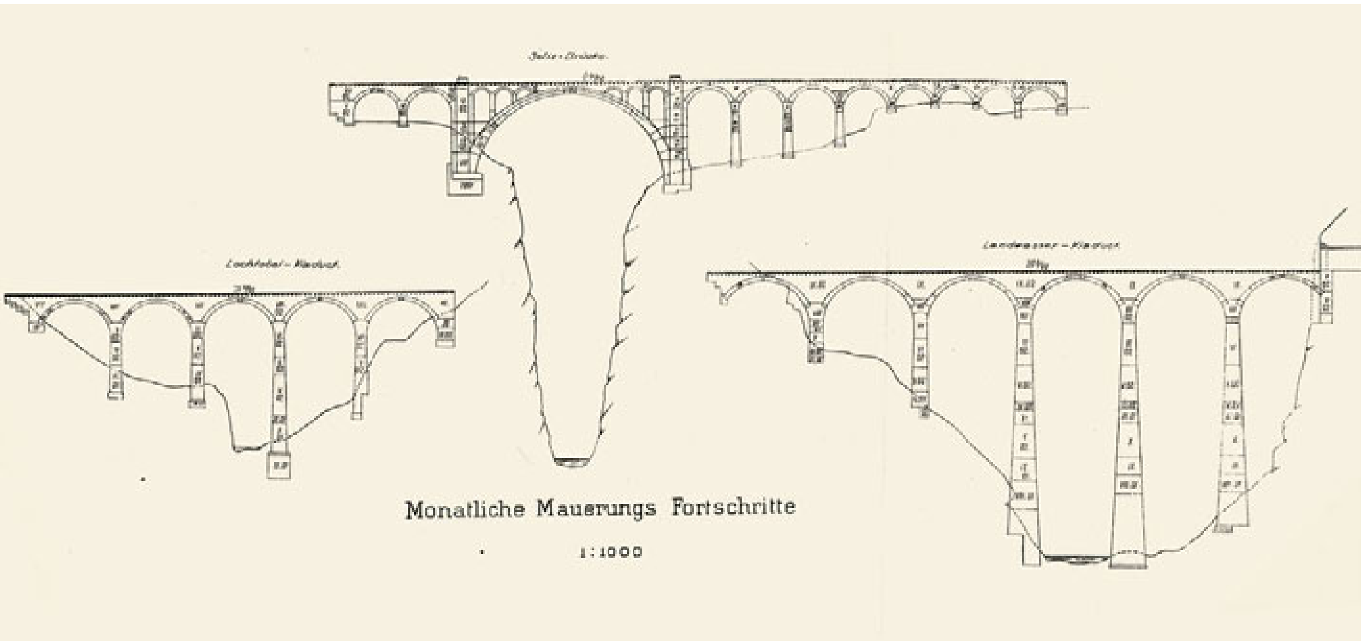
The engineering office in Chur began work in July 1898. The office was under the direction of Hennings and Giovanni Gilli, who had been appointed as Hennings' deputy. Initially, the task was to fix the precise alignment of the trackway through the terrain, using the general corridor alignment proposed by Robert Moser's design as a basis. Hennings introduced a number of changes to increase safety. At the same time the standards were developed which were to govern the construction of the works and the quality of construction. This provided the basis used for preparing the tender documents for the contractors to bid against. Factors used to determine the location of the stations called for political as well as engineering skills, particularly as the railway stations were not always constructed as close to the existing settlements as their representatives had wished. An estimate of the time needed to build the line showed that the construction of the Albula tunnel would be the main factor in determining when the line would be opened. For this reason the Rhaetian Railway began work on the tunnel as early as October 1898, even before the contract was awarded to a contractor, setting out the tunnel axis and working on the constructing of the base tunnel from both ends. Only such an early start on the construction of the summit tunnel gave any hope of opening the line in time for the 1903 summer season.

The full line was divided into three sections. The first included lots 1 – 4 from Thusis to Filisur, the second lots 5 – 8 from Filisur to the middle of the Albula tunnel and the third covered lots 9 – 11, from the middle of the Albula tunnel to St. Moritz. Each section had its own section engineer, who was in charge of the work. A site engineer and an assistant site engineer supervised the construction of each lot. The public viewing of design drawings in the various communities and the tendering and award of the construction of the track substructure all took place in the summer of 1900. Separate procedures were used for the tendering and award of the construction of the bridges over the Hinterrhein (Upper Rhine) near Thusis, for the construction of buildings and for the construction of the track superstructure. The design of the ironwork for the Rhine bridge in Thusis was planned, designed and carried out by the bridge construction company Theoder Bell & Cie. based in Kriens (Canton Lucerne). The assembly scaffolding was set up during the winter of 1900/01. Construction lasted from the beginning of May to the middle of August 1901 with bridge testing carried out on the 10th December 1901. The option selected for the section between Thusis and Solis did not require any forced alignment in the Viamala. Consequently the railway line had to run below the level of the road through the whole length of the Schin Gorge; it also meant that tunnels had to be built under the terraces of Campi and Freihof, even though these terraces were quite suitable for the construction of railway track. Consequently, the railway track now lay in an area of solid rock and

Albula line > Crane bridges were used for the construction of the Landwasser Viaduct. Photograph 1901.
Rhaetian Railway



Albula line > View for the Landwasser tunnel to the construction work on the piers for the Landwasser Viaduct, 1902.
G. Lorenz



Progress on the construction of the Lochtobel and Landwasser Viaducts were recorded precisely, with graphics, in monthly reports. Plan (reduced in size) taken from: Friedrich Hennings: *Albulabahn. Denkschrift*, Chur 1908.

was largely exempt from the risk of slope movements. The location of the railway line below the road also simplified the delivery of materials to the construction sites.

The foundations for the Lochtobel viaduct presented special engineering difficulties as the third of the central piers had to be sunk through the steep, unstable overlying material onto rock. Here, the sides of the 14 m pit, which was dug down to the level of the rock, had to be supported by extensive shuttering and the pit was filled in with debris from a mudflow while it was being excavated.

The engineers wanted to simplify the construction of the bridge over the Muttnertobel and avoid the construction of a particularly difficult section of track. Consequently the alignment was revised and improved after construction work had begun; the changes resulted in the Solis tunnel being extended by 127 m to a length of 987 m.

The material used for the attractive, dark, hard limestone ashlars of the Solis viaduct was obtained from locations very close to the bridge. The Munari, Cayre and Marasi company were able to construct the bridge in the surprisingly short period of one year. Construction costs amounted to CHF 125,000.

The original design of the Nisella tunnel foresaw a length of only 89 m, this, however, was later extended to 274 m in order to tunnel behind a scree which was exposed to rockfalls.

A number of factors were decisive in the design of the Filisur railway station. For one, it had to be positioned so as to keep the climb up to the Engadin as short as possible. The design also had to take into account the planned railway line between Filisur and Davos. Consequently, it would only be possible to keep to the maximum downgrade of 35 ‰ on the section Schmelzboden / Monstein – Filisur if the Filisur railway station was set at a relatively high level. Yet it was also important to make sure that the 35 ‰ slope did not begin before Surava railway station, as otherwise this station and the adjoining section of line would be forced to run along steep and difficult slopes and what is more the Landwasser viaduct would have to be built at an even higher level.

The station also had to be built at an accessible distance from the village; today's 50 m difference in altitude between railway station and village is still considerable.

If the principle normally followed in the construction of mountain railways had been applied, namely that the railway line should as far as possible be run along the valley floor, then the forced alignment of the line between Filisur and Bergün/Bravuogn would only have been necessary at the steep part of the Bergünerstein. However, comparative studies showed that a climbing section built in the terrain above Filisur would be feasible with shorter tunnels, which would save costs. The better geological conditions were obtained at the price of more difficult access to the construction sites, which now lay some 150 m above the bottom of the valley. Access was eventually provided by the use of existing tracks and newly constructed tracks and by way of a cable railway from Bellaluna to the Stulsertobel. The high location of the construction sites led to a rejection of the principle of balanced mass haul movements along the railway (that is, excavated material was disposed of locally) and to the use of dry stone walling wherever possible.

The construction of the Landwasser Viaduct lasted around 13 months. The work involved some 9,200 m^3 of masonry and cost CHF 280,000. Provision of the material used in the construction of the tall columns called for very complex organisation involving steel scaffolding that was set up inside the columns and connected to crane

Albula line > Alignment between the Tuoa and Zuondra spiral tunnel, 1902. The terrain alterations necessary prior to construction are hardly visible today.
Rhaetian Railway

Albula line > Construction of the Clix Viaduct, 1902.
Rhaetian Railway

Albula line > The Albula Viaduct I below and the Rugnux inclined viaduct above.
Rhätisches Museum, Chur

bridges. The construction site for the Landwasser Viaduct had electric lifts and electric mixing machines and boring machines were in use at the construction sites for the Albula tunnel. Together, these two sites offered what at that time were rare examples of mechanised construction sites.
On the 9th August 1901, during work on constructing the tunnel lining in the Greifenstein tunnel, the tunnel scaffolding near the upper portal collapsed; four workers were buried under the mass of debris. Section engineer Perbs was leading the rescue work when a second collapse took him unawares with fatal results.
The 333 m long Glatscheras tunnel was constructed in solid rock. Construction only took place after the railway line had been opened. The work lasted from 9th September 1903 to 28th January 1904 and was completed in only 144 days. Originally, the line here ran parallel to the cantonal highway and through a scree, which began to move uncontrollably in the spring of 1903. It was subsequently decided to build this bypass tunnel in order to safeguard the operation of the railway. Costs amounted to CHF 178,000.
The section between Muot and Preda proved to be difficult. Here, various alternatives for the track alignment were carefully weighed against each other in order to reach a solution that would provide an optimum balance in terms of ground conditions, the risk of rockfalls, avalanche tracks, landslides, exposure to the sun and – last but not least – construction costs. The final locations of the loops in the track alignment were substantially different from those in the original design.
The construction company Ronchi & Carlotti was awarded the tender to build the Albula Tunnel; from 1901 the Rhaetian Railway continued the work under its own name. It required extensive site installations at the headings in Preda and Spinas. Accommodation had to be built for the workers, supervisors and engineers; besides storehouses and workshops there were also buildings for the workers' canteen, baths, religious services, school, post office and so forth. Thus, residential settlements grew up at both ends of the tunnel, each with water supply lines and water hydrants; the colony in Preda even had electric lighting. The station buildings in Preda and Spinas were built as soon as the work on the tunnel was started; they served as site office and provided additional accommodation until the line was opened.
The railway also employed a railway doctor in Preda, where it set up a hospital staffed by an Italian nursing order who also ran a kindergarten for the younger children of the families in the residential settlement. The communities of Bergün/Bravuogn and Bever employed a teacher for the older children. In Spinas, the railway only needed to provide a sickroom for patients, as the nearby Samedan district hospital was available should the need for hospital facilities arise.
In July 1902 the number of workers employed in the construction of the Albula Tunnel reached its peak, with a total of 1,316 men: 984 in the tunnel and 332 in the open.
The tunnel was excavated using boring machines powered by water pressurised at 100 atü (the Brandt system). The water required for their operation was taken from Lake Palpuogna for the north side of the tunnel and from the Beverin River for the south side. The engineers had expected to obtain 200 HP on the north side and 150 HP on the south side, but the whole system had been designed on too small a scale; subsequently, as work on the construction was speeded up, the system had to be upgraded several times. It only later became apparent that during February – the harshest winter month – water power on the north side could only provide 140 HP, with

Albula Tunnel > Drilling team with the Brandt hydraulic drive drilling machine.

Albula Tunnel > The building team and the engineers collected in front of the building sheds at the Preda north portal for a photo session, 1902.
Rhaetian Railway

Albula Tunnel > A big show for the photographers at the south portal, about 1902.
Collection Peter Pfeiffer

the corresponding figure for the south side of only 100 HP. Eventually, two additional, 25 HP steam engines had to be set up in Spinas as a reserve which could be called upon when the water level was very low. For Preda, the water from Lake Palpuogna was led along a 560 m closed wooden channel 0.35 m wide and 0.35 m high with five ventilation shafts. The channel was routed alongside the cantonal road to the surge tank above the tunnel portal, from where the water was initially led by means of a 0.3 m wide iron pressure main to the turbines in the power house. For the force account operation, three additional 0.2 m pressure pipes were later branched off from the surge tank; each led to a turbine which drove one of three coupled ventilators, each with a diameter of 1.5 m. It was essential for adequate ventilation of the tunnel that the ventilators and machine boring had independent power sources. When running at a speed of 1,550 rpm the ventilators could deliver at least 1 m^3 of air per second at the tunnel face through a wrought-iron pipe of 350 to 400 mm in diameter and 3,000 m long. This was sufficient, since the tunnel cross-section was only slightly blocked by scaffolding and was not lined over the last kilometre before the breakthrough. The pressure head between the surge tank and the turbines was 75 m and the difference in the water levels of Lake Palpuogna and the surge tank was 53 m. However, the latter had to remain unused even during the force account construction since by that time it was no longer possible to upgrade the whole system. The main turbine was designed for 160 HP, each of the ventilator turbines for 30 HP and the lighting turbine for 15 HP.

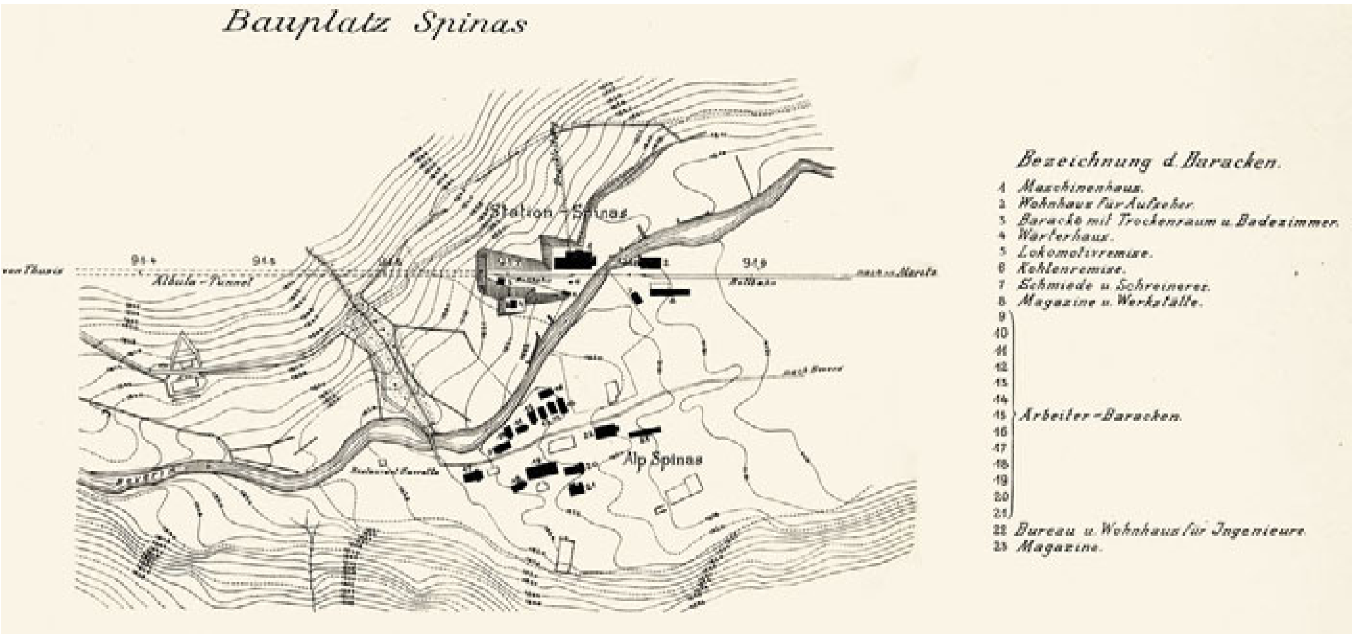
On the south side of the tunnel the Beverin River was blocked by a walled dam at a point where the river bed lay in the undisturbed rock; the water basin thus created was then covered with tree trunks as protection against avalanches and rockfalls. A sedimentation tank with an idle running fitting and an overflow was connected to the basin. A closed wooden channel 1,200 m long, 70 cm wide and 50 cm high led to the surge tank, from where the pressure mains branched off towards the turbines. The mains had a delivery head of 60 m and were 250 m long.

The workshops before each portal were equipped with lathes, drilling and milling machines. Two larger forges and a small brass foundry were connected to these for machine drilling, whilst special forges were set up for hand-drilling and for making other tools.

The selection of the site for the dynamite store and the construction of the store were subject to strict government regulations, whereby the handling of the material was always carried out in compliance with official rules and regulations. The construction railway used in building the tunnel had a track gauge of 750 mm. Around 10 km of track was laid, which weighed 15.5 kg per meter. 330 wagons were available for the construction, 75 of which were not fitted with brakes and 5 locomotives were acquired to move the wagons: one 40 HP, two 30 HP and two 25 HP.

On the south side, the base tunnel initially ran through saturated rock scree containing large erratic blocks and sand; this led to very uneven loading of the horizontal strutting und displacement of the tunnel installations. After 133 m of tunnel drive, work on the initial bore was stopped in order to excavate the tunnel out to its full dimensions up to this point. The excavation of the full face in this unstable mountain geology made only slow progress. On 19th November, when the drive had just reached tunnel meter (TM) 108 the installation of the last two rings gave way and the tunnel collapsed over a length of 12 m. The collapse created a 25 m deep, break-in funnel reaching up

Albula Tunnel > The construction workers in front of their plain huts in Spinas.
Staatsarchiv Graubünden



Overview of the Spinas building site. Plan taken from: FRIEDRICH HENNINGS: *Albulabahn. Denkschrift*, Chur 1908.

as far as the surface. Fortunately no-one was injured. Reconstruction work was carried out by the Rhaetian Railway's construction supervision unit at Ronchi & Carlotti's expense and was only finished at the end of July 1900. By March 1900, the first tunnel drive had pushed forward to reach the firm glacial till at TM 170 and then granite at TM 260. This allowed machine boring to begin on the south side on 17th October 1900. At that juncture the construction company no longer felt able to deal with the difficulties presented by the construction of the tunnel and asked to be released from its contract. After a brief period of negotiation, the force account unit of the Rhaetian Railway took up the work on the 1st April 1901, under the direction of engineer Weber from Zurich.
By 25th August 1901, when work restarted on machine boring on the north side at TM 1260, the tunnel on the south side had reached TM 1485, so that some 3120 m of tunnel still remained to be excavated. In order to win back the lost time, the number of Brandt boring machines was raised to three, working simultaneously on each face of the tunnel shaft. The ridge cut method then being used was expensive and time consuming and presented problems in terms of the ventilation.
As an alternative approach, in November 1901 engineer Weber introduced the Firstschlitz (first cut) method at TM 1320 m from the north portal; from April 1902 this method was also used for the work on the south side. Using light scaffolding it was possible to work in the cut up to the roof of the tunnel using two stages in level, with boring heads aligned at a 45° angle to the portal. The excavation of the first cut was followed by full excavation and this in turn was followed by the tunnel lining, although this was rarely needed in a tunnel where long sections were cut through granite. Work on the south side was stopped on 23rd May 1902 in order to avoid an accident. The breakthrough took place on 29th May 1902 from the Preda side, 3030.5 m from the north portal and 2835 m from the south. The breakthrough resulted in the extremely low deviation (between the heads of the north and south tunnel drives) of 50 mm in longitude and 48 mm in height. The last excavation work was carried out in January 1903 in the area of the breakthrough and the tunnel lining was completed by the end of February.
The material excavated from the Albula tunnel was used to construct the embankments, which in some places were quite high and to build the mounds on which the station facilities were set up. The track bed was thus protected from the groundwater which lies close beneath the surface in the plain of the Upper Engadin.
The completion of the section between Celerina and St. Moritz was delayed by the discussion on the location of the St. Moritz railway station. The community wanted the station built above the English church, at 1800 m above sea level, so that the station would be in the centre of the village ensuring an uninhibited view of the lake. The Rhaetian Railway however wanted to place the station towards the upper end of the lake on account of the possible continuation of the line towards Chiavenna. The final location of the station was a compromise, decided upon by the Swiss government on 5th November 1901. The Albula line was opened as far as Celerina on 1st July 1903, whilst the rest of the section to St. Moritz only entered service on 10th July 1904, as a result of the delayed decision on the location of the station.

Rolling stock, from the opening of the line to its electrification

The Rhaetian Railway had already gained experience in the operation of a narrow-gauge mountain railway using steam locomotives on the Landquart – Davos line. The estimated passenger

(1'B)B Mallet locomotive, 1903.
Rhaetian Railway

(1'D) 102 steam locomotive, after 1921.
Rhaetian Railway

(1'D) 112 steam locomotive, about 1910.
Rhaetian Railway

numbers and freight tonnages led to the decision to purchase 12 steam locomotives, 54 passenger coaches, 8 luggage coaches and 129 freight wagons in advance of the opening of the priority lines (Reichenau – Ilanz and Thusis – St. Moritz). Their designs were based on the types which the Rhaetian Railway already owned. Type 1’C tank engines with three driving axles were purchased for light duties and Mallet type (1’B)B tank engines for heavy duty work on the Albula ramps. These had two articulated groups of two driving axles, and were better able to negotiate the tight curves. The passenger coaches had two axles and an open platform at each end. The third-class coaches had open interiors with a central corridor; sections of the first and second-class coaches had single compartments with a side corridor. All the passenger coaches procured for the Albula line were fitted with electric lighting and could be heated in winter with steam from the locomotive. The freight wagons included both closed and open types; the open types included wagons with low-walls and with half-height walls. In terms of load-carrying capacity (10 tonnes) and size they were identical with the standard-gauge freight wagons of the period, which simplified the transfer of ongoing freight.
All the rolling stock was fitted with Hardy automatic vacuum brakes, which allowed more efficient operation of the line, since freight trains no longer needed any brakemen and the trains could be driven along downgrades at higher speeds. The uphill speed of the trains was limited by the power of the locomotive; speeds of 15 – 30 km / hr were achieved.
After only a short period of operation it became clear that the Albula line was attracting more traffic than had been predicted, with the result that the Mallet steam engines which had proven themselves over the shorter section between Landquart and Davos were no longer adequate for the operation of the line. A more powerful locomotive, more suitable for longer sections, was needed to carry passengers onwards from the Swiss Federal Railway’s standard-gauge connecting trains.
As early as the autumn of 1902 test runs had been carried out on the Rhaetian Railway network using a Consolidation type 1’D-linked locomotive, which the Swiss Locomotive and Engineering Works (SLM) in Winterthur had developed for the line from Djibouti to Addis Abeba in Abyssinia (today Ethiopia). These had four connected drive axles: two could be shifted laterally within the same frame. Placing the coal and water supplies on a tender meant that it was possible to increase the size of the boiler (and therefore the power of the locomotive) without increasing the locomotive’s weight. Between 1904 and 1915 the Rhaetian Railway purchased a total of 29 units of a modified version of these ‘Abyssinian’ locomotives. The 1’D steam engines bore the main burden of train operations on the Albula line up to the time the line was electrified. These double-headed locomotives could haul a train of 190 tonnes, the length of which matched the passing track length of 200 m exactly. Two engines of this type and several wagons dating from the first years of operation are still in working condition today.
The acquisition of coaches took into account the growth in traffic and the comfort standards expected. New passenger coaches had four axles, whilst for the fast trains the Rhaetian Railway even acquired coaches which had concertina connections like those on European luxury trains. When pulled by a 1’D locomotive, the 1913 Engadin Express, which had only first-class coaches and a luggage wagon, took only 2 hours and 42 minutes to travel from Chur to St. Moritz! Freight wagons delivered after 1911 had a load-

Albula line > The avalanche walls and snow catchers above Muot are almost snowed under.
Rhaetian Railway

Albula line > The Crasta Mora avalanche buried the track and tore down the catenary in Val Bever 23.12. 1919. A steam snow blower removing the compact snow brought down by the avalanche.
Rhaetian Railway

Albula line > Crasta Mora avalanche 23.12.1919. The top layer of avalanche snow had to be shovelled away before the steam snow blower could start work.
Rhaetian Railway

bearing capacity of 15 tonnes, the same as the newer, standard-gauge wagons.

Winter operation

When the Albula line was being designed the engineers involved could call on more than 30 years of experience in the operation of steam-powered mountain railway lines in winter. Moser and Hennings closely studied the characteristics of a number of existing railway lines, including the American trans-continental railway line through the Sierra (opened in 1869), the Gotthard and the Arlberg lines and the Rhaetian Railway line between Klosters and Davos. The idea proposed by the Albula line builders was that it should be possible to operate the line all year round, with a high level of safety and yet with costs kept as low as possible. And in fact the Albula line provides an outstanding example of a railway which, thanks to being suitably designed from the very beginning, was able to keep the costs of winter operation down to a minimum. Chief engineer Hennings had an admirable skill in estimating natural hazards and dealing with them appropriately. To increase winter safety the summit tunnel had been constructed at as low a level as possible and both the approach sections were sited on those sides of the valleys which were exposed to the sun. Extensive traverses across the terrain were made to optimise the alignment of the line along the sections most at risk of avalanches between Bergün/Bravuogn and Preda and between Spinas and Bever. Special engineering structures and other measures were provided to increase winter safety. These included stabilisation of the Muot slope with walling and afforestation measures, the walled avalanche galleries in Muot and Maliera, a number of other steel and timber avalanche galleries, diversion barriers and shelter walls. The risk of avalanches occurring along both flanks of the valley in the section between Spinas and Bever was considered to be so high that it was decided to locate the railway line on an embankment in the middle of the valley floor. Experience with snow-clearing operations between Klosters and Davos led to the decision to create enough space between track and revetment wall to dump the snow and to provide snow trenches on both sides along slopes, where possible. In the tunnels, care had to be taken that the mountain water run-off did not freeze and risk derailing. For this purpose, the Albula and Regnux Tunnels were closed with doors after a train had passed through; groups of workmen then removed the ice from the tracks and the run-off ditches were covered with snow to provide some insulation.

The rolling stock was also equipped for winter service. Experience taught that in winter only the more powerful engines should be used on the mountain sections and these should be fitted with a fixed snowplough. In this way new snow was constantly removed from the track creating walls of snow on the mountain side of the track which groups of workers then shovelled away. During heavy snow falls a wedge-shape snowplough with a pusher locomotive was used to clear the section. These track ploughs (procured from 1906 onward) removed the hardened snow between the rails which could otherwise have led to high levels of rolling resistance and even caused derailing. In 1913 the Rhaetian Railway purchased two steam snow blowers, which not only pushed the snow to the side but were also able to clear a greater width and blow it beyond the line. The blowers could even remove compacted avalanche snow.

All these facilities for winter operation have proved their value over time. Apart from downtime after a few rare, major avalanches the Al-

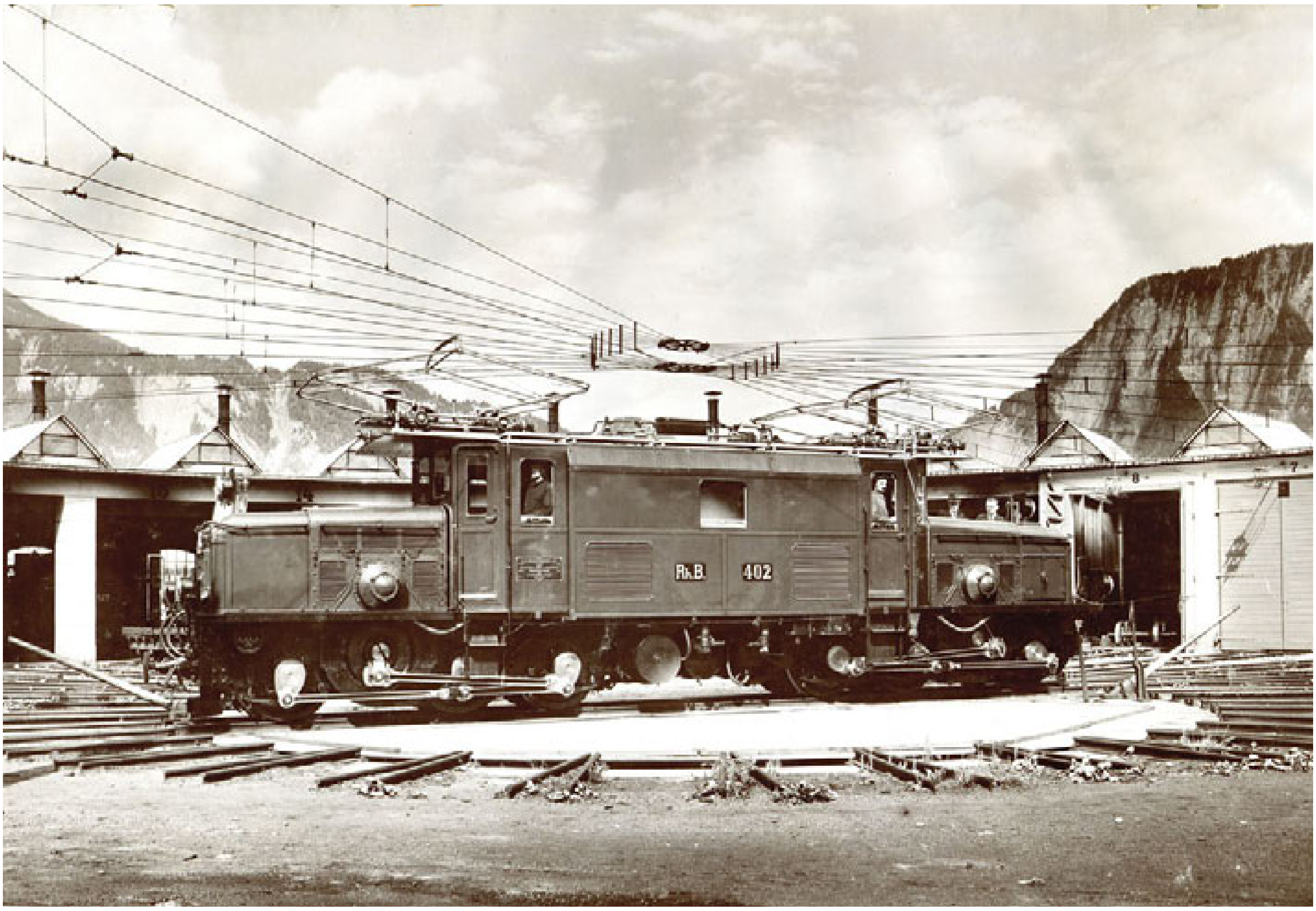
Electrification of the Albula line > Spinas portal of the Albula tunnel, G 3/4 steam engine in front of a Kummler & Matter assembly train.
Archives Hermann Kummler)

Electrification of the Albula line > Catenary works-train between Surava and Tiefencastel: photograph about 1918.
Collection G. Brüngger

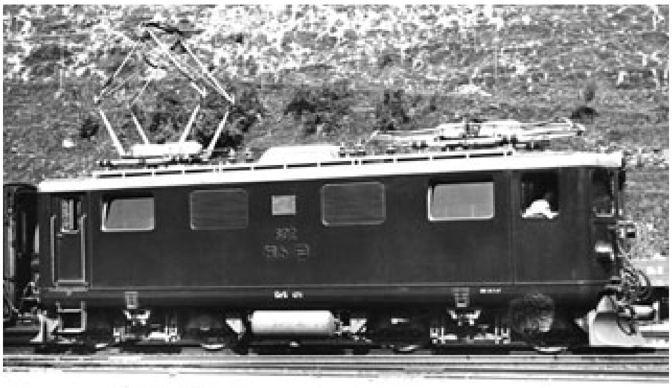
Electrification of the Albula line > Tiefencastel station: photograph 1919.
Archives Hermann Kummler

bula line has continued to operate all year round to the present day without any long interruptions. Extensions were added to the protective structures in the area of the avalanche barriers in Muot, Maliera and Valetta. When the line was electrified the exposed catenary masts were protected by means of timber or concrete avalanche breakers.
A pioneering step was taken in 1958, with the purchase of a diesel snow blower. This unit, which is lighter and faster than the steam powered version, has a higher output and can also be shifted laterally widening the cleared channel.

Electrification and rolling stock after 1919
At the time the Albula line was constructed nobody had given any thought to electrifying the section. The alignment, the location of the intermediate stations and the workshops in Samedan were all entirely designed for services operated by steam locomotives. Even with the increase in traffic during the years of operation up till 1914 the requirements for providing the train services do not seem to have exceeded the performance of the modern 1'D steam engine.
In 1905 the Rhaetian Railway joined the Swiss commission which was studying the question of electrified railway operation with a view to deciding on a suitable system for the main railway lines. In 1910, the Board of Directors of the Rhaetian Railway decided to electrify the Bever-Scuol line which was then being constructed, together with the two existing lines between Bever and St. Moritz and between Samedan and Pontresina; the electrification system to be used was the 10 kV 16 2/3 Hz single-phase system recommended by the study commission. In terms of the system selected, the fixed installations and the traction units, the electrification of the Rhaetian Railway matched the state of technology then in use for high-performance electric main railway lines. The power supply was provided by the Kraftwerke Brusio AG (today, the Rätia Energie AG) by means of a high-voltage line routed over the Bernina Pass to the new converter substation in Bever. The catenary system was constructed by the German company Siemens and consisted of steel masts with cross-arms, catenary wire and contact wire. The performances of the two locomotive types (type 1'B1' und 1'D1') were the same as that of the existing type 1'C and type 1'D steam locomotives. However, the drop in traffic after 1914 meant that the electrified Lower Engadin line was never used to its full capacity, although it certainly gave the Rhaetian Railway valuable experience in the operation of an electrified railway in mountain areas and also an opportunity to compare the suitability of different types of locomotive.
In view of the shortage of coal during the First World War there was a consensus that the railways in Switzerland should be quickly and completely electrified. The first priority was to extend those electrified systems already in existence. This applied to the Rhaetian Railway. Around 1920, a debate took place in Graubünden as to whether the use of hydroelectric power in the canton should be in private or public hands. As the Rhaetian Railway did not construct any power stations of its own, but rather obtained the electricity it needed from a number of power companies (cf. 2.b.7), it did not openly take sides in the debate. The electrification of the section between Bever and Thusis was completed in 1919. Operation initially continued with locomotives which were already available and by using power from the converter substation in Bever and the Viamala



C'-C'-Locomotive > The "Crocodile" locomotives have become a Rhaetian Railway trademark. A Crocodile in front of the Landquart depot, shortly after delivery, about 1921.
Rhaetian Railway



Bo'Bo' > After 1947, passenger trains were hauled by the Bo'Bo' locomotives, permitting higher speeds.
Collection G. Brüngger

Ge 4/4 III > The latest generation of electric locomotives.
P. Donatsch

power station in Thusis, which belonged to the Rätischen Werke für Elektrizität. The design of the catenary system was based on the model provided by the Lower Engadin line, but with the difference that, because of the shortage of material, the masts were built in timber rather than steel. Brick-walled switch houses based on the Engadin model were constructed at several of the stations. In 1920, the Rhaetian Railway estimated the costs of electrifying the Bever – Thusis and the Filisur – Davos lines at CHF 64,000 per km; since the locomotives and the substations required already existed, this sum probably only covered the cost of constructing the power supply lines. Cost comparisons between steam-powered and electrical operation were made both during the period while the detailed design was being prepared and again ten years later; they did not indicate any clear advantage in terms of electrical traction. The electrified option only became more favourable when other factors were taken into consideration, such as the elimination of smoke in the tunnels.

The decisive factor in the acquisition of new locomotives for the electrified Albula line was the increase in capacity. The locomotives that came into service after 1921 were of the C'C' type; 15 of these were purchased. However, one of these alone was as powerful as two of the strongest steam locomotives working together and could by itself pull a train that was as long as the passing tracks. Depending on the load hauled they could reach a speed of 30 – 45 km / hr along a section with an upgrade of 35 ‰ and could also be operated by one man. The C'C' – "Crocodile locomotives" – have even become a symbol of the Rhaetian Railway: where they once stood as a symbol of modernity, today they evoke a hint of nostalgia.

After 1939, trains ran using light railcars and from 1947 at higher speeds using the Bo'Bo' locomotives. Today fast trains and freight trains on the Albula line are pulled by Ge 4/4 III locomotives – the latest traction unit generation. These can achieve a speed of 50 km / hr when hauling a full load of 300 tonnes up the Albula ramp.

The catenary system was given steel masts in 1930 and has been completely renewed since 1980. Today the electricity is provided via a 66 kV ring main. The Sils im Domleschg power station has a feeder point for the Albula line, which means that hardly any physical traces of the electrification of the Albula line section have been preserved, although the line continues to operate with the electrical system selected a hundred years ago. It is therefore still possible today to use first generation rolling stock from the early days of electrified operation.

Changes

The Albula line has hardly been changed since it was first constructed. To date, the increases in capacity required have been achieved by means such as electrification, the lengthening of passing tracks, new control and safety installations, a new, stronger permanent trackway and new rolling stock. The start of services on the second railway link into the Engadin through the Vereina tunnel, in 1999 entailed a further increase in capacity, yet without the need to introduce material changes to the physical structure of the Albula line. In consequence, the Albula line, in its present well-maintained state and good operating condition, is protected against the two great risks a historic railway line is normally confronted with, namely closure due to too little traffic, or complete new alignment and redesign due to too much traffic. The number and locations of the intermediate stations on the Albula section have remained unchanged. The passing length of 120 m at the passing stations was originally designed for a

Preda > Extended stretches of double track, like here in Preda, make it possible for trains to cross without stopping.
A. Badrutt

Landquart > The north side of the Albula line has been controlled from the 'Rail Control Center' (RCC) in Landquart since 2005.
P. Donatsch

train with two engines and ten coaches, which would have been sufficient for the demand forecast at that time. Following the purchase of the longer and more powerful tender locomotives, most of the passing stations were extended to 200 m, the work being completed by 1908; this passing length proved to be quite adequate even many years after the line was electrified. Between 1965 and 1990 work was carried out in stages to increase the passing lengths at all stations to 250 – 300 m. The introduction of the "Bahn 2000" synchronised timetable meant that lengthened, twin-track sections would be needed at the passing points for the fast trains in Thusis, Filisur and Preda, so that trains can pass each other without having to stop.
Initially, operation of each intermediate station involved several staff; the stations used to offer a full range of services for both passenger and freight traffic. Today, however, they have been converted to unmanned, remote-controlled passing stations. The facilities in the fast-train stations (Thusis, Tiefencastel, Filisur, Bergün/Bravuogn, Preda, Bever, Samedan, Celerina and St. Moritz) were extended, with higher platforms and also in some cases with grade-separated pedestrian access to the platforms and renewed buildings, whilst the facilities in the smaller stations were cut back.
This substantially increased the capacity of the Albula line for the first time since its electrification. A further increase in train densities was made possible by a system of 'section blocking', introduced in stages between 1961 and 1969. Five block points were constructed to divide the longer sections. The St. Moritz station had been provided with an electrical switch control centre as early as 1951; when section blocking was introduced all the other railway stations and crossing stations were given 'Integra Domino 55' – type track plan control centres.
Remote control facilities were set up at both sides of the Albula tunnel in 1968; one in Filisur for the north side of the section and one in Samedan for the Bever and Spinas railway stations on the south side. The remote control system in Filisur was taken out of service in 2005. Since then the north side of the Albula line has been controlled from the Rail Control Center (RCC) in Landquart.
Up till 1989 the operational concept for the Albula line included fast train services (some of which were year-round services whilst others only ran in the holiday seasons), regional trains with facilities for freight transport which operated all year round and freight trains, some of which ran with passenger coaches. One speciality of the Albula line is the transport of cars on flatbed wagons between Thusis and Samedan. When road conditions are poor this service even has to put on extra trains.
The Swiss Railway's synchronised timetable has been introduced in stages since 1982, when it brought in an hourly fast train service in both directions all year round on the Albula line. Now only freight trains run between the fast trains while the Glacier Express and Bernina Express are operating in the peak season.

The future

The present Rhaetian Railway operational concept for the Albula line foresees that the hourly Regio Express in each direction should continue in the future. The current time table means a heavy load on the Bever – Samedan section, that occasionally leads to delays. In order to overcome this problem a design has been developed for a new corridor between Val Bever and Samedan; this project would include a short tunnel. Another alternative proposes widening of the Bever – Samedan section to two tracks; this

Bernina line > The Bernina railway has been using open goods wagons as panorama wagons from the beginning. A train composition in the Montebello curve about 1920.
A. Steiner/Rhaetian Railway

project would require modernisation of Bever railway station.
The track facilities and safety equipment in Bergün/Bravuogn do not fully comply with today's safety regulations, nor do they meet customers' current expectations. In the mid-term, this station will have to be provided with facilities to allow passengers to access the central platform without having to cross the tracks. The former arsenal (behind the station building) is now empty and is to be converted into the Railway Museum (cf. 5.h). A modern vehicle shed is to be constructed on the station square; the shed will be used to house historic rolling stock and will have a connecting track to the main line.
Separate facilities will have to be provided for passenger and freight traffic in St. Moritz. A modern freight transfer facility was constructed in Samedan in 1999 to serve the whole of the Upper Engadin; one consequence of this is that the demand for freight transfer in St. Moritz is no longer very high. A master plan for St. Moritz station also includes proposals for improving the facilities for the Bernina line.
The engineering structures on the Albula line have remained almost unaltered. The only loss has been the steel bridge over the Hinterrhein near Thusis, which was replaced by a twin track, concrete arch bridge in 1991. The viaducts and tunnels on the Albula line are over a hundred years old and many are in need of renovation (cf. 4.a.1). In future, the rehabilitation work will include fitting the trackway on the viaducts with a concrete trough, which should prevent the penetration of water and resulting damage to the masonry. The vaults of the tunnels will also have to be renewed. The Albula tunnel in particular is in need of structural rehabilitation. However, extensive reconstruction work or the construction of a new, parallel tunnel will be required to bring it up to the standards of today's safety regulations for long railway tunnels.

Bernina railway

Project development and financing

At one time the Bernina Pass was of national importance, as it provided a link between Graubünden and the Veltlin and Venice (cf. 2.b.3). The road from Samedan to Tirano was completed in 1865. However, given the high level of the crest of the Pass and the steep southern slope, for a long time the idea of constructing a railway line over the Bernina Pass was not considered, as the route over the Maloja Pass seemed much more suitable for the continuation of the line from the Engadin towards Italy.
The concession for an electrified line routed alongside the Samedan – Campocologno road was awarded to the construction company Froté & Westermann in 1899. A direct-current, surface railway with railcars operating alone allowed the construction of sections of line which, in terms of gradients and curve radius, could be based on the typical values for roads and not subject to the constraining values for steam-powered railway lines. Following the construction of the great railway lines it had been generally assumed that the bulk of traffic would shift from road to rail; the construction of a road trackway was therefore seen as a chance to add a new use to the recently constructed Alpine roads and so help to pay back the capital invested in them.
As design work began on the construction of a trackway along the Bernina pass road, planners started to consider using the hydro-power available in the Poschiavo valley (cf. 2.b.7). In 1904, the Kraftwerke Brusio AG (KWB; today Rätia Energie AG) and the Bernina railway were founded; both had the same shareholders – the Basel-based

Pontresina > Steam train on the section between Samedan and Pontresina, the starting point for the Bernina line, a station which was built by the Rhaetian Railway.
Archives Engadin Press

Pontresina > The railway station about 1910.
A. Steiner/RhB

Bernina line > Winter operation is a real challenge. The Number 5 engine has only a very narrow passage to keep traffic moving. Taken in 1926.
A. Steiner/Rhaetian Railway

Schweizerische Eisenbahnbank (Swiss Railway Bank). The Bernina railway had not been foreseen in Graubünden's railway law of 1897, with the result that it was financed entirely from private sources, without any contribution from the canton. The railway and the power station projects were weighted quite different from time to time. When design work began, the railway stood in the foreground, but later the power stations became more important in terms of capitalisation, profit and economic significance. By 1905 the construction company Albert Buss & Co. AG had re-worked the first design for the Bernina line, which now proposed a line that would have a considerably higher capacity than the line originally planned. Instead of simply following the mountain pass road, the line from the Bernina Pass to Poschiavo would now follow a separate corridor via Alp Grüm. This route was more attractive in tourism terms and was also suitable for transporting materials for the power station stages above Poschiavo. The construction of the Bernina line was only finally assured when the definitive decision was taken to set up the KWB.
In both cases financing was provided by the Alioth electricity company, based in Münchenstein, Basel. The funds needed had been set aside as early as 1905 so that it was possible to begin work on the construction of the railway line in 1906.
The general contractor, Buss & Co., took on the construction of the Bernina line for a lump sum of CHF 12 million, half of which was covered by shares and the other half by bonds. The company's management report for 1910 broke down the CHF 14 million in construction costs incurred up to the opening of the railway line as follows:

> Substructure	CHF 6.2 million
> Track superstructure	CHF 1.9 million
> Engineering structures	CHF 0.7 million
> Electrical installations	CHF 2.2 million
> Rolling stock	CHF 1.5 million

Of the CHF 2.2 million expenditure on the electrical installations, the transformer station accounted for 0.2, the machines in the hydroelectric plants for 0.7 and the high tension cables for 1.3. ²/₃ of the rolling stock costs, i.e. CHF 1.0 million were spent on railcars.
A comparison with the costs of constructing those sections of the Rhaetian Railway which were built at the same time is quite illuminating. The electrical installations on the Lower Engadin line (Bever – Scuol), with high-voltage AC current and main line catenary system, were even somewhat cheaper than the simple DC installations and timber masts of the Bernina line. The real potential for savings in what were considered to be low cost surface railways lies in their alignment, which could be kept simple thanks to the use of railcars. And in fact the trackway for the Bernina line, which after all runs through a high altitude mountain region, cost only CHF 135,000 per km, whilst the Lower Engadin line, which was designed for operation by locomotives, cost more than CHF 300,000 per km; the proportion of engineering structures on this line was higher.
By 1914, construction costs had increased to CHF 16 million, of which CHF 2.7 million had to be financed by short-term bank debt. The reasons for exceeding the budget were the need to widen the facilities and to add to the rolling stock, plus the additional investment required for winter safety. After agreement with the general contractor, in order to repay the debt, the share capital was partly written off and priority shares had to be issued.
Although public subsidies had already been provided in 1913 for avalanche protection measures along the Bernina line, the railway had to approach the communities and the canton again in the 1920s and 1930s for contributions to help

Bernina line > Inclined Viaduct next to the lower Cavagliasco bridge. Photograph from: E. Bosshard: *Die Berninabahn*, Zurich 1912 (*Schweizerische Bauzeitung*, offprint).

Bernina route > A G3/3 tramway steam locomotive, as construction work engine, crosses the largely complete bridge. Photograph taken about 1908 from: E. Bosshard: *Die Berninabahn*, Zurich 1912 (*Schweizerische Bauzeitung*, offprint).

Bernina line > View of Poschiavo and the Lago di Poschiavo. Photograph from: E. Bosshard: *Die Berninabahn*, Zurich 1912 (*Schweizerische Bauzeitung*, offprint).

cover the cost of maintaining winter services. Furthermore, after 30 years of operation there was a growing need to replace the rolling stock and to renew track systems and power supply, whilst at the same time income was sinking due to the Second World War. However, for political and military reasons it was necessary to ensure uninterrupted operations. Under these circumstances the Bernina line found itself no longer able to operate the line independently, with the result that the Rhaetian Railway took it over in 1944.

The construction of the Bernina line

The Bernina Railway was built between 1906 and 1910. The construction company Buss & Co, mentioned above, was the general contractor, the electrical company Alioth supplied and installed the electro-technical equipment; they were also responsible for the rolling stock. The construction contract was based on the 1905 design as re-worked by Buss. Compared with the initial project, this design included alterations which added to the price. These alterations were the lengthening of the trackway, reduction in the maximum gradient from 82‰ to 70‰, elimination of the setting back tracks originally planned near Pontresina and Cavaglia, lengthening of the usable passing lengths from 45 m to 90 m, the addition of new station halts and new passing tracks and the creation of an option to allow the later addition of passing sections at various points on the line, without excessive additional cost. These improvements had been demanded by the KWB investors, who wanted to use the Bernina line not only for tourist traffic but also as a freight supply line for the construction of their power stations along the section.
Two separate construction offices were set up to manage the construction of the railway, one in Celerina for work on the north side and the other in Poschiavo. Up to 2,500 workers, mostly Italian, were involved in the construction of the railway. The hard working conditions traditionally found in the construction of a railway line were added to here by the difficulties associated with the remote location and with the Alpine climate. In May 1907, 1000 workers on the Engadin construction sites went on strike; military forces were eventually called in to suppress the strike.
The stone material used for the visible surfaces of the engineering structures was almost exclusively granite, which could be found in excellent quality at various locations close to the trackway, for example near Montebello, Ospizio Bernina, Cavaglia and Brusio. The superstructure had to be completed first to permit the delivery of the quarry stone direct to the site.
The most technically demanding structures were the Charnadüra tunnel (the only long tunnel on this line) and the tunnels and bridges along the Cavagliasco loop. Even the shorter tunnels presented difficulties, since the tunnel shaft had to be driven upwards along the steep upgrade and ventilation in such circumstances was very difficult. Here, the low temperatures on the mountain section resulted in the dynamite freezing; it is highly explosive in this state.
Parts of the line were opened before the whole route was completed; the Pontresina – Bernina Suot and Poschiavo – Tirano sections in the summer of 1908 and the St. Moritz – Pontresina and Bernina Suot – Ospizio Bernina sections in the summer of 1909. Trains could travel along the full length of the Bernina line from 5th July 1910.

The construction of the electrical works

The supply of electricity was provided by the Campocologno power station, completed in

Bernina line > Stablini curve against the backdrop of the Palü glacier and Piz Cambrena. Taken shortly after the Bernina line was opened in 1910.
A. Steiner/Rhaetian Railway

Bernina line > The Bernina line runs through the hamlet of S.Antonio like a tram. Photograph 7th April 1927.
A. Steiner/Rhaetian Railway

Pontresina > BCe 4/4 3. Photograph 4th August 1948.
Collection G. Brüngger

1906/07, with the Robbia power station near Poschiavo available as a reserve from 1910. Both facilities belonged to KWB. There were twelve generators in Campocologno, three providing power to the local mains network and to the Bernina railway. Electricity was supplied to the converter substation near Campocologno railway station at the output voltage from the generators of 7,000 V / 50 Hz, which the substation converted to 23,000 V and then fed to the high voltage line from Campocologno to Pontresina, from where it was sent to the three other converter substations in Poschiavo, Ospizio Bernina and Pontresina. Part of the power supply was converted down to 500 V and then used to run the transformer which provided the DC supply to the catenary system.

The construction of the high tension wires Campocologno – Pontresina was independent of the construction of the railway; it had to be finished early as the plan was to start work on certain sections on the north side as soon as the high tension cables were in place. The line was erected during the summers of 1907 and 1908 by groups of workers who lived in tent encampments. Food, masts, insulators and even cement, water and sand had to be laboriously transported by mules using bridleways; in some cases the old mule tracks were improved while others were newly-constructed.

The four converter substations with buffer batteries provided the catenary system with 750 V DC current. The substations were all identical, both in terms of their technical equipment and in terms of their architecture. The quarrystone masonry of the building in Ospizio Bernina has been left exposed, whilst the façades of the other buildings have been plastered. Window sills and lintels are in exposed brickwork. The intention had been to build these stations where the electricity demand was highest, along the steep ramps. The substations, however, were eventually constructed at the larger railway stations because the rotating motor-generator sets required constant monitoring by an engineer; a house was even built next to the converter substation in Ospizio Bernina as accommodation for the engineer. Shortly after the start of services it became evident that the power supply was not sufficient for peak traffic times; both the north and south sides were then given a simple station battery which was linked only with the DC feed line.

The catenary system matched the standard design developed by the Alioth company for DC railways, where simple, swung-out, T-iron cross arms were attached to impregnated timber masts. The overhead conductor lines were suspended from cross wires and consisted of two adjacent round copper wires; at the passing stations one wire was run over each track. At larger stations the cross wires were tensioned between iron lattice pylons and an additional feed line was attached to the masts. Where the railway track runs along a loop, the supply line was often routed along a more direct corridor. The electrical return was via the track rails, which were connected by copper bands at the butt joints. The bands were hidden below the fish plates to prevent copper pilfering.

The overhead power line over the pass proved itself in practice so that the Rhaetian Railway too decided to take the power for its electrified railway lines in the Lower Engadin from the KWB. For this purpose, the KWB took over the high voltage line from the Bernina line in 1912 and built a second supply line along a separate corridor up to the converter substation in Bever.

Rolling stock

By 1917 some 17 bogie railcars with second and third class compartments had been purchased

Bernina line > The first Rhaetian Railway electric snow blower: 1943. Here it is in operation between Arlas and Ospizio Bernina.
Rhaetian Railway

Bernina line > Historical photograph of snow clearance at the Alp Grüm station.
Rhaetian Railway

Bernina line > The R 1051 steam snow blower, built in 1911, in front of the Alp Grüm reception building.
Rhaetian Railway

as tractive units; three of the railcars also had a luggage compartment. With four 75 HP motors they were quite powerful and could haul a load of 17 tonnes up the steep sections of the track (the equivalent of two, two-axle passenger coaches or a loaded freight wagon) and still reach a speed of 18 km/hr up the steep incline. There were no plans to run several railcars as sets. Since the simultaneous control of two connected but independently-operated railcars in the upgrade was difficult, the railcar drivers were provided with a system which allowed them to communicate with each other by alarm bells. The towing and shunting attachment and the Hardy vacuum brakes were compatible with those in use on the Rhaetian Railway. The railcars also had a short-circuit resistance brake and magnetic rail brakes. The Bernina line also had a two-axle freight railcar and two, two-axle assisting locomotives. The number of passenger coaches and freight wagons available was relatively low, respectively 16 and 28.

Winter operation

In contrast to the costly mountain railways, it was not possible to provide for all the necessary for winter safety measures during the initial project phase of the Bernina railway, which was built with relatively low capital expenditure; the objective of all-the-year-round operation was only achieved thanks to subsequent interventions guided by practical experience. In the first two years, there was no train service on the Bernina line between Ospizio and Poschiavo during the winter months; a sleigh service was used instead. In the 1911/12 winter season it was possible to reduce the sleigh service on the Alp Grüm – Cavaglia stretch and in the following year passengers only had to use sleighs on a few days. It was not until 1913/1914 that an uninterrupted year-round service was available between St. Moritz and Tirano. The necessary measures taken by 1914 to ensure winter operation along the whole line comprised the construction of snow galleries at exposed points along the pass, extension of the tunnels by means of snow galleries, replacement of the wedge-shape snowploughs by steam snow blowers, which in turn required strengthening of the bridges and construction of watering stations and turntables. The slopes of Alp Grüm were protected by walling and afforestation measures following the example offered by the Albula line.

New investments in winter operation were made in the years following 1927; these involved the relocation of two exposed sections near the top of the pass, the acquisition of a special snowplough locomotive, a clearer (which in turn meant that the trackway had to be widened) and the use of mortar bombs to trigger avalanches. In the hard winters of the 1930s the railway company threatened to discontinue the winter service across the Bernina if the subsidy from the public purse did not materialise. From 1950, the Rhaetian Railway made significant efforts to increase winter safety along the section. Galleries were built on the section between Alp Grüm and Cadera to protect the track. The use of new, electrically-powered snow blowers and track ploughs increased the speed of snow clearance work whilst at the same time the number of workers could be reduced.

Even today great efforts by men and machines are required to keep the Bernina line open in winter.

Modifications

From St. Moritz to Montebello and from Scala to Tirano the Bernina line still largely runs along its original corridor; this has been straightened a little at only a few isolated points. Along Lake

Bernina line > Early morning at Lago Bianco.
R. Pedetti

Bernina line > Alpine winter landscape between Bernina Lagalb and Arlas.
P. Donatsch

Poschiavo, a longer section of the line still runs in its original position alongside the road (cf. 2.a.3). In the summit area of the pass, however, between Montebello and Scala, the line underwent quite a number of modifications. In 1934, in order to avoid the hazardous area near the broad avalanche slope on the Piz Alv, it was relocated to the Alp Bondo side of the valley, which is better protected against wind and avalanches. Near Scala, between Ospizio Bernina and Alp Grüm, the original alignment proved to be too expensive for winter operation and a new section was constructed in 1923. This was located on an embankment and had a crossing with the old section which thereafter remained in service for some years during the summer periods.

The increasing volume of motor traffic initially only led to problems for those parts of the line which were embedded in the road direct, like a tramway. However, as traffic densities increased problems spread to the areas where the line ran (like a surface railway) alongside the road. Characteristics similar to those of a tramway can still be seen today in S. Antonio, Le Prese, Campocologno and Tirano. The line still runs directly beside the highway over the sections between Montebello and Bernina Suot and between Li Curt and Le Prese.

Technical developments in the field of electrical engineering allowed the expensive converters to be replaced by smaller and much more powerful mercury vapour rectifiers. In 1936, after the catenary system had been renewed and its cross-section increased, it was possible to increase the catenary voltage from 750 V to 1,000 V. The line has continued to operate using DC voltage, although as time passed the power supply system was renewed a number of times and modified to bring it up to the latest state of technology.

When the new ABe 4/4 III railcars came into service all the rectifier stations had to be strengthened and additional new rectifier stations built. Today, a static rectifier can be found at almost every passing station between Pontresina and Tirano, feeding current into the catenary system.

Train radio providing direct communication between the railway stations and the trains was introduced in 1971 as a means of increasing capacity. This tool has proved to be very useful, particularly in snow clearance operations. However, it will only be possible to increase capacity without upgrading the line, if section blocking is introduced. In 1977, section blocking came into service along the section from St. Moritz to Poschiavo. Since then the intermediate stations have been monitored and remotely controlled from Pontresina. Initially, only the exit signals (block signals) were taken up by the safety system. Section blocking was extended to the section from Poschiavo to Tirano in 1985. Work is presently in progress to give each of the intermediate stations a remote-controlled signal box; this is expected to be completed by 2008. All the points on the main tracks are being fitted with electric drives and the railway stations fitted with entry signals. This means that it will eventually be possible to control all the passing stations from the Rail Control Center (RCC) in Landquart and in future also from the remote control centre in Samedan, which is presently being designed.

The rolling stock in use on the Bernina Railway was up to 2.5 m wide and therefore 0.2 m narrower than those of the Rhaetian Railway. In order to be able to make free use of Rhaetian Railway rolling stock, the line was gradually widened to take a vehicle width of 2.7 m; the related improvement work took several years to complete, particularly in the tunnels and in the sections edged by retaining walls and rock faces.

Bernina line > A trip with the Bernina Express is an unforgettable experience.
P. Donatsch/Rhaetian Railway

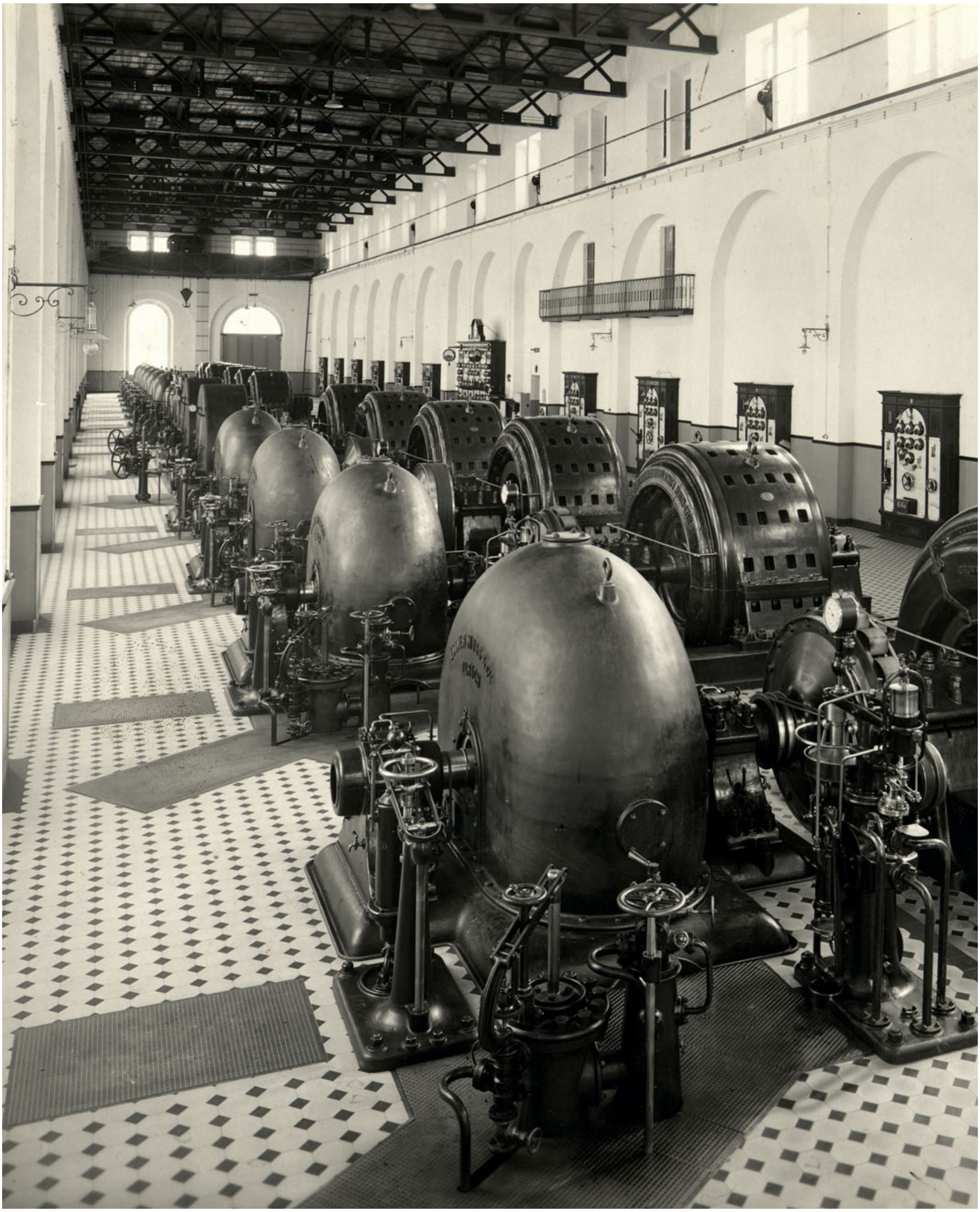
Bernina line > Passenger and goods traffic take the same train on the Bernina line.
P. Donatsch/Rhaetian Railway

Bernina line > Passing over the circular Viaduct at Brusio is one of the highlights of a trip from St. Moritz to Tirano.
P. Donatsch/Rhaetian Railway

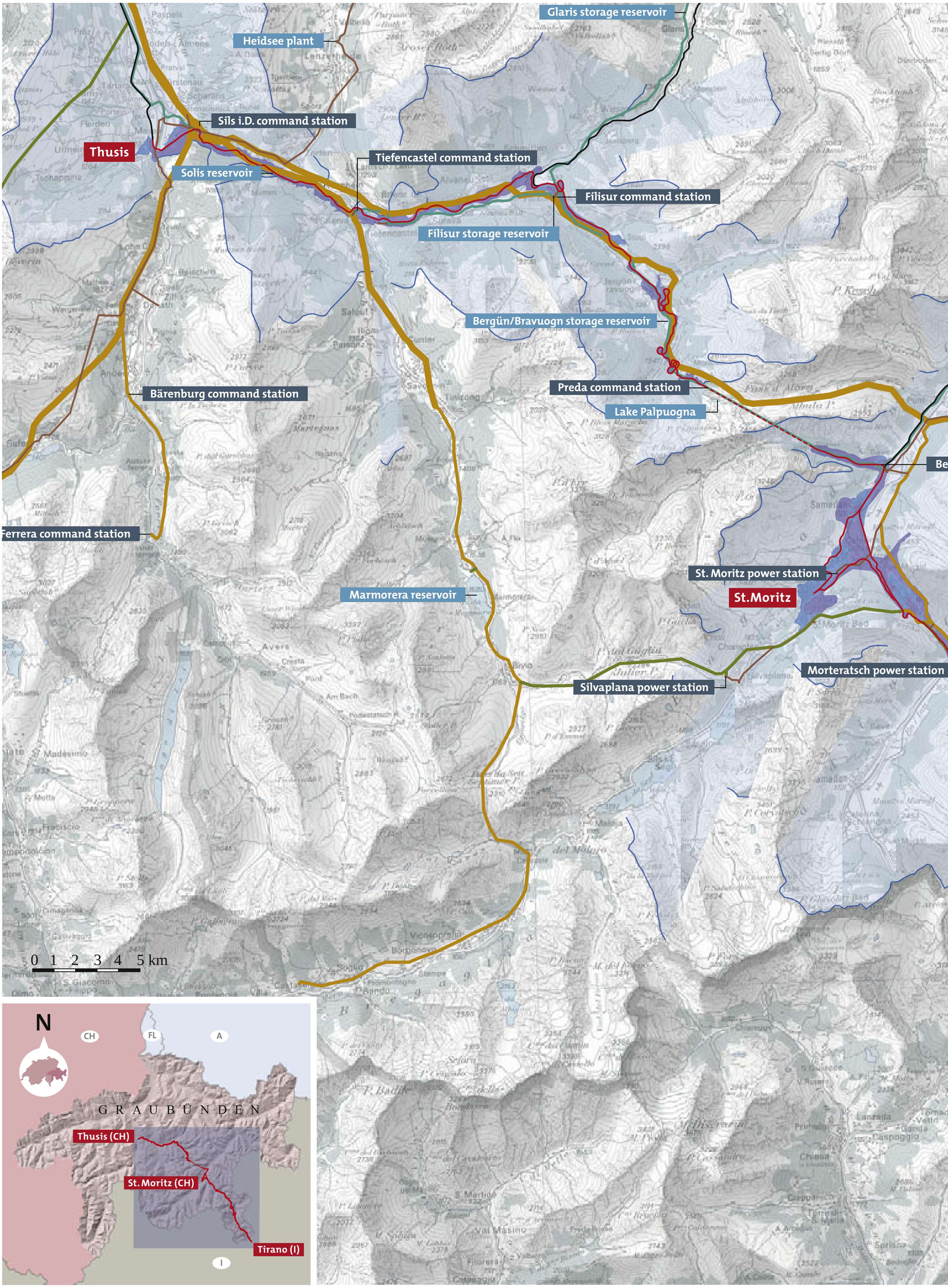
The concept of the Bernina line as a surface railway meant that new station halts could be opened or closed at will. The construction of the cableways to Diavolezza and to Piz Lagalb led to the construction of new halts close to the cableway valley stations. The two adjoining halts of S. Antonio and Annunziata were later merged to become the station halt of Li Curt.
The four-axle passenger railcars and the two-axle trailer coaches originally purchased proved to be quite suitable for the Bernina line services, both in terms of their number and their capacity. Additions to the existing rolling stock were only needed in isolated cases (and financially acceptable). In 1928, a freight locomotive was acquired for the transport of material for the construction of power stations. Two dining cars were delivered in the same year; these were combined with two passenger coaches which had concertina connections (and were already available) to form the St. Moritz – Tirano fast trains.
Since 1973, the Rhaetian Railway timetable has included a direct train connection, known as the 'Bernina Express', from Chur via Pontresina to Tirano. In recent years the Express has become the trademark of the Bernina line. The panorama coaches acquired for this train in 2000 ensure passengers travelling from Chur to Tirano can enjoy the magnificent views of the landscape unimpeded.

The future

The tight curves and the traction force needed for the inclines mean that the length of trains operating in either direction on the Bernina line cannot exceed 200 m. In order to make the best use of the opportunities offered by the line, the Rhaetian Railway is attempting to lengthen all the passing stations to a usable length of at least 200 m. The modification of the stations to the standards required today for inter-track spacing and platform heights will change the appearance of the stations which until now have largely preserved their original form.
Over the next few years the Rhaetian Railway plans to acquire 15 three-section, twin-drive tractive units for their main network and for the Bernina line. Together with the ABe 4/4 III units, these railway vehicles will maintain the future services on the Bernina line.
Despite constant maintenance the engineering structures, which will soon be a hundred years old, are in need of repair (cf. 4.a.1). The viaducts will be fitted with a trough under the track ballast, which should prevent the penetration of water and so avoid corrosion. In addition, the metal galleries must be cleaned of rust and the domes of the tunnels will also gradually require comprehensive renovation.



Campocologno > Machine room of the Campocologno power station with the turbines on the left and the generators on the right. Photograph before 1933.
A. Steiner/Rhaetian Railway


Glaris storage reservoir
Heidsee plant
Sils i.D. command station
Thusis
Solis reservoir
Tiefencastel command station
Filisur command station
Filisur storage reservoir
Bergün/Bravuogn storage reservoir
Bärenburg command station
Preda command station
Lake Palpuogna
Ferrera command station
St. Moritz power station
St.Moritz
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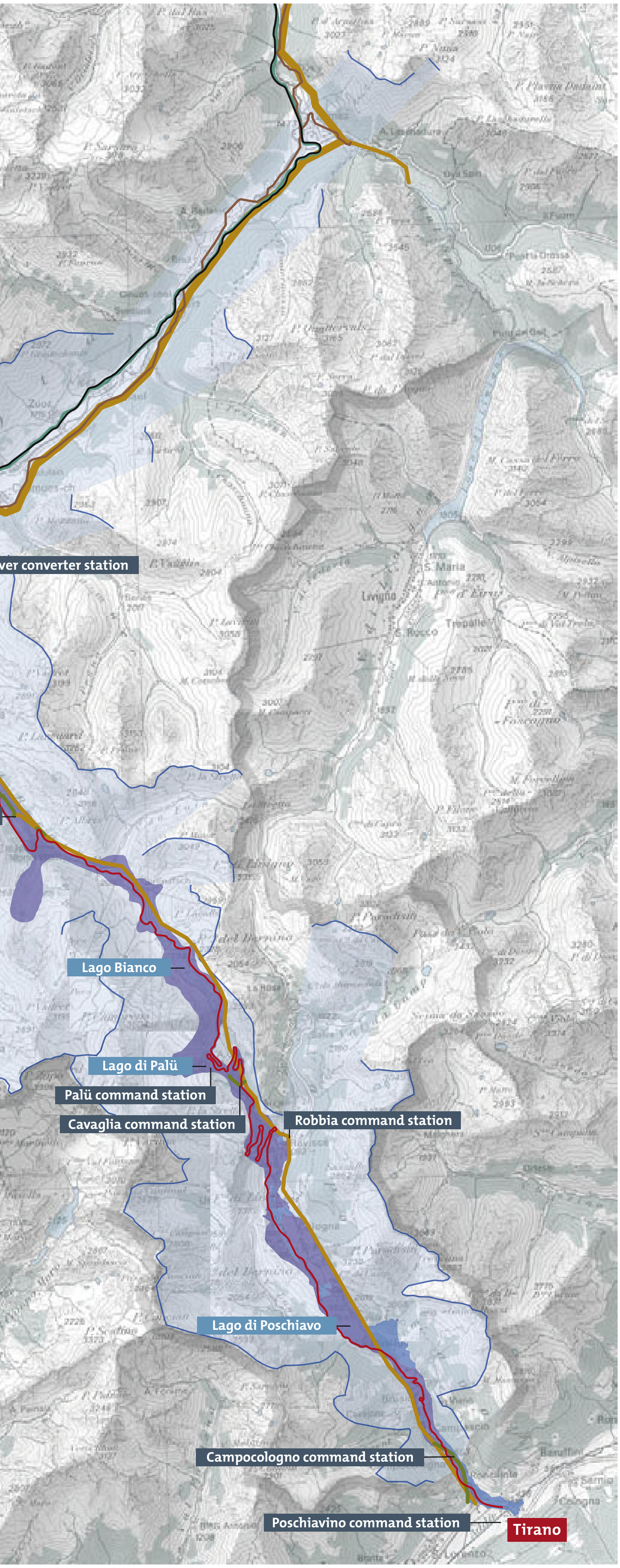


Infrastructure for the generation of hydroelectric power and the transport of power

	50 kV – 60 kV	Transmission cables
	66 kV	Transmission cables (Power for the railway)
	130 kV – 150 kV	Transmission cables
	220 kV – 380 kV	Transmission cables
	Control centres, power plants and converter stations	
	Reservoirs	

Core zone

Core zone with railway and cultural landscape

Buffer zone

Buffer zone in the near area

Buffer zone in the distant area (backdrop)

Horizon line

Other contents

Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Thematic data: Adrian Collenberg
Design: Süsskind, SGD, Chur

2.b.7 Power for the Albula and Bernina line: the power station buildings along the railway line

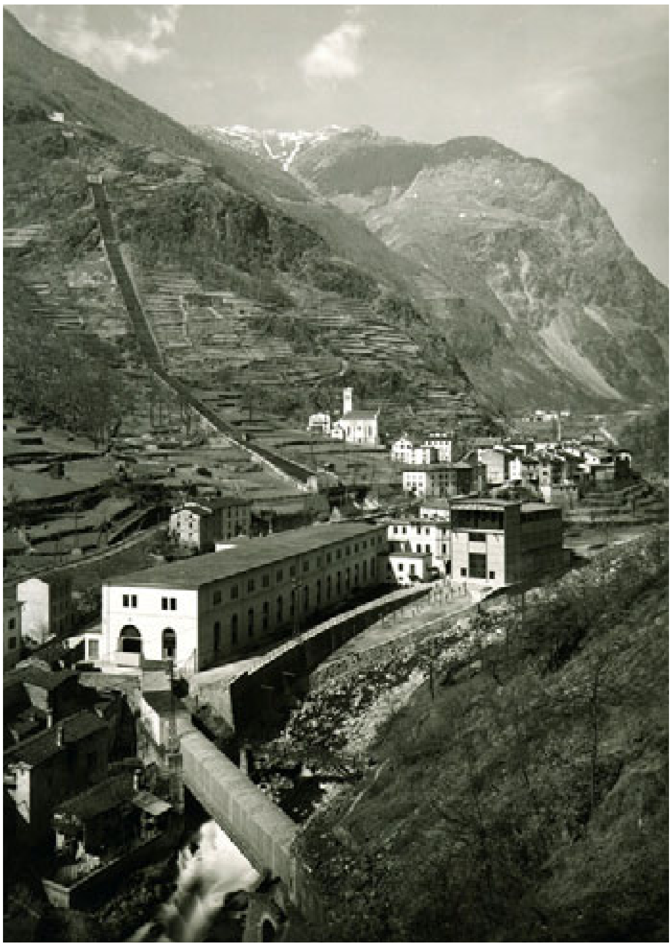
There are several power stations along the Albula and Bernina line documenting the surge in the use of hydroelectric power during the 20th century. When they were built 1906/07, the works in Campocologno represented the largest high-pressure power station in Europe; its construction was closely linked with that of the Bernina Railway. Other power stations along the river Albula were built later, primarily to produce electricity for the urban and industrial centres in Switzerland. The electrification – very early on an international comparison – entailed the construction of electro-technical facilities that are an important feature of the cultural landscape between Thusis and Tirano.

In summer 1879, Johannes Badrutt surprised his guests at the St. Moritz Kulmhotel with electric arc lamps in the dining room. He had simply coupled the "light machines" first demonstrated the previous year at the Paris World Exhibition with a water-powered generator. Similar lighting systems were soon introduced in the luxury hotels in Pontresina, Maloja, Davos and Flims. Then small hydroelectric power stations started to spread throughout Switzerland to provide light in the towns and villages. Decisive for global electrification, however, was the successful high-voltage power transmission over a distance of 175 km first presented at the Frankfurt Electrotechnical Exhibition in 1891. It showed that the generation of electricity was not necessarily location-determined but that electric power could also be used, irrespective of where it was produced, for distant sales and consumer areas. As the water power could be used for industrial purposes, this technical innovation was the impetus for the first power station boom in the Alps.

On an international comparison, Switzerland and Graubünden experienced very early electrification thanks to the power stations, as there was a plentiful supply of water to provide the energy. This boom not only had considerable repercussions on industry and the economy but also on people and the environment. Analogous to the building of the railway, the power stations in the 20th century radically changed the landscape along the Albula and Poschiavino rivers: besides rail tracks, viaducts and stations there were now reservoirs, pylons and works buildings. Naturally, the railway and power generation plants were and are closely linked.

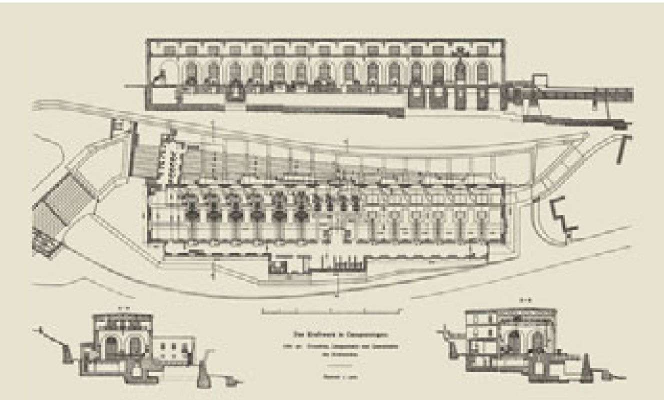
Inter-connections on the Bernina

Initial studies on the exploitation of water power in Val Poschiavo were undertaken by the Zurich engineering office Froté & Westermann. The concessions acquired 1898/99 were sold to General Water Power Limited in London; later they went over to the Alioth electricity company in Basel. On 14th June 1904, the latter, in conjunction with the Società Lombarda per distribuzione di energia elettrica in Milan, founded the Kraftwerke Brusio AG (KWB; today Rätia Energie AG). The new company was to supply power to the industrial centres in Lombardy as well as the Bernina railway which would be electrically operated from the outset. The new line aimed to provide access to the scenic landscape between



Campocologno > Six penstocks of the largest storage power station in Europe of the time ran from the Scala gallery to the Campocologno station. Photograph before 1933.
A. Steiner/Rhaetian Railway

1929 relief of the Poschiavo Valley with the hydroelectric power plants, together with the "large Palü reservoir" and the "Asciatti" auxiliary line projects. Illustration from: *Die Kraftwerke Brusio 1904 – 1929*, published by Kraftwerke Brusio AG, Poschiavo 1929.



Ground plan and elevations of Campocologno control centre.
Rätia Energie AG, Poschiavo

Lago Bianco > The south wall of the Lago Bianco with the 1911 valve tower (left) and the new valve tower built in 1927. Photograph before 1942.
Rätia Energie AG, Poschiavo

St. Moritz and Tirano for a broad public.
The first hydroelectric power station used the water from the lake at Poschiavo; this was led via a surge tank in Monte Scala through five (later six) above-ground penstocks down to the turbine chamber in Campocologno. This covered a surface of 104 x 17 m. The works were upgraded in 1906/07 to a turbine power of over 26,000 kW. In winter 1908/09 the number of generator sets was increased from ten to twelve, raising the output to over 30,000 kW. For a short time, with respect to building, the Campocologno power station was the largest plant of the kind in Europe. The spectacular works were praised at length in engineering publications and viewed by visitors from all over the world.
A second power station with its command station in Robbia, opposite San Carlo, utilised the hydropower from the Bernina lakes and the Palü glacier, collected by two dams. The works came into operation in November 1910 with three generator sets. Shortly afterwards the power output was raised to 11,000 kW.
Four converting stations were set up in Campocologno, Poschiavo, Ospizio Bernina and Pontresina to supply power to the Bernina Railway, which transformed the three phase high-voltage current into 750 volt direct current. After the successful start of the Bernina railway, a power supply contract was concluded with the Rhaetian Railway and the KWB built a converter station in Bever, which supplied the Engadin railways with power from 1913. The KWB contracted further supply agreements with the local electricity works in St. Moritz and Madulain, while the local distributor networks in Poschiavo and Brusio were established and operating earlier. Two power lines were taken over the Bernina Pass and one to Italy to distribute the current. At first, most of the hydropower was exported to Italy. It was only with the political disputes at the beginning of the 1920s that the KWB began to orient its supplies to the north.
The complex roles played by the leading personalities were a striking feature of the founder years. Between the years 1904 und 1914, for example, Alfred von Planta (1857 – 1922) was at the same time president of the KWB, the Bernina Bahn AG and the Rhaetian Railway. His successor, Alfred Sarasin was President of the Board of Directors of the KWB 1914 – 1953 and responsible for the Bernina Railway until 1935. Further his bank in Basel played a major financing role for other Swiss mountain railway projects.
After the end of the First World War the utilisation of hydropower spread throughout the Alpine region. To meet the rising demand for power, the KWB expanded its plants and built the Palü and Cavaglia power stations in the upper Poschiavo valley. Water from the Bernina lake is run through a subterranean pressure tunnel to the Palü command station where there was a 10,000 kW machine set. The penstocks and connecting tunnels led down to Cavaglia from the additional reservoir which stored the water in Lago Palü. The output of the Pelton turbine installed there was over 7,000 kW. This upgrade entailed renewal work on the plants in Robbia and Campocologno. The increased production volume was still exported to Italy, but the electricity could now be taken via the Albula power line to Thusis and Sils i.D.
Besides generating tax and duties income and preferential electricity for the Val Poschiavo, the KWB created jobs and earning opportunities in a remote Alpine region. In the mid 20th century, the power company had a total staff

Transporting the pole wheel (rotating part of a generator) for a machine aggregate at Campocologno power station by horse and cart between Tirano and Campocologno. Photograph about 1906.
Rätia Energie AG, Poschiavo

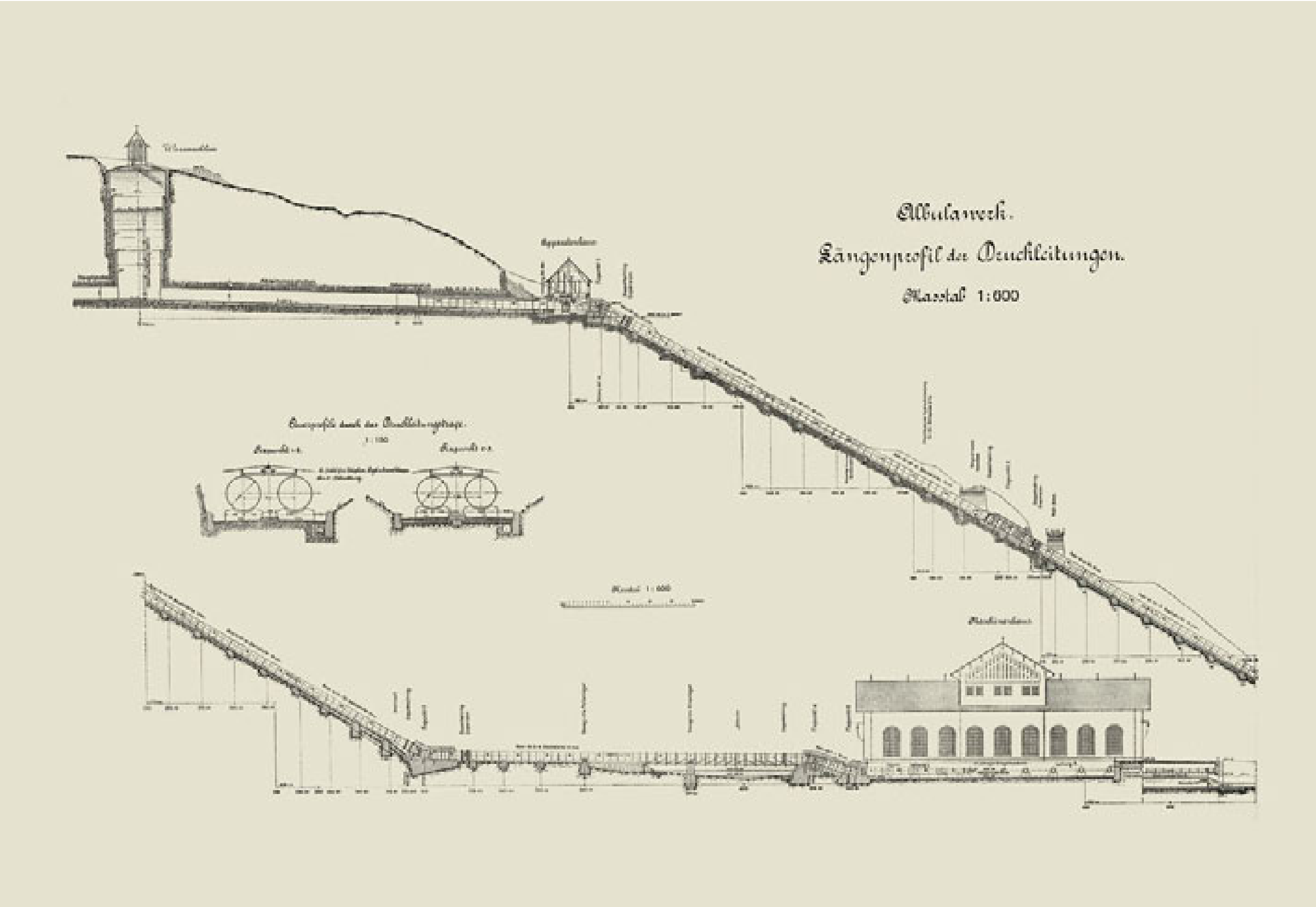
The Rhätische Werke Thusis built a power line over the Albula Pass in 1921. This created a link with the south; with the Brusio power stations. The photograph shows the erection of the iron masts in the Engadin.
Rätia Energie AG, Poschiavo

Electrification of the Albula line > The trial-run train in Bergün/Bravuogn station. Photograph about 1919.
Collection G. Brüngger

of 117 while the continuous expansion and maintenance work created more earning possibilities. The KWB also supported social and cultural projects in the valley. In contrast to the Bernina Railway, which experienced serious economic crises and was taken over by the Rhaetian Railway in 1944, the use of hydroelectric power proved to be a relatively safe investment even in difficult times.

Electricity for the Albula Railway

A small electricity works was set up in Preda as early as 1898, during the construction of the Albula tunnel; after the railway line was opened this went over to the community of Bergün/Bravuogn. The water was tapped from the lake at Palpuogna and run to the machine house in Preda to a Pelton turbine with an output of 88 kW. Besides Preda and Bergün/Bravuogn, it also supplied power to Latsch, Filisur and the spa hotel in Alvaneu. Particularly for the latter, having electricity was an important publicity argument – to be able to keep up with other wellness resorts.
The Albula Railway from Thusis to St. Moritz was not yet electrified when it was opened in 1904; steam locomotives were used. At that time the voltage was still insufficient for transporting power over considerable distances. In view of the positive experience with the Bernina Railway, the Rhaetian Railway resolved, in 1910, to power the new Lower Engadin line from Bever to Scuol with 11,000 volt single-phase alternating current. At the same time the existing Bever – St. Moritz as well as Samedan-Pontresina lines were converted to electricity. Electric operation started 1st July 1913; as already mentioned, the power was supplied by the KWB.
The scarcity of coal during the First World War accelerated the electrification of the entire rail network of the Rhaetian Railway. On 20th April 1919, the Rhaetian Railway “after completely satisfactory trials” opened the electrically powered scenic stretch from Bever to Filisur and, 15th October 1919 from Filisur to Thusis.
The conversion in Bever was not sufficient to power the extended electrified network. However, the Rhaetian Railway – in contrast to the Swiss Federal Railways (SBB-SFR) – did not opt to build its own power stations. Instead it obtained its electricity from the AG Rhätische Werke für Elektrizität (RhW), founded 1920 in Thusis. The KWB also held a share in the RhW, which transferred its power supply contracts with the Rhaetian Railway together with the Bever converter station to the new company. The RhW took over the Thusis electricity works, at the end of the Viamala gorge, which were used for industrial purposes. Various extensions raised the turbine output to 10,000 kW by 1921 and the plant was converted to produce single-phase current. After the first 60 kV power line across the ridge of the Alps was built, the Albula line from Thusis to Bever could also be supplied with electric power. Later the Rhaetian Railway also concluded agreements with the AG Bündner Kraftwerke (BK) that operated hydroelectric power stations in the Prättigau for the supply of power throughout the region.
The reciprocal relationship between clean rail power and the promotion of tourism was underlined in a publication by the Graubünden tourist association with the title “Recalling the completion of the electrification of all narrow gauge railways (400 km) and the expansion of the greatest electricity works in Graubünden” that was addressed primarily to English-speaking tourists. Despite economic fluctuations, hotel bookings



Sils i.D. > Penstocks, gallery, pressure pipe and control centre of the Albula works, owned by the city of Zurich. Plan (reduced in size) from the report on how the works were built: *Bericht zur Erstellung des Albulawerkes*, Zurich 1910.
Elektrizitätswerk der Stadt Zürich

Nisellas > Running off floodwater at the Nisellas wier gate. Photograph from before 1980.
Elektrizitätswerk der Stadt Zürich

Sils i.D. > The enormous control plant along the Albula river is a very important intersection in the Swiss power network. The EWZ machine house bottom right.
E. Süsskind

in the Upper Engadin, which is served by the Albula line, continued to rise and the railway proved its worth in making it possible for tourists to travel in comfort. The connection between the electrified Albula railway and the tourist industry in the Engadin was as evident as that between the building of power stations and promoting economic development in Val Poschiavo.

Hydroelectric power stations along the River Albula

The city of Zurich electricity works (EWZ) had a hydroelectric plant built in the years between 1907 and 1910 to cover the rising need for electricity in Zurich. The engineering office already mentioned, Froté & Westermann, was responsible for this costly building project. The Albula river was dammed at Nisellas, below Tiefencastel, and the river led off to the machine room in Sils im Domleschg via a gallery and hydro dam. The turbines installed there initially had an output of 18,000 kW; the capacity was raised continuously. The renowned Zurich architect Gustav Gull (1858 – 1942) was responsible for building the 65 x 22 m machine house; the settlement around it was built by Nicolaus Hartmann the younger (1880 – 1956) from St. Moritz. Today there is a switching station built on to the great hall – the first 380 kV plant in Switzerland with an open transformer field next to it.

The EWZ built the Heidsee plant on the Lenzerheide as a “supplementary plant for winter power” in the years 1917 – 1920. To cover the continually rising need for energy in winter, the EWZ had the Juliawerk built between 1949 and 1954, with an artificial lake in Marmorera as the main reservoir and with the command station in Tiefencastel. The EWZ also built enormous plants between 1954 and 1959 in Bergell and a 220 kV line over the Julier Pass to Zurich. At the beginning of the 1980s, the old Albula river dam at Nisellas was demolished and replaced by a 61 m arch dam. This raised the content of the regulating reservoir considerably. Further, a new penstock was built from the Solis storage reservoir to the command station at Rothenbrunnen. All the EWZ plants were now remotely controlled from the new operational buildings in Sils i.D.

At the beginning of the 1960s, the Kraftwerke Hinterrhein (KHR) had storage reservoirs built in Valle di Lei and on the Hinterrhein (Upper Rhine) with its principal command stations Ferrera, Andeer-Bärenburg und Sils i.D. tapping the water used by the RhW power station at Thusis and jeopardising the power supply for the Rhaetian Railway. Consequently, two single-phase machine sets with a total capacity of 5 MW were installed as a “special case plant”. From 1961 these have been producing exclusively single-phase current with 16 $^{2}/_{3}$ Hz for the Rhaetian Railway catenary network.

This KHR command station in Sils i.D. – in the immediate vicinity of the EWZ command station – was completed under the direction of the architect Konrad Metzger, who subsequently also modernised the smaller pioneer electricity works in Morteratsch (1968) and Silvaplana (1973). The enormous switchboard plant along the Albula river in Sils i.D. is a very important intersection in the Swiss power network. Today shareholders of the KHR include Rätia Energie AG, Canton Graubünden and the city of Zurich.

The Albula – Landwasser Kraftwerke AG (ALK) was formed in Filisur in 1961 with the objective of exploiting the river Albula between Naz/Preda und Bergün/Bravuogn and the river Landwasser between Davos and

Current power stations in the Albula / Bernina region:

Company	Power station	Turbine capacity	Annual production
Rätia Energie AG	Campocologno I	49.60 MW	195.00 GWh
	Campocologno II	1.62 MW	6.00 GWh
	Robbia	27.00 MW	105.60 GWh
	Cavaglia	8.30 MW	20.00 GWh
	Palü	10.40 MW	14.00 GWh
Rätia Energie Klosters AG	Morteratsch	0.57 MW	3.70 GWh
	Silvaplana	1.47 MW	4.80 GWh
EW St. Moritz	Islas	3.60 MW	12.80 GWh
EW Bergün	Preda	0.90 MW	3.60 GWh
ALK	Filisur	60.00 MW	266.20 GWh
	Tiefencastel	24.00 MW	100.00 GWh
EWZ	Tiefencastel East	56.00 MW	145.30 GWh
	Tiefencastel West	26.00 MW	76.80 GWh
	Solis	7.30 MW	26.40 GWh
	Sils i.D.	26.00 MW	92.60 GWh
KHR	Sils i.D.	255.40 MW	645.00 GWh

Source: Graubünden Energy Office from the 1.1.2005 Federal Statistics

Lago Bianco > The northern dam wall built 1910 – 1911.
A. Badrutt

Filisur. Due to rising building costs and competition from nuclear energy the original project had to be downsized. From two shallow storage reservoirs in Bergün/Bravuogn and Glaris, pressure pipes lead to a joint hydro dam above Filisur. The subterranean Francis turbines in the command station, opened 1965/66, achieve a capacity of 60,000 kW. The Filisur – Tiefencastel gradient was first used in 1988; a regulating reservoir was built below Filisur for this purpose and a head-race tunnel was laid from there to Tiefencastel. A capacity of 24,000 kW is generated in this inconspicuous building.

Important electro-technical historic structures alongside the railway

The Albula and Poschiavino rivers had already been used to generate power. Both the Rhaetian Railway contact wires and the hydroelectric companies' high-voltage lines follow the course of these rivers. Further several storage reservoirs, walls, pressure pipes and industrial buildings stand out in the landscape from the Schin gorge to Tirano. The engineers, architects and many workmen played a significant role in forming the landscape as we see it today.

The landscape on the Bernina Pass is sharply defined by the Lago Bianco (White Lake) that was created when the power station and the two dams were built; before then there were two small lakes with silted banks of alluvial deposits. The dam to the north at 2,200 m is on the watershed; water flows to the north with the Inn and the Danube towards the Black Sea, the Adda and the Po flow south to the Adriatic. It was built in 1910 – 1911 as a three-element, arched gravity dam. The wall to the south, facing down the valley, the Diga Scala with the maintenance tower standing proud is clad with local stone so that it looks like a natural dam. In the mid 1920s there were plans to dam Lago Palü with a 40 m wall, which would have been a serious intrusion in the sensitive glacier environment. The project encountered too many problems and was abandoned. Instead the Diga Scala was raised by 4 m in the 1940s; entailing a massive increase in the volume of the Bernina lakes. Today the crown of the dam is 190 m long.

Nicolaus Hartmann takes pride of place with respect to architectural influence in the building of the power plants: Hartmann, who also realised projects for the Rhaetian Railway (cf. 2.a.5), built the high-altitude command stations in Palü and Cavaglia. The Palü command station, with its vantage position at 1,923 m, perched in the midst of a wild mountainscape, is a fascinating sight even from the train window. All the technical elements are so well hidden in this massive rough-stone masonry structure that the first glimpse is reminiscent of a fort from the Middle Ages; the impression is accentuated by the irregular arrangement of the windows. The tower-like machine hall rears above the connected cube-shaped auxiliary buildings with the switching stations, the workshop, the shop and an apartment. Inside, the hall is almost baronial; the sole technical installation is the generator that is driven over a 28 m long vertical cam by Pelton and Francis turbines.

In contrast, the Cavaglia command station (1,706 m) at the northern edge of the forest on the plain of the same name looks like an oversized traditional “Engadin farmhouse” (cf. 2.a.6). The building complex is in roughcast stonework, the wooden roof frame is covered with large shingles of local stone. As in Palü, the auxiliary facilities are arranged around the machine house, but the power line exits here

Diga Scala > The Lago Bianco south dam wall and service tower, clad in local stone, looks rather like a natural dam.
L. Dosch

Palü power station > The tower-shaped machine house, designed by the architect Nicolaus Hartmann the Younger is reminiscent of the weirs built in the Middle Ages.
L. Dosch

Cavaglia power station > The building complex, reflecting the lines of a house in 'Engadin style' was also designed by Nicolaus Hartmann the Younger.
L. Dosch

and the transformers are clearly visible. The architect brilliantly realised the building concept "form as simple as possible rationally adapted to the interior arrangement". In winter, the water stored in Lago Bianco is used to produce power via the Palü and Cavaglia stations. The two power stations are linked by a gallery track along the penstock. This is still used today for personnel and material transport.

The converter station in Bever is another important architectural object; Nicolaus Hartmann was again the architect.

The four-storey main building together with the distributor substations is right next to the rail track and has the same form and design as the neighbouring traditional Engadin houses. Stylistically, the complex is described as "Heimatstil" (cf. 2.a.4 and 2.a.5).

The other power station buildings were renewed and converted over the years to keep pace with technical progress. For example a second command station was added to the gigantic Campocologno station in 1950 to exploit the remaining gradient of the Poschiavino river as far as the border. The principal command station from the pioneer days had to give way to a new building in 1968/69. At the same time the original, striking six-lane head-race tunnel was replaced by a single penstock. At the time it was built opinions were divided on the aesthetics of this open head-race tunnel; rejection on romantic grounds met technical pragmatism head on. The principal argument in favour of the open version was the danger of rust, to be countered by painting. National heritage and tourism circles, however, complained that the complex was "unnatural". After all, an intact and unspoiled natural environment was a central element of tourism marketing.

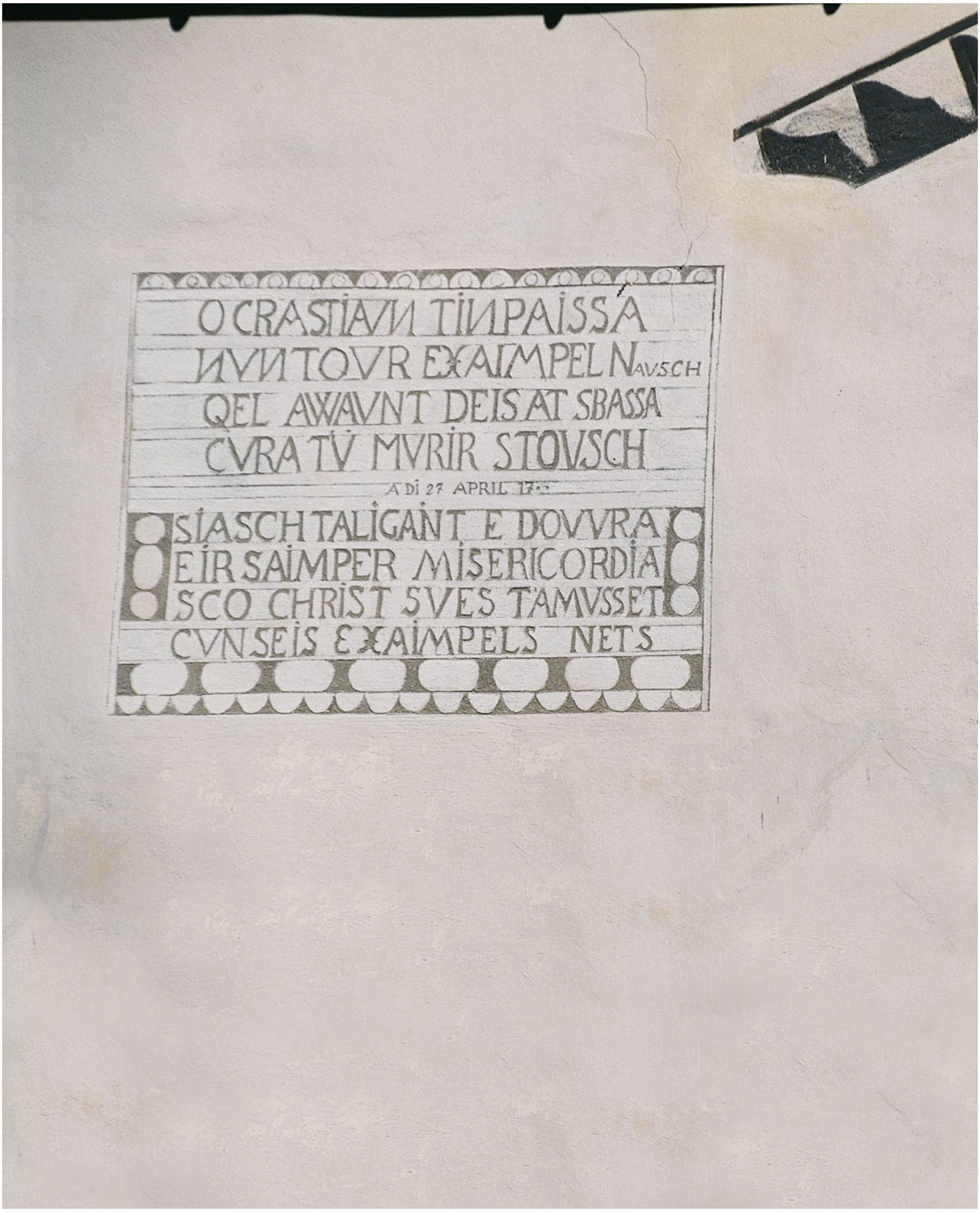
The critics were taken seriously in Brusio: "In the interest of the landscape, from Pontresina to Punt Muraigl [sic] and from Samaden to Bevers the Engadin power station 8 kV and 23 kV three-phase power lines shall run parallel on the same masts." Wooden masts were used for the transmission lines to the north with lengths of 46.4 and 28.6 km – whereas only the cheaper iron masts were used for the "C" line from Robbia to the Veltlin valley. Already by 1945 the KWB were claiming "despite considerable extra cost" to have taken national heritage issues into account "to a very great extent". In particular in the renewal of the power lines over the Bernina Pass, the building companies and engineers took the impact on the landscape into consideration by replacing the wooden masts with more transparent lattice masts. The Engadin architect Ulrich Könz (1899 – 1980), himself a member of the Engadin National Heritage Association, praised his work: "We managed to render the entire line from Morteratsch opposite Pontresina up to and including the pass into Val Roseg virtually invisible." Also in the extensions and changes to the power lines, switching stations and power stations of more recent times "consensus solutions" are aimed at and cooperation sought with the regional and national landscape conservation organisations and the Cantonal authorities.

Recent developments

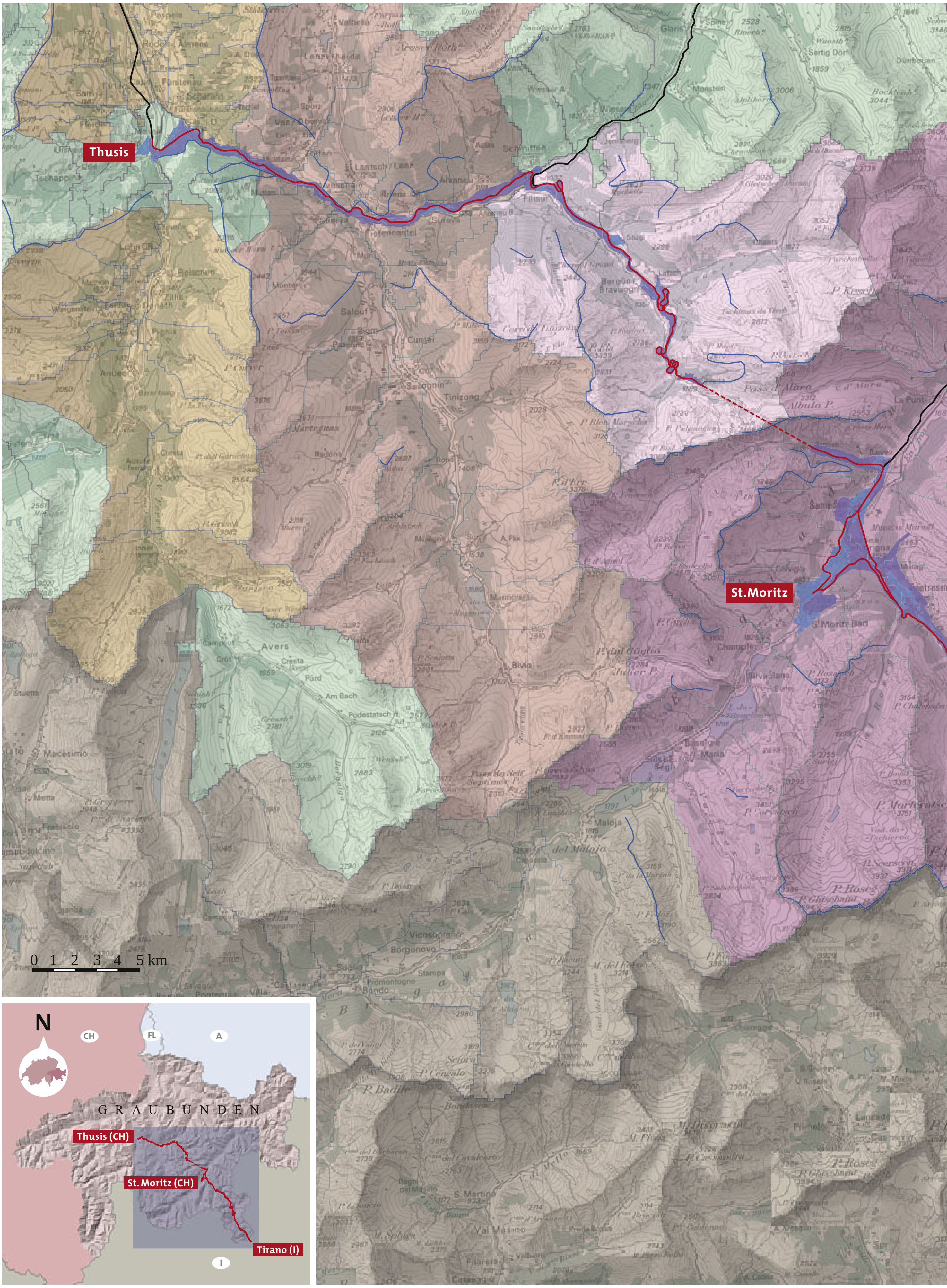
The KWB command stations were automated from 1970 and remotely controlled from Robbia. With the 220 kV Albula line, the KWB connected up with the west European combined network. In 1978 the Italian shareholders gave up their KWB holdings, which they had held since the earliest days. In 2000 the KWB, BK und RhW electricity companies merged as the Rätia Energie AG domiciled in Poschiavo. The principal shareholders are the Canton Graubünden, the Aare-Tessin AG and the Elektrizitätsgesell-

The eco-power trail from Ospizio Bernina to Cavaglia, opened in 2002, gives details on the production of eco-power on twelve information boards.
Photos: Rätia Energie AG, Poschiavo

schaft Laufenburg. In 2004, the Rätia Energie's own power stations produced 598 GWh energy while the EWZ, with all its plants in central Graubünden, produced 732 GWh. This gives both companies a significant position on the Swiss electricity market. In summer 2002, Rätia Energie and the Rhaetian Railway collaborated on laying out an eco-energy teaching trail from the Ospizio Bernina along the Bernina lake down to the glacier moulins at Cavaglia. This demonstrates yet again the intimate link between the railway and its power producer. The close meshed network of catenaries and power lines represents an essential economic artery, symbolic of the parallelism of the most important economic factors in Graubünden, namely tourism and power. A network that is vital for so many.



Engadin > Sgraffito inscription in Romansh on a house wall in the Engadin.
P. Donatsch



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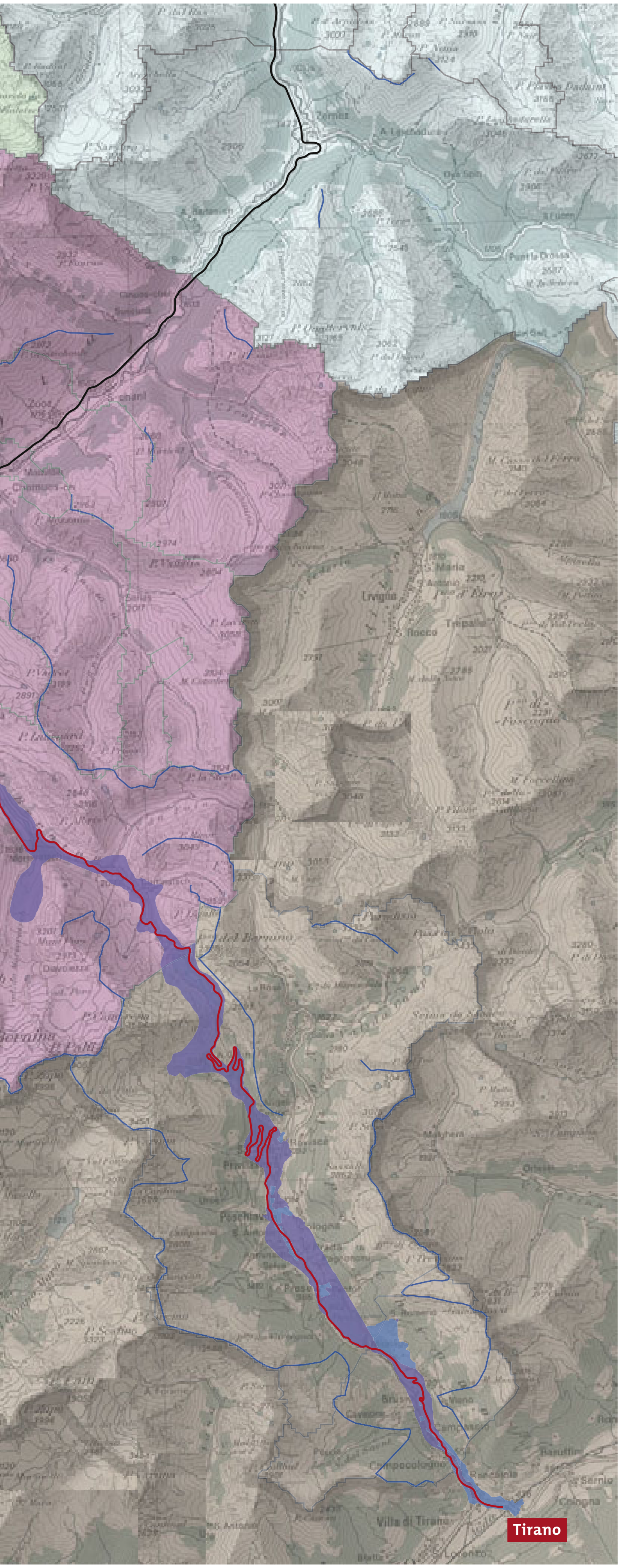


Language landscapes

- German
- Italian
- Romansh “Sutsilvan”
- Romansh “Surmiran”
- Romansh “Puter”
- Communities using central Graubünden dialects and writing in “Puter”
- Romansh “Vallader”

Core zone

- Core zone with railway and cultural landscape

Buffer zone

- Buffer zone in the near area
- Horizon line

Other contents

- Other stretches of the Rhaetian Railway

Sources:
Basic map: PK 200’000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Design: Süsskind, SGD, Chur

2.b.8 Language landscapes

The fascination of travelling through the world of languages in the Albula / Bernina region is the existence of the German, Rhaeto Romansh and Italian languages and their dialects side-by-side within such a small area. Virtually every village constitutes a microcosm with a settlement history and language development of its own; a puzzle piece in a multi-faceted overall language pattern. The Rhaetian Railway has wholeheartedly embraced Graubünden's trilingualism, as can be gathered from the official name "Rhätische Bahn – Viafier retica – Ferrovia retica".

History and current situation in the language landscape of Graubünden

With its national languages German, Rhaeto Romansh and Italian, Graubünden is the only trilingual canton in Switzerland. Virtually nowhere else, can such linguistic diversity be found in such a small area.

Until the middle of the 19th century, Rhaeto Romansh was the mother tongue of most of Graubünden's population. With roots going back more than 2,000 years it developed, after the advance of the Romans into the alpine region, from the language of the native inhabitants (generally referred to as Rhaetians) and dog Latin. The five Romansh idioms still spoken today – Sursilvan, Sutsilvan, Surmiran, Puter and Vallader – evolved along different lines, depending on the degree to which they were influenced by German or Italian.

Today German is dominant in Graubünden; introduced early by immigrants from the north, it gained momentum progressively with the colonisation by the Walser in the High Middle Ages, the settlement of the Rhine Valley by the Alemanni and the impact of tourism in modern times. According to the 2000 public census, 14.5 % of the canton's population give Rhaeto Romansh as the language they speak best. The proportion of Italian speakers has always been small and currently stands at 10.2 %.

But this trilingualism is by no means a relict that belongs in the museum. Besides the regional associations with their strong commitment on the cultural front and the various language institutions, the cantonal government also supports and promotes linguistic diversity. There are three models for schools in Graubünden: one each with German, Rhaeto Romansh or Italian as first language and a second cantonal language taught as compulsory first foreign language. Both the state and the canton are in the process of drawing up language laws in line with the constitutional requirements.

A special measure to protect the threatened Rhaeto Romansh language is the introduction of the standardised Rumantsch Grischun; merging the five written idioms currently in use. While the passionate debate this has triggered reflects the difficulties of language policy today, it also underscores the vitality of language diversity in Graubünden.

Medley of languages

What is the linguistic situation along the railway line between Heinzenberg/Domleschg and the Poschiavo valley? Thusis, where the line starts, originally belonged to the Sutsilvan language area, but German was already dominant here before 1850. This is explained by the village's role as an important reloading point on the Splügen/

San Bernardino transit route. Indeed, the entire valley community of Heinzenberg/Domleschg was affected by the successive ousting of Romansh in favour of German. Today Sutsilvan – the most endangered Rhaeto Romansh idiom of all – is only spoken beyond the Viamala in the villages around Zillis and Andeer.

The Schin Gorge, that imposing natural frontier between Thusis and Tiefencastel, is also the language border between Sutsilvan and Surmiran. In the midst of this Rhaeto Romansh-speaking area is the tiny Walser settlement of Mutten, an island where German is spoken; as in so many other places, the colonists who had come over the mountains from the Valais into an area that was already settled, had to put up with a remote, inhospitable piece of land.

The distribution area of Surmiran originally extended over the entire Albula valley and beyond, towards Lenzerheide to the north and to Savognin/Surses to the south. Romansh is being eroded both in the Albula valley and in the area towards Lenzerheide. According to the 2000 census, native Romansh speakers account for between 10 and 40 % in the communities along the railway line. At 36.5 %, the proportion was already low in Filisur in 1880; the continued sharp regression in the following decades is a direct consequence of the building of the Albula line (1898 – 1903) and the opening of the railway from Filisur to German-speaking Davos, in 1909. In 1914 the community adopted German as the official language.

However, the villages of Schmitten and Wiesen on the way to Davos are again Walser settlements and thus quite distinct from the Surmiran language area, like the next village on the line towards Albula, Bergün/Bravuogn. Even though it is still on the north side of the Albula tunnel, this village is already in the catchment area of Puter the Romansh idiom spoken in the Upper Engadin. Together with the Lower Engadin form, Vallader, Engadin Romansh is also called Ladin.

St. Moritz switched to German very early due to the boom in tourism in the late 19th century. The villages of Bever, Samedan, Celerina and Pontresina, on the other hand, continue to run a school with Rhaeto Romansh as the first language despite the low proportion of Romansh speakers (now between 10 % and 20 %). Like certain communities in the Albula valley, this is their way of emphasising the importance of schooling in Rhaeto Romansh for the conservation and promotion of the original language. Furthermore, the region has also tried out a new bilingual educational model in recent years and new methods of promoting the language are also being implemented outside the schools. Samedan, for example, has created the post of languages officer whose job is to ensure the continued use and cultivation of Romansh in the community.

The Bernina Pass is the next language 'watershed'. Poschiavo together with the Misox, Calanca and Bergel valleys all belong to the "Valli" or Italian-speaking valleys in southern Graubünden. The local dialect spoken in the valley of Poschiavo is called Pusciavign. In contrast to Romansh, which has no cultural hinterland to fall back on, the Valli can orient linguistically to the Ticino and Italy.

Proactive trilingualism on the Rhaetian Railway

The Rhaetian Railway has succeeded in making the linguistic multiplicity of the region an integral element of their corporate identity. The use of Italian on the Bernina line, which runs through the Italian-speaking region, has always been a matter of course from the very outset. However, integrating Rhaeto Romansh was incomparably more difficult. The construction of the rail network brought with it far more widespread use of German in Romansh-speaking Graubünden while the regular train services and increasing number of tourists (cf. 2.b.10) accelerated the regression of Romansh. The names of all the stations in the Romansh-speaking regions were originally written only in German. After Rhaeto Romansh was officially recognised as one of the national languages in 1938 the Romansh place names were added in brackets after the German names, for example Bergün (Bravuogn) or Celerina (Schlarigna). Since 1944 the policy has been to write the names of all stations in the Romansh-speaking regions in the original language or at least to use German-Romansh double names. This change affected a total of 21 stations which, as the Rhaetian Railway emphasised in its annual report, entailed "by no means insignificant costs". However, it did send a valuable signal to the Romansh-speaking population: the rest of Switzerland, not to mention foreign visitors, should recognise the Romansh identity of its villages and hamlets. In this sense the Viafier retica, as the Rhaetian Railway is called in Romansh, contributed to the strengthening of the minority language and the self-awareness of its native speakers.

Today the Rhaetian Railway is proactively trilingual. The footer of its stationery reads: "Die kleine Rote. Il trenino rosso. La pitschna cotschna" – referring to the red colour of the trains. For some 20 years all the writing on all the engines and carriages has been in all three cantonal languages; in the case of Romansh, the Rumantsch Grischun standard version has been adopted: "Rhätische Bahn – Viafier retica – Ferrovia retica". Pragmatism determines the use of the three cantonal languages, not theoretical considerations based on fictitious functionality that is not questioned due to the dominance of German and the consequent bilingualism of the Italian- and Romansh-speaking people of Graubünden. The choice of language for the writing on the trains is left to the painter in his workshop, a connoisseur of Graubünden and its linguistic peculiarities. The writing on the snow blowers used on the Bernina line is in both Romansh and Italian ("Viafier retica / Ferrovia retica"); they must be the only 'bilingual' snow blowers in the world. Conversely, the same name on both sides of the blowers used in the German-speaking Schanfigg valley on the stretch from Chur to Arosa, is written only in German.

Graubünden's trilingualism as practised by the Rhaetian Railway goes even further: since May 2001 passengers have been informed by loudspeaker of the change in language area whenever the train enters the Romansh- or Italian-speaking region. On the Albula line this happens in the Albula tunnel shortly before reaching the Engadin. In the Engadin itself, all the station names are announced first in Romansh and then in German. An interesting feature here is that regional differences in language forms are respected. So in the Upper Engadin, before the train arrives at the main town of Samedan, you will hear "Prosma fermeda Samedan" (next stop Samedan) whereas in the Lower Engadin village of Guarda (the setting for the delightful Schellenursli children's story) you will hear " Guarda – fermada sün dumonda" (Guarda – request stop). People from these regions recognise their local identity in the small linguistic nuance of the E of fermeda and the A of fermada; this might even prompt the attentive tourist to take an interest in the richness and variety of Rhaeto Romansh.

Bergün/Bravuogn > The name of the station is given in German and Romansh.
Rhaetian Railway

Albula line > A panorama carriage on the Landwasser Viaduct; the writing is in Italian and German.
P. Donatsch

So everyone – whether there is a sense of identification with the languages or not - has the opportunity of experiencing trilingualism as a concrete fact on every trip and of hearing the Latinate cantonal languages as they are used day in day out.
Rhaetian Railway employees are naturally also recruited from all three language areas. A scientific study of trilingualism in Graubünden concludes that the proportion of Romansh- and Italian-speaking employees in the company reflects the linguistic make-up of the canton. What is very important from a European perspective is the fact that a high percentage of the workforce is either bilingual or multilingual. Even in the staff bulletin, for example, information from senior management is published in Italian under the heading “La voce della direzione”. And from time to time the bulletin runs articles written by members of staff in Romansh. Clearly Rhaetian Railway personnel can rest assured that their views are taken seriously, despite being written in a minority language!

Advertising poster for St. Moritz created by E. Stiefel, 1920.
Kur- und Verkehrsverein St.Moritz/ KGMZ

2.b.9 The history of tourism in the Engadin

The Grand Hotels with their generously laid-out sports facilities, inviting lakeside promenades and paths along routes with spectacular views were already typical of the Upper Engadin when the Albula railway arrived in 1903. At that time, St. Moritz had already established its reputation as a playground for Europe's elite. But the railway initiated a second phase of this development. After a tourist infrastructure had been created and had become taken for granted, it became important to highlight the image of the resort by using culture, in particular art, as well as major sporting events to invent a local tradition and anchor it permanently in the collective memory.

The upsurge in tourist travel went hand in hand with a large-scale extension of the transport routes and the development of ever faster, more reliable, safe and comfortable ways of travelling. At their journey's end, visitors soon encountered not only simple lodgings and inns, but from the mid-19th century genuine Grand Hotels that offered exceptional comfort and also satisfied the demand for entertainment with dancing, theatre and concerts.
In his book *A Tramp Abroad* published in 1880, Mark Twain recorded the impressive changes in travel habits that had taken place during the course of the 19th century: "What a change has come over Switzerland, and in fact all Europe, during this century! Seventy or eighty years ago Napoleon was the only man in Europe who could really be called a traveler; he was the only man who had devoted his attention to it and taken a powerful interest in it; he was the only man who had traveled extensively; but now everybody goes everywhere; and Switzerland, and many other regions which were unvisited and unknown remotenesses a hundred years ago, are in our days a buzzing hive of restless strangers every summer." But what had produced this pervasive wish to travel? The eagerness of the European elite to travel to the mountains cannot be explained merely on the basis of better modes of transport. Rather, this desire was aroused by writers such as Albrecht von Haller, later Jean-Jacques Rousseau and Friedrich Schiller, with his glorification of William Tell, as well as numerous veduta painters. They contributed greatly to representing the Alps, which had hitherto been feared, as a paradise for visitors. Then came the English, with their sporting ambitions, who caused a furore with their first Alpine ascents and stimulated the collective enthusiasm for mountain climbing.

A new orientation

The modern history of tourism in the Upper Engadin begins around 1800 and is closely linked to the loss of a traditional way of life: the political reorganisation of Graubünden in 1797 (cf. 2.b.2) led to the Veltlin region being excluded from the canton, so that the Engadin lost its breadbasket. Left to itself, however, this high-lying valley could live from farming only to a very limited extent. The population had to seek new strategies in order to secure a livelihood. So it is characteristic that an open letter written by an anonymous hand addressed to *Ehrsame Gemeinde St.Mauritz, im Thal Oberengadin* (the honourable community of St. Mauritz in the Upper Engadin) appeared precisely at that time. It pointed out graphically to the leading figures how they

St. Moritz Bad > The Grand Hotel des Bains (Neues Kurhaus), photograph about 1930.
Dokumentationsbibliothek St. Moritz

St. Moritz > Cresta Run, photograph about 1930.
Dokumentationsbibliothek St. Moritz

St. Moritz > The Kulm-Park tennis courts, about 1900.
Dokumentationsbibliothek St. Moritz

could use the St. Moritz springs – already praised extravagantly by Paracelsus in 1538 – in a profitable way. By proposing tourism as a promising source of future income, this letter became an eloquent sign of a new beginning.

In fact, the extension of the springs had begun in 1815 and a modest infrastructure had been set up. Ultimately, the success of the first Kurhaus (pump-room) already required it to be enlarged shortly after its completion in 1856. The Neue Kurhaus was opened in 1864: with its imposing buildings set at an angle to the valley, 129 rooms as well as elegant reception rooms, it represented the first veritable Grand Hotel in the Upper Engadin. Like the subsequent buildings of its type, the Neue Kurhaus was designed to satisfy all the requirements of a demanding clientele in a single establishment. In this sense, it represented its own microcosm, rather like a luxury liner.

The arduous journey by coach over dusty roads and steep passes failed to dissuade visitors from undertaking a health cure in the Engadin; but it certainly explained why the travellers, when they finally reached their goal, stayed there for several months, more or less settled in for the duration, and appropriated the landscape. At a correspondingly early period, therefore, the local authorities organised themselves into a "beautification association", a predecessor of the Kurverein founded in 1874, that enhanced the landscape with paths and parks, benches with scenic views and lakeside walks for tourists. But the visitors themselves also made a significant contribution to extending the tourist infrastructure.

The landscape as playground

The first winter visitors during the 1860s, when the introduction of high-altitude treatments aroused hopes among many patients, had travelled to St. Moritz for health reasons. They were followed by a sports-oriented winter tourism that began in the 1880s. Chronicles from the period shortly after the turn of the century report: "English doctor J. F. Holland, who had already spent several winters in Davos with his patients at a time when the town had 1,000 winter visitors, arranged for a select company of English aristocrats to join him on a trip to St. Moritz in 1883. […] Almost the entire small English winter colony stayed at the Engadiner Kulm, which remained the only winter hotel for many years. Some 100–200 visitors came around 1885, while the number had risen to between 300 and 400 by the end of the 1880s".

With their inexhaustible enthusiasm for sport, these early, predominantly English, visitors initiated a spate of innovations. They saw to it that keen travellers (also from abroad) no longer perceived a winter stay in the Engadin as an exile imposed by ill-health, but rather as a time and place of manifold pleasures. *The St. Moritz Post,* a tourist newspaper founded in December 1886, whose editor-in-chief and voluntary contributors were based at St. Moritz's Kulm Hotel, served to disseminate such a viewpoint for the tourists. Under the expert guidance of these first visitors, ice rinks were built for curling and ice-skating. Intrepid sportsmen launched themselves in a prone position on toboggans down the Cresta Run, for the first time in 1884, and the Bob Run was added in 1903/4. In summer too, everything was laid on for sports and other leisure activities. At the instigation of the English visitors, the first tennis court was laid out in the Kulm Park, in 1893 the Engadin Golf Club was founded and the game was soon being played on an 18-hole course on the plain near Samedan – and has continued up to the present.

These facilities were created by the visitors themselves out of a desire to enjoy themselves,

Samedan > Golf course, about 1920.
Dokumentationsbibliothek St.Moritz

St.Moritz > A race on the bob run, about 1920.
Dokumentationsbibliothek St.Moritz

St.Moritz Dorf > The station on the valley's floor, left the Hotel Margna built by Nicolaus Hartmann the younger 1906/07.
Dokumentationsbibliothek St.Moritz

and gave the Upper Engadin an early reputation as the playground of an international elite. Supply and demand coincided in the pioneering period of tourism and together succeeded in founding a strong tradition. The awareness of having created a unique tourist infrastructure with runs and courses, which had to be carefully maintained and marketed, was already clear to the leading figures around 1907. At that time, an extensive winter sports exhibition was held in Berlin, and the persuasive Pastor Camille Hoffmann, who was also President of the St. Moritz Kurverein, was able to present his Engadin home-town in eloquent terms as the cradle of winter sports.

The train steams in

Ever since it had been decided to build the Albula railway, the question arose as to how the rail connections would impact tourism in the Upper Engadin. This question was firstly directed at specific problems and concerns such as at the lively and occasionally vehement discussions on the optimal track layout for the railway route in St. Moritz from a tourist angle (cf. 2.b.4 and 2.b.6). And the demand was naturally made that its construction should also consider the Cresta Run and Bob Run and bridge them elegantly, as they were already in place and thus had "right of way". The railway planners had to recognise that the Albula line did not run into a remote and wild Alpine valley, but into a carefully managed tourist landscape that had to be respected and even enhanced.

On the other hand, it had become necessary to reorient the entire resort in order to set its direction for the future. This is illustrated by the following excerpt from a treatise entitled *Über die Zukunft des Kurortes St. Moritz* (on the future of the resort of St. Moritz) written in 1898 by local doctor and later painter Peter Robert Berry: "Formerly, our feared mountain passes formed a natural and secure barrier against undesired intruders. This barrier will go when the Albula has been tunnelled through, and what then? Then there's no reason why consumptives should not just as well travel here as to Davos, especially if one were to build specific nests for them in the form of 'sanatoria' as an advertisement. This is a danger for St. Moritz that will certainly not go away if we close our eyes to it. On the contrary, the time has come to become aware of its gravity". So St. Moritz had to respond to the situation and decided, backed up by medical studies, to prohibit the building of sanatoria and make it consistently clear that consumptive patients were not welcome. On the meeting of the St. Moritz Kurverein concerning the impact of the Albula railway, which had in that year opened as far as Celerina, the local newspaper the *Engadin Express & Alpine Post* noted on November 14, 1903 that: "Pastor Hoffmann [had stressed] the necessity that the Kurverein and the entire winter resort of St. Moritz should unite, in putting aside all particular interests, on a joint approach, namely with a view to two great tasks: 1. A unanimous response to the question of consumptive patients, naturally in the sense that St. Moritz concisely explains that it is not a tuberculosis station nor intends to be one and therefore cannot accept any such patients; 2. the creation of a large communal ice rink on which international races can be held."

Scenic views

As the early tourist posters from around 1880 show, they initially focussed on assuring travellers, with the aid of timetables and by displaying various modes of transport in swift movement, that they would reach their destination. But when

Advertising poster “Chemins de fer de l’est” for the Upper Engadin by F. Hugo d’ Alesi, 1895.
Dokumentationsbibliothek St.Moritz

Advertising poster for ski races in St. Moritz by Walter Küpfer, 1911.
Dokumentationsbibliothek St.Moritz

this had been effectively achieved and the Albula railway entered the Engadin, the emphasis shifted somewhat. The posters were no longer designed to provide information, the railway had become part of the landscape and no longer needed to be highlighted, so the illustrators focused on evoking the local atmosphere and bringing the landscape and scenic views into the foreground. The large-scale project in which Engadin financiers and hoteliers joined local artist Giovanni Segantini in presenting a grandiose panoramic view of the Upper Engadin landscape at the Paris World Exhibition also fitted into this new approach to tourist advertising. Their aim was to highlight the tourist achievements of the 19th century and simultaneously present them to a broad public. However, these ambitious plans had to be abandoned shortly after their proclamation in 1897 due to a lack of funds. Ultimately, the cooperation between local tourist-based businesses and artists resulted in the more modestly dimensioned but artistically convincing Alpine triptych “Becoming, Being, Passing-Away”. And in 1908, a year before the triptych was shown to an arts-loving public in the Segantini Museum (cf. 2.a.4 and 5.h) built by Nicolaus Hartmann the Younger as a rotunda, the cableway on Muottas Muragl enabled travellers to experience the panoramic scene, previously painted on canvas, in three-dimensional reality. So one might say that technology had overtaken art within a few years: the railways had opened up landscapes that a wider public could previously only experience indirectly via paintings.

Boom in hotel construction

The railway triggered a veritable building boom. The St. Moritz Kurverein already spoke of a surge in the number of summer travellers in 1903. And it was expected that above all older visitors and families, who had previously been reluctant to venture over the snow-bound passes, would visit the Engadin in winter too.
One of the first and simultaneously most remarkable fruits of this renewed interest in investing in hotel construction was the imposing Grand Hotel. This major project, completed in 1905, was backed by a joint-stock company chaired by local worthies: Karl Koller was responsible for its architecture. Whereas the building was a shining example of profitable entrepreneurship, it was also a bone of contention for the newly founded Graubünden Heritage Society that was keen to ensure a link-up to local building traditions (cf. 2.a.3 and 2.a.4). They attacked the Grand Hotel, which was impressive and splendid but at the same time designed in a cost-effective way as a compact block, by calling it a “dividend box”. It had become an emblem of a new type of tourism that was for the first time aimed at a mass clientele made possible by the railway.
The Hotel Margna designed by Nicolaus Hartmann the Younger and built directly next to St. Moritz railway station was regarded by traditionally minded innovators as a counter-reaction and valid response to these new challenges in terms of both tourism and architecture. In their eyes, it satisfied the contemporary need for modern and comfortable accommodation, was adapted to the local topography and at the same time complied with traditional and locally rooted types of building in its typology, selection of materials and details. It became the yardstick for many other hotel buildings. Whereas the Hotel Margna is still standing today and continues to bear witness to the spirit of that time, the Grand Hotel burned down in 1944 while being used by the Swiss army as accommodation when it was closed to regular guests.

St. Moritz Dorf > Hotel Palace (left) and Grand Hotel, abut 1910.
Dokumentationsbibliothek St. Moritz

St. Moritz > Olympic ski jumping, 1928.

St. Moritz > The start for the 1928 Olympic bob races.

Upturns and downturns

When the First World War broke out, the great euphoria collapsed, all hotel construction was stopped by a federal decree and many tourist infrastructures fell largely into disuse. The old Grand-Hotel Association, forerunner of an active international community, was obliged to wind itself up. The Upper Engadin hotel trade had to endure years of stagnation and await the 1920s before an upturn occurred, reaching a new record in 1929 with 693, 162 overnight stays. But the Great Depression brought the industry to the brink again. Several establishments had to close and the number of recorded overnight stays had dropped by half in 1932.

The Winter Olympics of 1928 marked a high point of the halcyon years. And it is significant that the Rhaetian railway, the Resort and Tourist Association, the Graubünden Kantonalbank, hoteliers and the municipality i.e. the principal tourist institutions, all worked together, advertised for the great event and secured the necessary funds. As the centrepiece and core of the Games, architect Valentin Koch designed a simple and striking building in the modern classicist style in the Kulm Park, which forms a unique natural stadium together with the opposite hill and the broad plain. And it was here, at this symbolic place that celebrated a common objective, that the people of the Engadin started afresh in 1948: after the difficult and paralysing war years, the second Winter Olympics aroused renewed hopes and were seen as a sign of a new beginning. If St. Moritz had previously paid little attention to the spirit and the history of these two unique sports events in Switzerland, this was now to change with the planned Olympic museum.

In view of the increasing mobility of broad sections of the population and the associated social changes, the popularity of skiing and other winter sports increased significantly in the 1950s and 1960s. This period also saw the opening up to tourists of the ski areas of Furtschellas – Corvatsch, Corviglia (Piz Nair) as well as Diavolezza-Lagalb with ski lifts and cable cars. By running such major sporting events as the Engadin Ski-marathon and finally the 2003 World Ski Championships, the Upper Engadin further boosted its international reputation as a prime location for skiing and winter sports.

Contemporary witnesses

If the taste of the times and the newly awoken understanding of democracy led to the palatial hotels acquiring a certain notoriety after 1945, they were effectively rediscovered during the 1980s. The monument conservationists prepared inventories and there was renewed appreciation for the foundation period and its wish to create buildings of architectural significance. The post-modern period also involved a reawakening to history. Important publications appeared, such as Isabelle Rucki's *Das Hotel in den Alpen* (The Hotel in the Alps), that was dedicated for the first time to a comprehensive study of the history of hotel building in the Engadin. Thus the Kronenhof in Pontresina is a building of historical significance, testifying to the phases of its extension from a farmhouse to a Grand Hotel in an outstanding way. The reception rooms and their ceiling paintings by Otto Haberer, created in 1901, were expensively restored in the early 1990s on the basis of monument preservation principles and set a new standard for dealing with valuable hotel architecture in the Engadin. The major investments of recent years in traditional St. Moritz establishments such as the Kulm Hotel, Badrutt's Palace, the former Kurhaus and today's Kempinski, the Suvretta House and most recently the Carlton,

St. Moritz Dorf > The "world resort" with its striking backdrop of hotels seen from the lake.
R. Canal, Kur- und Verkehrsverein St. Moritz

St. Moritz Dorf > The Palace Hotel, symbolises the dazzling history of hotels in St. Moritz.
Badrutt's Palace Hotel

also bear witness to the fact that luxury hotels in particular have again become attractive to both investors and visitors.
Despite these positive developments, many less prestigious hotels are in danger of losing their historical heritage. This threat ultimately stems from their success in convincingly transmitting a picture of an exceptional combination of urban lifestyle, cultural landscape and mountain world. Their scenic situation leads to demands for more cost-effective solutions by demolishing buildings and rebuilding anew on the cleared terrain or for a lucrative reassignment of large buildings to become second homes. The development of tourism in the Upper Engadin was, from the outset, accompanied by a critical response to this process. The awareness of the balance of the unique co-existence of architecture, landscape and society has a long tradition; it was not least the critical voices from the Upper Engadin that had contributed to founding the Graubünden Heritage Society. The most recent example is the initiative designed to restrict the construction of second homes accepted in June 2005 by the Upper Engadin voters – another mosaic stone in the fascinating history of tourism in the Upper Engadin that can already look back onto a century and a half of development.

Engadin > Without the Rhaetian Railway events like the Engadin Skimarathon would hardly be feasible.
A. Mettler

2.b.10 The railway as important influencing factor for the development of tourism

There was some tourist activity in the valleys along the main routes, particularly in the Upper Engadin, before the Albula and Bernina Railway (1903/04 and 1908/10) opened them up to tourism. The new rail connections improved the accessibility of the region enormously, which was reflected in a great increase in the number of guests. As elsewhere, the demand for tourism in Graubünden was subject to considerable fluctuations over the past 100 years. It has become apparent that the Upper Engadin railway brought and brings the greatest economic benefits to the area. Various major events, particularly in sports (e.g. the Winter Olympic Games, the Engadin Skimarathon, World and European Championships in various disciplines) would be unthinkable without the Rhaetian Railway to provide the transport.

Railway – an impetus to tourism in Graubünden

Until the mid-19th century, tourism in Graubünden – then usually referred to as 'visitor traffic' – had little significance as an economic factor. It focussed, on the one hand on transit traffic across the passes of Graubünden, on the other on spa cures where the various spa bathing and therapy institutions provided the infrastructure. Alvaneu, St. Moritz and Le Prese were renowned spas in the Albula/Bernina catchment area. New medical findings on the curative effects of the mountain climate represented one factor contributing to the rapid development of tourism after the middle of the century, while the boom in winter sports was another. Previously relatively modest farming villages like Davos, Arosa, St. Moritz and Pontresina developed into smart destinations where the jet set from all over Europe would congregate.

Rail development in Graubünden largely took place against this background: easy access to the resorts, nature and landscape was to be assured for the tourists. The Graubünden narrow gauge rail network would never have been built so quickly – if at all – without impulses (and the prospect of profit!) from tourism. However, the railway-tourism relationship works both ways. It is uncontested that tourism has only been able to develop so well in Graubünden because a rail link ensured rapid, safe and reasonably priced access to the tourist destinations. Rail access meant that the major population centres in Switzerland and other countries, and thus potential holiday guests, 'moved closer' to Graubünden. Chur could already be reached by rail by 1858. With the "Engadin Express" Pullman train which started operation in 1895 (eight years before the Albula railway!) the cantonal capital of Chur could be reached from London in just 24 hours, and from Calais on the French side of the Channel in less than 20 hours. However, the rest of the journey from Chur to St. Moritz took at least 13 ½ hours. The railway cut the time for the trip from Chur into the Engadin dramatically.

Unfortunately there are few interesting tourism statistics for the Albula/Bernina catchment area in the period around the turn of the century, and these are not based on uniform sources. However, in the case of St. Moritz, we do know that the hotels there already had 4,000 beds in 1900; when all were occupied the number of guests was already two and a half times the number of inhabitants – which was then 1,600. The rail link gave tourism a new, powerful boost. Ten years after the Albula Railway came into operation, St. Moritz already had 6,000 beds for guests.

Tourism-induced population growth

A glance at the population growth in the region accessed by the Albula Railway (1903/04) and the Bernina Railway (1908/10) shows the following pattern:

Area	1888	1910	Index (1888 = 100)
Railway communities, Albula Valley (Thusis, Sils i.D., Tiefencastel, Surava, Alvaneu, Filisur, Bergün/Bravuogn)	3,065	3,705	121
Railway communities, Upper Engadin (Bever, Samedan, Celerina, St. Moritz, Pontresina)	2,510	6,390	255
Railway communities, Poschiavo Valley (Poschiavo, Brusio)	4,107	4,996	122
Rest of Canton Graubünden	85,128	101,978	120

Compared to developments in other parts of the canton, the Albula and Poschiavo regions in the period under consideration showed only slightly above-average population growth; in contrast, the population in the Engadin villages, now accessible both from the north and from the south, doubled in the same period.

Naturally it is questionable whether the population growth in the various areas can be attributed directly and exclusively to the rail access. Could there be other reasons for the over-proportional growth rate of the Engadin communities accessed by the railway? Even if this cannot be ruled out with absolute certainty, there are unmistakable indicators that the presence or absence of rail access to a community did play a significant role with respect to prosperity: thus, for example, the two villages of Sils in Engadin and Silvaplana, immediately adjacent to St. Moritz but without direct rail access, also showed population growth between 1888 and 1910, but with an index of 122 this was only half as high as in the Upper Engadin communities served by rail.

Rising rail frequency parallels the growth in tourism

For the time immediately after the opening of the Albula Railway (1903/04) there was a sharp increase in the traffic figures for the Rhaetian Railway:

Key figure	1902	1907	Index (1902=100)
Passengers transported	576,000	1,149,000	199
Kilometres per passenger	10,460,000	27,302,000	261
Goods transported (tonnes)	126,600	220,000	174
Freight-kilometres	3,931,000	9,084,000	231

In view of the relatively low population figure in the valleys served by the Rhaetian Railway at that time (1910: approx. 62,000 persons) the effect of the opening of the Albula stretch on tourism is patent both for the newly accessed regions as well as for the Rhaetian Railway itself.
Unfortunately, the figures in the Bernina Railway annual reports were not as detailed. However, it is clear that in the first full year of operation after the opening of the direct St. Moritz – Tirano line in 1910, some 333,000 passengers and 18,600 tonnes of freight were transported. In view of the low population of the Poschiavo valley (some 5000 inhabitants in 1910) these figures are very impressive; they show clearly the relationship between railway and tourism. The reciprocal dependence can also be demonstrated "negatively" with a glance at economically difficult times. In the pre-war years 1912 and 1913 transport volumes were on a par with 1911, but in 1915 they slumped to barely 75,000 passengers and 12,800 tonnes of freight.
The enormous dependence of tourism on economic and political circumstances is reflected in the growth pattern for overnight stays in St. Moritz:

1900: 125,000
1910: 372,000
1915: 119,000
1920: 211,000

Development of tourism in the Albula Valley, Upper Engadin and Poschiavo regions

Neither the Albula nor the Bernina Railway were entering territory unknown to tourism when they were opened. In 1905, the hotels, spas and boarding houses in the valleys served by the railway could offer:

	Hotels	Number of beds
Albula Valley (Thusis, Sils i. D., Tiefencastel, Alvaneu, Filisur, Bergün/Bravuogn)	22	880
Upper Engadin (Bever, Samedan, Celerina, St. Moritz, Pontresina)	76	6799
Poschiavo Valley (Poschiavo, Brusio)	14	318

The railway is the effective "lifeline of tourism" for the Albula Valley. More nostalgia trips with steam driven trains are planned for the future.
P. Donatsch

The stretch of road between Preda and Bergün/Bravuogn is closed in winter; it is then converted into a sledge run. The Rhaetian Railway trains bring enthusiasts to the start of the run.
A. Badrutt

Early tourism in the *Albula Valley* is connected principally with the Bad Alvaneu spa, which enjoyed its peak period in the mid-19th century. The spa had to close down in 1962 as it was no longer profitable, but was recently revived with the building of a thermal and indoor swimming pool (with adjacent golf course). To date, however, all the hotel beds in the community are in Alvaneu Village.

The construction of the Albula line was at once a threat and an opportunity for trade and tourism in the community of Bergün/Bravuogn. The flourishing traffic with the horse-drawn post coaches – they transported no less than 22,000 passengers in 1900 – was lost and with it the overnight stays of the guests who stopped over to “acclimatise” before moving on into the 400 m higher Engadin or simply because they needed a rest after the rigours of their journey. Consequently many well-established jobs were lost. However, the improved access assured by the railway did eventually boost tourism in Bergün/Bravuogn – even if it developed gradually and was not spared some very hard blows, as shown by the recent temporary closing down of three major hotels. Today tourism in Bergün/Bravuogn is oriented principally to the family holiday segment: the proportion of overnight stays in self-catering accommodation (80 %) is also correspondingly high compared to the cantonal average of 51 %.

In winter, the road over the Albula pass is closed from Preda onwards in view of the very high snow clearance costs and the potential danger to road traffic from avalanches. The commissioning of the Albula railway opened up new ways of utilising the terrain. From 1904 the stretch of road from Bergün / Bravuogn to Preda was used as a bob run during the winter half-year; after World War II it became a sledge run for the general public. Since 1973 the Sportbahnen Bergün sports facilities have been offering a wide range of other activities for winter sports fans.

The Rhaetian Railway mountain transport was and is essential to bring people to the 6 km sledge run between Preda and Bergün/Bravuogn. All in all, the railway is now recognised as the “lifeline of tourism” not only in Bergün/Bravuogn but for the whole region. Consequently, since 1999 the marketing concept for the entire Albula valley focuses on activities and attractions particularly close to the railway (cf. 5.h). These include the railway adventure trail along the Preda – Bergün/Bravuogn-Filisur route, the planned railway museum in Bergün/Bravuogn, the impressive model railway in Bergün’s local museum and the planned nostalgia trips on the Davos line with trains pulled by steam locomotives.

The *Engadin* is one of the best-known holiday destinations worldwide, principally due to St. Moritz and Pontresina. Many pioneering steps in tourism were initiated in this region. A “Fremdenverkehrs- und Sommer-Verschönerungsverein” (“Visitor Traffic and Summer Enhancement Association”) was founded very early in St. Moritz, namely in 1864. The first electric lighting in a hotel was installed on the initiative of the famous hotelier Johannes Badrutt in 1879. And the first electric tram in Switzerland did not run in urban surroundings, but linked St. Moritz Spa and St. Moritz Village from 1892. The variety of leisure activities offered in the Engadin was already striking in the 19th century (cf. 2.b.9); they were renewed continually and adapted to the needs of hordes of international guests: in particular, the potential of the winter sports that started to develop in the second half of the 19th century was recognised early. The cableway on Muottas Muragl was built in 1907 and the one from St. Moritz to Chantarella in 1913

St. Moritz > Major sports events like the World Alpine Skiing Championships in 2003 have been and are highlights on the Engadin tourism calendar.
P. Blarer

Silvaplana > Over 70% of the some 12,000 – 13,000 participants of the annual Engadin Skimarathon use public transport.
A. Mettler

Bergün/Bravuogn > The Glacier Express links St. Moritz with Zermatt (Canton Valais) and carries 250,000 passengers every year.
A. Badrutt

(continued up to Corviglia in 1927). They were followed by Pontresina – Alp Languard (1945), Corviglia – Piz Nair (1955), Bernina – Diavolezza (1956) and Celerina – Saluver (1958). Numerous ski lifts were erected around the mountain railway stations; many of these have recently been replaced by comfortable cable cars that are independent of the terrain and offer protection from the elements.

Various major sports events have marked and still mark the tourist calendar in the Engadin; notable among them were the Olympic Winter Games in 1928 and 1948, the Skimarathon that has been held annually since 1969, the regular European and World Bobsleigh Championships, several World Championships in Alpine and Nordic skiing, World Cup races etc. An increasing number of major cultural events have also become established here.

These events always involve the transport of participants and spectators on a scale that could hardly be managed without the railway. The capacity of the current road network is restricted and expansion faces not only financial problems but clashes increasingly with ecological and even tourism interests. The most recent studies show that 70 % of the approximately 12,000 – 13,000 participants of the Engadin Skimarathon use public transport.

The railway is far more than a means of transport appropriate for conveying large numbers of passengers. It offers excursion visitors and holiday guests a more attractive means of planning their trips there and back. The proportion of rail to overall traffic entering the Upper Engadin is very high with 30%. Besides, other resorts and regions can also be visited from the Engadin by rail. The Rhaetian Railway's "Glacier Express" plays a special role here. The train that has been plying regularly between St. Moritz and Zermatt in the Canton Valais since 1930 carries over 250,000 passengers a year.

As in the Albula Valley and in the Engadin, the beginnings of tourism in the *Poschiavo Valley* go back to the mid-19th century and the appeal of spa cures. In 1857 a hotel with therapeutic sulphurous baths was built in Le Prese (today the Hotel Le Prese). However, the Ospizio Bernina hotel on the summit of the Bernina Pass was opened under other auspices; the valley of Poschiavo – often referred to as the Lost Valley – was gradually "discovered" by guests staying in the Engadin. The "Pro Poschiavo" association was already founded in 1903 (followed in 1958 by "Pro Brusio"), with the objective of promoting the hotel trade and marketing the scenic attractions of the valley; the organisation is still active today under the name of "Ente turistico Valposchiavo".

It was the commissioning of the Bernina Railway, realised in various phases between 1908 and 1910, which significantly boosted the attraction of Poschiavo for tourism. The alignment of the track was planned to take the tourist aspects into account i.e. to highlight the spectacular natural drama of the landscape.

Tourism in Poschiavo grew gradually, in step with the highs and lows of national and international economic development, though it was primarily oriented to the summer visitors. The number of hotel overnight stays has more than quintupled since 1947, amounting to some 57,000 today. Guests can enjoy a southern atmosphere in one of the most varied landscapes in Switzerland as well as a number of historic cultural attractions.

The Rhaetian Railway's "Bernina Express" is essential to tourism in the Poschiavo valley. The direct link between Chur, the capital town of Graubünden and the Italian border town of Tirano, commissioned in 1973, now carries 200,000 passengers a year.

The Rhaetian Railway's "Bernina Express" is essential to tourism in the Poschiavo Valley.
P. Donatsch/Rhaetian Railway

Tirano > The Italian border town of Tirano marks the end of the trip for the "Bernina Express".
P. Donatsch/Rhaetian Railway

Influence of the railway on tourism in Tirano

The railway line from Sondrio to Tirano was opened in 1902. Six years later the first Bernina Railway train from Graubünden in Switzerland arrived in Tirano. The construction of the railway gave an impetus to the economy and to the fledgling tourist industry. Tirano developed into an important hub for tourism towards the mountain passes of Stelvio and Bernina. A heavy transport association and two tourist bus companies were founded in the town. There had been a bus link on the road between Tirano and Bormio since 1905.

The railway also provided the impetus for the construction of two important hotels in Tirano: the Hotel Merizzi and the Grand Hotel Tirano (that remained open until the 1980s), both near the railway station. The Grand Hotel was open all the year round. The bus station for post buses to Bormio, S. Caterina, Livigno, Stelvio, Trafoi Merano and Aprica-Ponte di Legno-Tonale is also located here. Both hotels enjoyed the ambiance and elegance of early elite tourism, a lifestyle that was in vogue in the Lombardy Alps at the turn of the century. The roads and railway linked these hotels to the spas and clinics of Switzerland and Italy. This network included the hotels at Bellagio, Cadenabbia and Tramezzo on the lake of Como and the high-altitude resorts of Bormio and S. Caterina but connections extended as far as St. Moritz and other resorts further afield like Merano and Nice. In fact, at the beginning of the 20th century, Tirano gave its tourists the opportunity of changing direct from the train coming from Nice to that going to St. Moritz on the same platform.

3. Justification for Inscription

Albula line > The steep climb between Bergün/Bravuogn and Preda called for a complicated alignment with numerous engineering structures. A Rhaetian Railway passenger train crossing the Albula Viaduct III.
Foto Geiger

3.a Criteria under which inscription is proposed (and justification for inscription under these criteria)

The property is nominated according to Criteria i, ii and iv pursuant to Article 77 of the *Operational Guidelines for the Implementation of the World Heritage Convention* on the following grounds:

Criterion i

The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" is an exceptional masterpiece of creative genius generated by the interaction of aesthetic standards, engineering acumen, technical innovation and perfect craftsmanship in a *Gesamtkunstwerk*. It is the outcome of the outstanding cooperation of wide skills with a highly innovative approach and handling of difficulties.

Criterion ii

The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" is a pioneering work of modern engineering and architectural structures that exhibits the important interchange of human values on innovative technical developments in the early 20th century. It is an excellent example of a harmonious relationship between human interaction and natural beauty, exemplary of the perception of the Alps as a sublime experience of the relationship between nature, culture and technology.

Criterion iv

The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" is an outstanding example of a technological ensemble which illustrates the zenith of the golden age of mountain railways. It has also exerted a powerful influence on how the Alps have been perceived over the years.

Bernina line > The daring alignment at Alp Grüm ensures an unimpeded view of the landscape.
C. Gilli /Rhaetian Railway

3.b Proposed Statement of Outstanding Universal Value

In exceptional fashion, the "Rhaetian Railway in the Albula/Bernina Cultural Landscape" is an example as unique as it is typical of a mountain railway integrated into an Alpine landscape. The Albula line, with its spectacular alignment and original engineering structures that represent a most impressive technical achievement, is an outstanding 'product' of the golden age of high altitude railways. From the outset, it was recognised as a transport route most harmoniously embedded in the landscape. The Bernina railway, as an electric surface railway at exceptionally high altitude and with extreme upgrades, is a unique example of the application of a technology that was highly innovative about 1900, but would soon become widespread. What is more, the development of its alignment was planned with a view to the best possible integration into the surrounding landscape. The Albula/Bernina line, as a railway that traverses an entire mountain range, links three distinct linguistic and cultural regions. To this day, it remains in full service, transporting both passengers and goods.

The combination of two different kinds of mountain railway – on the one hand with crest tunnels (and the equally technically demanding spiral tunnels) and on the other a surface electric railway crossing a high altitude mountain pass in the open – make the Albula/Bernina line simultaneously unique and typical, an outstanding example of a railway in the mountains. Its major role in the history of railway construction and the quality of the achievement established the basis for the worldwide recognition it has enjoyed ever since it was first brought into service. It is essentially different from the mountain railways already figuring on the World Heritage List: the Albula line, as a masterpiece, constructed with lavish planning and excellent craftsmanship, represents the archetype of the mountain railway from the golden age of rail. With its many stone viaducts of varying heights and lengths, the complex, sometimes overlaid structures of the helical tunnels and the long crest tunnel, the meticulous and architecturally valuable design of the elevated structures, and finally the actual operation itself, it displays all the characteristics of a mainline railway, even though it was constructed with a narrow gauge. The Bernina line, on the other hand, an electric surface railway at a high altitude and with the extreme gradient of 70‰, opened up new technical territory and introduced a new type of railway which would soon become widespread. The Albula/Bernina section represents a special type of "high-altitude mountain railway": over a distance of some 130 km and with a maximum difference in altitude (1,550 to 1,700 m) it crosses a mountain range, from one side to the other. While the "Semmeringbahn" UNESCO World Heritage Site marks the beginning of accessing mountainous areas by rail, the Albula/Bernina line represents the golden age of mountain railway construction: it was only with the development of mechanical tunnelling machines in the second half of the 19th century that long tunnel constructions and special types of tunnel (such as spiral tunnels) could be erected within acceptable time and cost constraints. The construction of alpine mountain railways came to an end with the First World War. Since then, no new trans-alpine railways have been completed, while spiral tunnels no longer feature in contemporary rail construction.

The construction of the Albula/Bernina line was rendered possible by an exceptionally creative exploitation of technical, economic and socio-cultural influences. An important goal which was promoted by the construction of the railway, was to preserve the diverse cultural and linguistic areas within the canton of Graubünden. In view of the topography, the Albula line was laid out as a narrow-gauge railway, but its design and operation followed the pattern of a mainline (standard gauge) railway. The aim was to facilitate access to the Engadin, in both summer and winter. Thus the railway contributed to the development of a new branch of the economy, namely winter (sports) tourism. Indeed tourism was to become the main industry in the region. The railway line was integrated subtly into the diversified cultural landscape and continues to enrich it today. The Bernina line was a product of the hydroelectric projects, built on Italian initiative, to generate power for the Lombard metropolis of Milan, and exploited the capital released by these projects. Moreover, the concerns of tourism were taken into account by aligning the track to ensure an exceptional ‘mountain experience’ from the comfort of the train. To satisfy these special conditions, the latest technology was used to construct the high Alpine railway as an electrical surface operation. The “Rhaetian Railway in the Albula/Bernina Cultural Landscape” is an exceptional example of a masterpiece created by a unique and diversified interplay between economics, politics, engineering, culture and nature.

Even at the time the railway was built, the outstanding quality of the landscape to be traversed was recognised and deemed worthy of preservation. Emphasis was put on harmonious integration of the railway infrastructure, while at the same time the alignment – particularly in the case of the Bernina line – was planned, as far as possible, to present the landscape to the traveller in all its magnificence as a landscape experience. The structurally created measures to enhance perception of the landscape during a rail journey together with the railway landscaping realised during construction are unique in the early 20th century. The experience of the exceptional views is an inherent element of the quality of the property. The “Rhaetian Railway in the Albula/Bernina Cultural Landscape” displays emblematically this synthesis of nature, culture and technology which has exerted a powerful influence on how the Alps have been perceived over the years: a vignette of cultural history.

Bernina line > The train crosses the 2,253 m Bernina Pass in the open giving passengers an uninterrupted view of the mountain panorama.
P. Donatsch / Rhaetian Railway

3.c Comparative analysis (including state of conservation of similar properties)

3.c.1 Identifying comparable railways

The aim of the comparative analysis is to show that the potential UNESCO World Heritage Site of the “Rhaetian Railway in the Albula/Bernina Cultural Landscape” is of an exceptional and universal value that transcends specific countries, periods and cultures. Both its particular and shared features, i.e. its unique and typical aspects, will be highlighted with reference to comparable railways.

The comparison will be made systematically and on the basis of transparent criteria. The first object is to select a number of railways for a detailed comparison i.e. the development of a method for the selection of comparative railways throughout the world. Secondly, the relation between those railways and their environs will also be compared.

The views from the railway and on to it (landscape perception) as well as other functional points of contact with the surrounding landscape enhance the intrinsic value of the Albula-Bernina railway: they have been incorporated in the buffer zone and duly protected (cf. 1, 2 and 5). The aim to integrate the engineering structures of the railway line in the cultural landscape contributes to the quality of the property as well and will be compared with the circumstances surrounding the comparative railways. It is therefore appropriate to consider the various functions of the environs of comparable properties in this respect. Consequently, the comparative properties were also analysed from the aspect of “Railway lines within their surrounding landscape”.

Type definition

A group of international experts was set up to identify the comparative railways. It comprised Prof. Robert Lee (Sydney, Australia), Mag. Günter Dinhobl (Vienna, Austria), historian of technology, Dr. sc. techn./dipl. Arch. ETH Hans-Peter Bärtschi (Wintherthur, Switzerland), historian of industry, and Gion Caprez (Chur, Switzerland), specialist in the history of the Rhaetian Railway. The Director of the Institute for Railway Studies & Transport History, Prof. Colin Divall, (York, UK), agreed to produce an expert opinion and act as external consultant to the study.

In a first step, the world was subdivided into six regions for separate examination:

> Oceania, East and South Asia
> South and West Asia
> Africa
> South America
> North and Central America
> Europe

The railways comparable with the Albula/Bernina line were selected on the basis of the categories proposed on the occasion of the *1st World Railway Heritage Conference* held on March 16, 1998 (cf. the ICOMOS study *Railways as World Heritage Sites*, 1998). The proposal made at that time was to subdivide the railway lines into:

> Main lines
> Colonial lines
> Mountain railways, and
> Narrow-gauge railways.

This categorisation was used at the Conference to evaluate the subsequent UNESCO World Heritage Site of the “Semmeringbahn” in Austria both as a main line and a mountain railway. The two Indian railways of “Darjeeling” and “Nilgiri” were also inscribed in the UNESCO World Heritage List: they were categorised as colonial railways but at the same time as mountain railways and narrow-gauge railways. The Albula/Bernina railway can also be assigned to three different classes on the basis of these criteria: it is a narrow-gauge railway, a mountain railway and – in its section between Thusis and St. Moritz (Albula route) – structurally also a main line railway (whose route parameters and structural design are adapted to mainline standards, cf. 2.a.3). This composition – a narrow-gauge main line located in a mountain region – was decisive for selecting the international comparative railways. These were consequently – with two deliberate exceptions – restricted to those railways that satisfied these criteria.

The special case of mountain railways

In the mountain-railway category, a distinction must be noted that has become established in the German-speaking area: that between a “Gebirgsbahn” and a “Bergbahn”.

Mountain railways of the “Bergbahn” type

These railways are used to open up mountain regions to economic activity, either to tourism, to agricultural use or for mining. Some of them were built in isolation, i.e. with no connections to railways linked to the major network. When used for tourism, they are usually operated only on a seasonal basis. So mountain railways of the “Bergbahn” type are not comparable with the Albula/Bernina line and are therefore outside the scope of the present analysis.

Selection of high-altitude mountain railways of the “Bergbahn” type

Country	Connection	Gauge	Culmination point [1] [m]
USA/Colorado	Manitou Springs – Pike’s Peak (Manitou & Pike’s Peak)	Normal, Z	4302, Pike’s Peak
USA/Colorado	Silver Plume – Mt. McClellan	914 mm †	4159, Mt. McClellan
Switzerland	Kleine Scheidegg – Jungfraujoch (Jungfrau Railway)	Metre, Z	3454, Jungfraujoch
Switzerland	Zermatt – Gornergrat (Gornergrat Railway)	Metre, Z	3088, Gornergrat
Germany	Garmisch-Partenkirchen –Zugspitze (Bavarian Zugspitze Railway)	Metre, Z	2650, Schneeferner
Switzerland	Brienz – Rothorn	800 mm, Z	2349, Rothornkulm
Switzerland	Alpnachstad – Pilatus-Kulm (Pilatus Railway)	800 mm, Z	2070, Pilatus
Switzerland	Lauterbunnen – Grindelwald (Wengernalp Railway)	800 mm, Z	2061, Kleine Scheidegg
Australia	Perisher Blue (underground Skitube 1986)	Metre, Z	2054, Perisher Blue
Switzerland	Glion – Rochers-de-Naye	800 mm, Z	1973, Rocher de Naye
Switzerland	Wilderswil – Schynige-Platte	800 mm, Z	1967, Schynige Platte
Spain	Ribas-Caralps – Nuria	Metre, Z	1964, Nuria
USA/NH	(Bretton Woods) – Mount Washington	Normal, Z	1918, Mount Washington
France	Chamonix – Montenvers	Metre, Z	1913, Montenvers
Austria	Puchberg – Hochschneeberg	Metre, Z	1798, Hochschneeberg
Switzerland	Arth – Rigi	Normal, Z	1750, Rigi-Kulm
Austria	Brannenburg – Wendelstein	Metre, Z	1723, Wendelstein
Switzerland	Capolago – Monte Generoso	800 mm, Z	1620, Monte Generoso
Switzerland	Aigle – Leysin	Metre, Z	1453, Leysin
Great Britain	Llanberis – Snowdon Mountain	800 mm, Z	1064, Snowdon
Japan	Yokogawa – Usui Toge	1067 mm*, Z †	940, Usui Toge

Z = cog system
[1] various figures are quoted for highest stations or culmination points
* 3.5 feet, also known as Cape gauge
† closed down

Mountain railways of the "Gebirgsbahn" type

The term "Gebirgsbahn" has become accepted in the German-speaking area for a railway that traverses a mountain massif or range in its entirety. For a long time, mountains represented an obstacle to human movement and acted as barriers for the regions on either side. As a result – despite quite short physical distances in some cases – these became the scene of various cultural developments manifested in the diverse characteristics of the individual cultural landscapes. Consequently, a mountain railway of the "Gebirgsbahn" type often has particular importance from a cultural or cultural-landscape viewpoint, as it represents the technological connecting infrastructure between cultural areas separated from each other by the local topography. In the Alps, for instance, the southern cultural area has a Romance character, whereas the northern one is Alemannic.

Railways of this type are usually integrated into larger super-regional railway networks (e.g. railways in low-lying and hilly country).

In his railway encyclopaedia *Enzyklopädie des Bahnwesens* (Railway Encyclopaedia), a standard work published in 1912, Victor Röll characterises mountain railways of the "Gebirgsbahn" type as possessing the following features:

> Prolonged steep gradients
> Numerous curves
> A complex layout on steep slopes high above the valley floor
> Reach a significant height
> Extensive safety measures protecting against snowdrifts, avalanches, rockfalls and mudslides
> Sometimes traverse major deep-cut valleys and waterways that have to be diverted to prevent flooding of the railway track.

Fürst's lexicon *Der Verkehr auf dem Land* (Vol. II) (Transport on land) from 1924 lists the elements along the route of "Gebirgsbahn" railways that allow major differences in altitude to be overcome:

> Setting-back tracks
> Circumventing the mountain
> Tunnelling under it
> Loops in tributary valleys
> Helical and spiral tunnels

Taking all these factors into account, the Albula/Bernina must be classified as a 'Gebirgsbahn'.

Comparative railways >

1 Yunnan Railway	Vietnam / China
2 Darjeeling Railway	India
3 Nilgiri Railway	India
4 Eritrea Railway	Eritrea
5 Guayaquil&Quito Railway	Ecuador
6 Denver&Rio Grande Railroad	USA
7 Train Jaune	France
8 Semmering Railway	Austria
9 Gotthard Railway	Switzerland

Selection

A list of all existing mountain railways of this type would exceed a thousand. Ascanio Schneider mentions 170 railway lines in his hitherto unique overview *Gebirgsbahnen Europas* (Europe's mountain railways), first published in 1967, for Europe alone. Further delimitation short-listed only those mountain railways with culminating points above 1,000 m or 3.230 feet. This delimitation is also used in British publications, such as the *Guinness Book of Rail Facts* of 1979. Even then, that left more than 100 technically comparable routes for selection, although some routes, like a number of those opened in China since 1960 with culminating points above 1,000 m, were excluded due to a lack of specific data. In cooperation with the staff of *Fahrplancenter-News*, a journal that reports on the latest developments in railways outside Europe, the railways best suited for comparison with the Albula/Bernina line were selected for further evaluation from the lists for each world region according to the above criteria. These remaining 46 railways were examined in depth in a transparent way on the basis of the following detailed comparison criteria and subsequently evaluated:

> **Construction period:** (a) early high-altitude railways up to and including the Gotthard Railway (1882); (b) railway structures built up to the First World War (before 1915) or (c) more recent railways built after 1915.

> **Difficulty and attractiveness** of embedding the route in the local topography.

> **Alignment:** (a) largely original; (b) slightly changed; (c) greatly changed.

> **Density of engineering structures** (tunnels, bridges, cuttings, embankments): (a) very high; (b) high; (c) low.

> **Equipment:** (a) with rare/early/innovative power supply; (b) with largely original or significantly changed superstructures; (c) with rolling stock from the period of construction or electrification.

After consultation in the expert group, the selection for the detailed comparison was restricted to one railway for each world region. In view of the exceptional importance of Europe both for the development of the railways in the 19th and early 20th centuries as well as for modern tourism, three railways were selected for this region. The railways already listed in the UNESCO World Heritage List were also used as comparison railways. This explains the inclusion of the Semmering Railway, whose culmination point is below 1,000 m.

The following railways were selected for a detailed comparison:

> **Oceania, East and South-East Asia:** *Yunnan Railway*, Vietnam/China

> **South and West Asia:** *Darjeeling and Nilgiri Railway*, India

> **Africa:** *Eritrea Railway*, Eritrea

> **South America:** *Guayaquil&Quito Railway*, Ecuador

> **North America:** *Denver&Rio Grande Railroad* (especially *Cumbres & Toltec Scenic Railway*), USA

> **Europe:** *"Train Jaune"*, France

> **Europe:** *Semmering Railway*, Austria

> **Europe:** *Gotthard Railway*, Switzerland.

Making the comparisons

The comparative analysis of the railway line was performed on the basis of its significance in terms of its technological and economic history. The visual and functional relationships to the buffer zones of the comparative railways will be analysed in a second part. This data, initially divided up into regions, will finally be combined in a third step to produce an overall view of the *unique* and *typical* features of the Albula/Bernina railway corridor.

Comparison of railways (core zone)

The first part of the analysis compares the selected railway routes, whereby each section is preceded by an overview of the railways in the respective world region. Here attention is drawn explicitly to the pioneer character of the work, particularly with respect to the tabular breakdown. This is followed by a detailed study, performed on the basis of a standardised grid, of the selected railway lines covering the following points: "construction history"; "line layout and railway structures" and "operation and equipment". A comparison with the Albula/Bernina line is made at the end of each chapter.

Comparison of the surrounding countryside (buffer zone)

The second section of the comparison focuses on the countrysides that surround the railway lines or in which the latter are embedded. In this section as well, the comparison is made systematically on the basis of a standardised survey grid comprising four sectors: "agriculture"; "structures"; "transport routes" and "perception". As in the railway comparison, this section also concludes with a comparison with the Albula/Bernina.

3.c.2 Comparison of railways

Oceania, East and South-East Asia

Railways came rather late to densely populated East Asia and the sparsely populated “fifth continent” of Australia. The most outstanding achievements in railway construction were realised in Japan and China.

From 1872 onwards a rail network in Cape gauge (1,067 mm) was introduced on all four of the main Japanese islands. In Honshu, there are several cross connections with a pronounced mountain railway character. The Shinkansen (New Trunk Route) standard-gauge network, which opened in 1964 and was intended for high-speed transport, without a doubt, marked the most important milestone in railway traffic after the Second World War. This line incorporated not only two of the longest tunnels in the world, but also the world’s densest succession of earthquake-proof civil engineering works.

After the Second World War, China restored the colonial railway network from the second half of the 19th century. With the exception of the Yunnan Railway, the mountain railways providing access to the interior were all opened after 1950. The latest Chinese mountain railway – first brought into use in 2006 – connects the Chinese heartland with Tibet and crosses over a 5,000 meter high mountain pass; no other railway in the world travels at such high altitudes. The current Chinese railway network also includes the Manchurian segment of the Trans-Siberian Railway, built between 1891 and 1903, and its bypass route, the Amur Railway, built by Russia after the Russo-Japanese War (1904/05). Due to the construction difficulties, the Amur Railway could not be brought into operation until 1916. The Transiberian is the oldest East Asian mainline railway in continuous operation. It runs on the segment between Chita and Ulan Ude at over 1,000 m.

With the exception of the so-called “Great Zig Zag” – the oldest mountain railway line in this part of the world (opened in 1868) and the best known railway monument in Australia – the majority of the mountain railways in Australia and New Zealand have their highest points at below 1,000 m. The Great Zig Zag travels over the Great Dividing Range of the Blue Mountains, with its highest point at an altitude of 1,114 m in the Lithgow Valley. The original route was replaced by a direct railway line in 1910; today a museum railway is operated on the older route which, however, does not have the original standard gauge; the rail line was reconstructed in the narrower Cape gauge (1,067 mm).

The South-East Asia railway network is characterised by the colonialist efforts to build an uninterrupted meter-gauge connection from India to China. The unfinished segment of this route, between Thailand and Myanmar (Burma), was built during the Second World War by Japan, which occupied large areas of South-East Asia at that time. Parts of this South-East Asian meter-gauge network can be classed as mountain railways.

The railway network in Indonesia dates back to the period of Dutch colonial rule – this was the first and originally also the densest in the whole of Asia. Several of its lines it have mountain railway features. Worthy of mention is the cog railway to the collieries in West Sumatra, as it travels from the sea port to an altitude of 1,154 m.

Mountain railways in Oceania, East and South-East Asia (a selection for China) with highest points over 1,000 m

Country	Connection	Gauge	Highest Point in m 1)	Opened 2)
China	Qinghai/Xining – Lhasa (Tibet Railway)	Normal	5072, Tangula	2006
China	Wuwei – Shibalipu (Silk Road)	Normal	2400, Shibalipu	1962
China	Urumqi – Kasachstan (Silk Road)	Normal	2400, Tunnel Wushaoling	2006
China	Lanzhou – Xiling	Normal	2300, Xiling	1960
China	Chendu – Kunming	Normal	2300, Samala	1970
Vietnam, China	Haiphong – Kunming (Yunnan Railway)	Metre	2026, at Yiliang	1910
China	Nanning – Kunming	Normal	2000, Kunming	1998
China	Peking – Suiyuan	Normal	1585, Suiyuan	1970
China	Baotou – Lanzhou	Normal	1560, Lanzhou	1958
China	Xian – Lanzhou	Normal	1560, Lanzhou	1952
China	Zhongwei – Baoji – Lanzhou	Normal	1560, Lanzhou	1960
Vietnam	Thap Cham – Da Lat	Metre, Z	1463, Da Lat	1933
Japan	East Koumi – Nobeyama (JR East Koumi Line)	1067 mm*	1345, Nobeyama	1919
Myanmar	Mandaly – Myitkyina (Burma Railways)	Metre	1405, Kalaw	1921
Indonesia	Padang – Kota Baru (West-Sumatra Coal Mine)	1067 mm*, Z	1154, Kota Baru	1891
Australia	Lithgow Valley – Clarence Tunnel (Great Zig Zag)	Normal, 1067 mm*	1114, Blue Mountains	1868
Russia	Ulan Ude – Chita	1524 mm	1040, Jablonovyi	1900

1) various figures quoted for highest stations or culmination points
2) various figures quoted for part or generally continuous opening
* 3.5 feet, also called Cape gauge
Z cog system

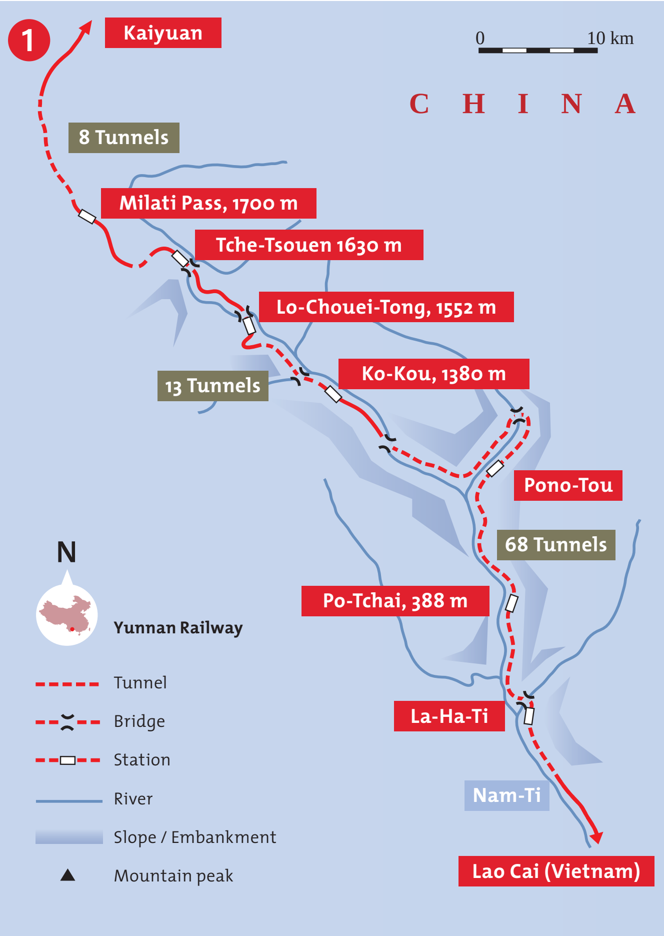
Yunnan-Bahn, Vietnam/China

The choice of the Yunnan Railway for comparison with the Albula/Bernina line was based on the following criteria:

> Construction period comparable with the Albula/Bernina line
> Narrow gauge
> Outstanding contemporary construction work and engineering achievements
> Overcoming of large differences in altitude (several vegetation zones)
> Still in operation

Construction history

The Yunnan Railway connects the Vietnamese seaport of Haiphong with Kunming (formerly Yunnan Fou), the capital of the Chinese Province Yunnan and located on a high plateau at and altitude of 1,900 m, between the rivers Yangtse and Yuan Jiang. Kunming, an ancient trading centre, acquired a strategic importance with the French colonisation of Indo-China and the English expansion in East India in the last quarter of the 19th century. Both of these colonial powers pushed on towards Yunnan with railway constructions. In the 1880s Britain built a mountain railway from Rangoon to Lashio, in the heart of Myanmar. From there the route progressed on the road (Burma Road) high above the canyons of the Salween and the Mekong to Dali and then on to Kunming. A rail connection between Xiaguan, near Dali, and Kunming was opened in the middle of



Yunnan Railway > Mountainous section.
H.P. Bärtschi

Yunnan Railway > Bridge at km 83 with works train. Photograph 1906.
Edition Si-An

Yunnan Railway > Haiphong station, built 1903. Photograph 2003.
H.P. Bärtschi

Yunnan Railway > Bridge on the delta of the Red River. Photograph 2003.
H.P. Bärtschi

the 1990s. France, for its part, built the Yunnan Railway. The origins of the project date back to the year 1897, when Paul Doumer, in his function as the French Governor General of the Annam colony (Vietnam, Laos, Cambodia), drafted a meter gauge network to open up the colonial empire. The core element was the *Ligne impériale de l'Indochine*, between Phnom Penh and Yunnan. From 1898 to 1899 the *Société de Construction des Chemins de Fer Indochinois* carried out survey work for the line routing of the Yunnan Railway. Under the engineer Guillemot, the accredited surveyors proposed a line routing from the port railway in Haiphong over Hanoi and along the Red River to Lao Cai (today Vietnam). A dispute arose on how best to overcome the sharp gradient that starts there; this led to adjustments of the originally planned alignment during the construction work. Eventually a deviation from the main valley was made which allowed the track to follow the contours of several side valleys. In the most difficult segment, between Lao Cai and Mengzi, 149 tunnels, mostly short, were planned. In 1901, even before the start of construction work, the financing had to be reorganised with the *Compagnie Française de Construction des Chemins de Fer de l'Indochine et du Yunnan*. The realisation of the 861 km rail line began in the river delta, and the segment between Haiphong and Hanoi was completed in 1903. In 1906 Lao Cai was reached. The completion of the demanding mountain segment would not have been possible without several additional subsidies. Around 60,000 local workers were reckoned to have been involved in the realisation of this ambitious project, for which the construction site managers were mainly recruited in Italy. In addition, 8,000 horses and mules were used as beasts of burden. The construction work was eventually completed in 1910.

Feeder lines

Work began on the construction of a 160 km long Y-shaped network, in 600 mm gauge, in 1915. The line, which began at Mengzi, was built to provide access to the coal mining areas in the southern Chinese provinces of Gejiu and Baoxiu . Further connecting rail lines, tangent to the Yunnan Railway, led to the Sa Pa mountain health resort near Lao Cai and to the "Petrified Forest" at Shiling near Kunming. Around 1970, China completed the standard-gauge high mountain segment from Kunming to the northerly Chengdu, as well as a railtrack along the coastline, from Nanning to Hanoi, and in 1997 a similar standard-gauge railway connection was opened between Nanning and Kunming.
In the late 1990s a revival in rail transportat led what is currently the last new construction, namely from the Vietnamese side. To improve access to Hanoi, the Vietnamese State Railway began with the construction of a secondary rail route lying to the north of the Yunnan Railway, as well as a second rail and road bridge over the Red River.

Track layout and railway structures

Despite repeated destruction due both to natural disasters and as a consequence of the various hostile disputes in the region, the single track rail route has survived over long stretches in its original condition.
In Haiphong, the harbour buildings and the – still usable – harbour tracks built in 1903 are still in existence; the neoclassical entrance halls and, to a large extent, the workshops (smithy, steam hammer) and the mechanical equipment are also retained in their original form. The railway line runs to Hanoi mainly on embankments above rice paddies and irrigation canals. The trusses of the three major bridges, Som-Tam-

Bac (90 m span), Song-Lai-Vu (120 m) and Thai-Ninh (380 m), are to a large extent original, although the pillars and abutments have for the most part been replaced. The line leaves the river delta by the bridge over the river Claire (295 m). From there, a branch line leads to the main station of Hanoi, which has been largely reconstructed. In contrast, the nearby depot still retains its concrete skeleton constructions dating from 1903. The bridge over the Red River, repeatedly bombed during the Vietnam War and originally a cantilever metal construction, was reconstructed with surviving truss components supported by eleven old and twenty-six new pillars – its length today totals 1,513 m. The next segment of the route, extending as far as Lao Cai, where the railway runs alongside the Red River, does not have any large engineering structures. Between Lao Cai and Lahadi, the line climbs at gradient of 10 ‰, and subsequently at 25 ‰. On the 82 km route up to the Milati Pass at 1,700 m, the train passes through a total of 81 tunnels. The route then dips downhill to Kaiyuan at 1,059 m, before climbing up to the highest point in Yiliang (Kuangyuan) culminating at 2,026 m. The difference in altitude on the few remaining kilometres to Kunming (1,900 m) is relatively modest. The total route boasts 172 tunnels, as well as 107 bridge structures. The most spectacular construction is the triple arched bridge over the Nam Ti canyon with a height of 100 metres. Bridges were also constructed in stone and in the typical American trestlework design. On the mountain section, small railway stations in the French style, the majority of which have been preserved, were erected at regular intervals. These were not provided as shelter for travellers, but to protect linesmen and the operational safety facilities. In the urban areas of Kunming the railway installations have been relocated, and the original buildings have mostly disappeared.
Both the base structure and superstructure of the Yunnan Railway today show evidence of improvised maintenance procedures. Many track sections reveal ferro-concrete sleepers which, however, have frequently been poorly serviced.

Operation and Equipment

The Yunnan Railway probably reached its peak frequencies in freight transport during the two World Wars and in the Vietnam War. The sections in the border regions remained closed from 1979 to 1994. After expensive repairs to these segments the railway was later brought back into operation along its entire length. However, flooding caused extensive damage in 2002. In the meantime, the mountainous segment of the railway has been repaired yet again, and two tandem trains per week have been running between Kunming and Hanoi since 2005. In addition, the line in the commuter belts around Kunming and Hanoi is still used widely for local transport.
China is currently planning the construction of a Trans-Asia railway line from Kunming to Singapore, which would give Kunming a standard-gauge connection with the Red River valley. The narrow-gauge line for transport between Kunming and Hanoi is nonetheless to be retained as declared by the Chinese Railways Ministry at the end of 2004.
Around the year 2000, wagons and steam locomotives from the French colonial period and their Chinese-Vietnamese duplicates (141 N°101– 115 SACM 1953 ff., N° 121 – 122 Vietnam 1961 ff., N° 151…216 Tangshan; N° 231–301 SACM 1932) could still be seen in Haiphong and Hanoi. In 1988, Japanese steam locomotives from the Second World War (131 “C12” Nr. 96–97 and 140

"KD55" N°. 501…576 Kawasaki 1913– 1926) were parked in China and also in Vietnam. These days, Bo'Bo'diesel locomotives from the 1970s and 1980s, as well as converted and newly constructed passenger carriages are deployed on the Yunnan Railway.

Comparison

The Yunnan Railway was built in the same period as the Albula/Bernina route and also boasts spectacular route planning, overcoming differences in altitude by loops sweeping into side valleys. However, no costly spiral tunnels or prolonged crest tunnels were needed on the Yunnan line, as was the case, on the Albula. And in a similar manner to the Bernina line, the Yunnan Railway also traverses a pass in the open, which, with an altitude of 2,026 m, is at approximately the same elevation as the Bernina Pass (2,253 m). Here, the alignment on the steep slopes high above the valley floor also proved to be complicated. As with the Albula/Bernina line, the layout of the route on the Yunnan Railway remains to a large extent the original; the railway buildings have, however, been replaced in part, especially in urban areas, and route segments affected by storm damage have frequently simply been patched up. Whilst the Albula/Bernina route has operated a full passenger and freight service since its construction, cross-border operations on the Yunnan between Vietnam and China were discontinued in the 1970s, recommencing in the 1990s, albeit with only modest train traffic. And while the Albula route was completely electrified in 1919, the Bernina route operated electrically from the outset. The Yunnan Railway switch to diesel locomotives took place in the 1970s. Whereas the Albula/Bernina route is today an important element in the public transport system, the continuation of the Yunnan Railway was long in the balance – until 2004 when Chinese Railways Ministry declared its intent to retain and expand the line. Like the Albula/Bernina railway, the Yunnan Railway also has an inventory of historical rolling stock.

South and West Asia

In 1848, the British colonial power began the construction of a railway network on the Indian sub-continent with a wide gauge of 1,676 mm. On its completion the network covered a total length of 30,000 km. The pioneer route from Bombay to Thane was opened in 1853 as the first railway line in Asia. From 1870, in addition to the wide-gauge network, a total of 26,000 km of metre-gauge railway lines was built. In India, over the past several decades these were either for the most part broadened to wide gauge or they were closed down. Nonetheless, as in Pakistan and Bangladesh, both gauges are still in use there today. In Sri Lanka, on the other hand, only the wide gauge is still operated. In this part of the world railways with gauges of 762 mm and 610 mm were also common; these covered a total length of over 5,000 km.

In India, in particular the surmounting of the Deccan Plateau presented serious challenges to the railway builders; however, none of the routes built there exceeded 1,000 m. Altitudes of well over 2,000 m are indeed reached by three other mountain railways in India: – the Darjeeling Railway in the hinterland of Calcutta, the Nilgiri Railway in the region of Madras and the Kalka–Simla Railway to the north of Delhi. Each of these lines leads from a valley into the mountains, but none of them crosses a mountain range. Furthermore, all of these railways have a connection to a main-line service at their starting points.

The wide-gauge network in very mountainous Sri Lanka reaches its highest point at 1,898 m. The Pakistani Quetta–Zhob (Fort Sandman) line – a part of the 762 mm gauge railway network already mentioned – reaches an altitude of 2,222 m. All of the various projects launched by the British colonial powers to build a railway connection between India and Iran failed due to British conflicts with the highland peoples of Afghanistan and Beluchistan. The railway connection from Karachi over Quetta, Kandahar and Herat to Turkmenistan, begun in 1876, also remained incomplete on Afghan territory. The dual-track section between Sibi and Chaman, built between 1880 and 1891 under Field Marshal Lord Roberts of Kandahar, reaches its highest point of 1,950 m on the Bolan Pass. The second mountain railway from Pakistan to Afghanistan also rises to an altitude of over 1,000 m. The line winds up through the Khyber Pass using setting back tracks. The Trans-Iran Railway, completed in 1941, which leads into the Iranian highlands and crosses the foothills of the Elbrus Mountains to Turkmenistan, reaches heights of over 1,000 m. Mountain railways were also built in Turkey to overcome the mountain chains between the Mediterranean and the Black Sea, leading over the Taurus and the Pontin mountain ranges. The Hedjaz Railway and its feeder lines over the Lebanon and Anti-Lebanon mountains also reach heights of over 1,000 m at three points.

Many railway pioneers of the 19th century shared a vision of linking up all the existing railways to create an uninterrupted network stretching from Europe to South-East Asia. From the West, standard-gauge railway lines ran through Turkey and Iran. However, the strategic railway project from the Mediterranean ports to Mecca, dating back to the last year of the Ottoman Empire (1922), remained uncompleted. Under German influence the first segments of the Baghdad Railway (Instanbul – Baghdad) were opened before the First World War, whereas the entire stretch could not start operating until 1940.

Mountain railways in South and West Asia with highest points over 1,000 m

Country	Connection	Gauge	Highest Point in m 1)	Opened 2)
India	Shiliguri – Darjeeling (Darjeeling Railway)	610 mm	2258, Ghoom Pass	1889
Turkey	Sivas – Kars	Normal	2256, Asit	1917
Pakistan	Zhob – Quetta	762 mm †	2222, Kan Mehtarzai	1918
Iran	Ahvaz – Tehran (Trans-Iran South Section)	Normal	2217, Nurabad	1930
India	Mettuppalaiyam – Udagmandalam (Nilgiri Railway)	Metre, Z	2203, Udagamandalam	1899/1908
Iran	Tehran – Gorgan (Trans-Iran Elbrus)	Normal	2112, Gaduk	1938
India	Kalka – Simla	610 mm	2094, Simla	1903
Pakistan	Quetta – Chaman	1676 mm	1950, Shelabagh	1891
Sri Lanka	Kandy – Badulla	1676 mm	1898, Pattipola	1894
Syria	Damaskus – Zebdãni	1050 mm	1794, Zebdãni	1895
Pakistan	Sukkur – Quetta	1676 mm	1791, Kolpur	1887
Turkey	Adana – Taurus	Normal	1494, Taurus	1920
Lebanon	Beirut – Zebdãni (Libanon Railway)	1050 mm †	1487, Zhale	1895
Jordan	Amman – Maan (Hedjaz Railway)	1050 mm	1128, Maan	1904
Pakistan	Peshawar – Landi Kotal	1676 mm	1068, Khyber Pass	1926

1) various figures quoted for highest stations or culmination points
2) various figures quoted for part or generally continuous opening
† closed down
Z cog system

Darjeeling and Nilgiri Railways, India

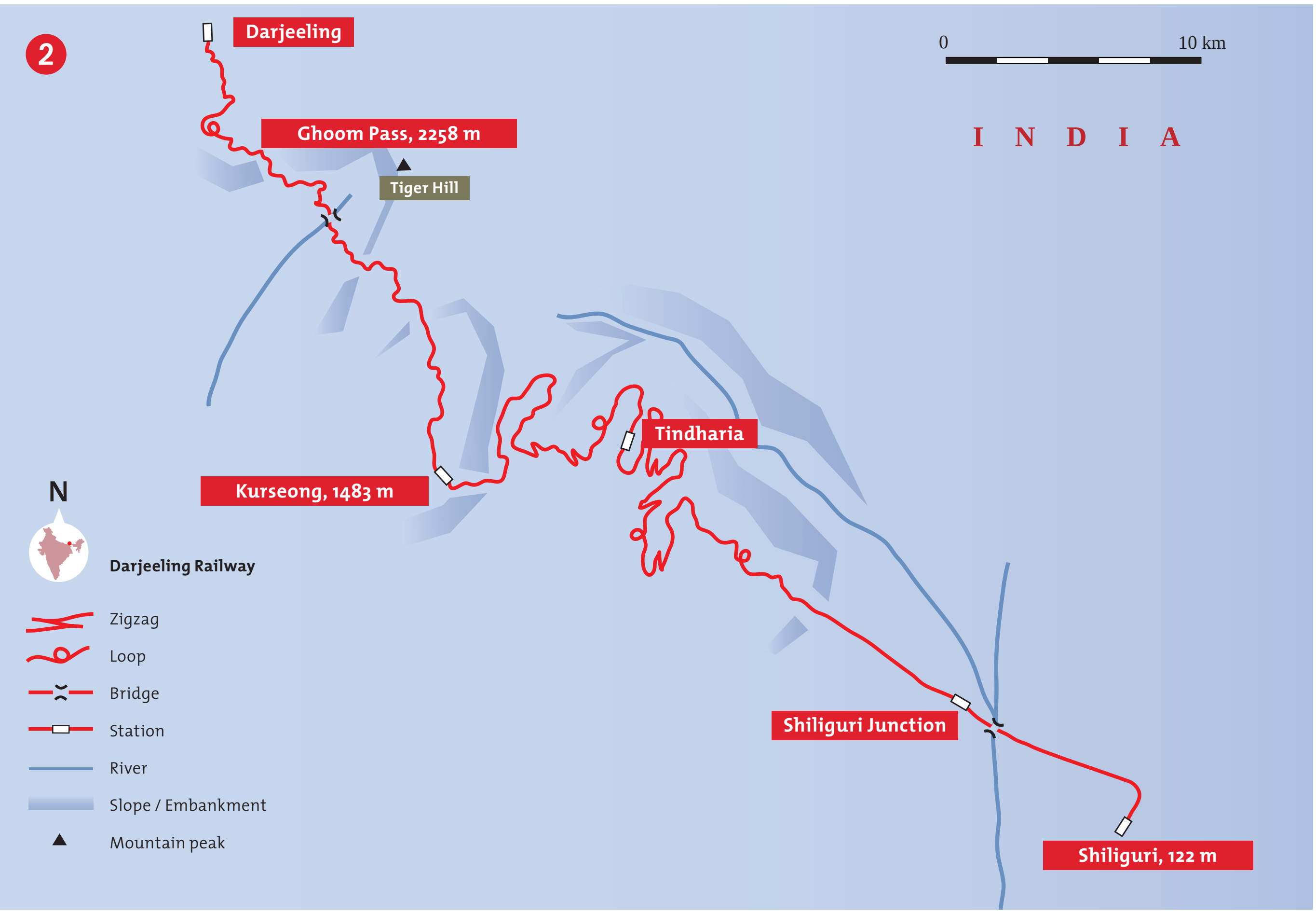
The choice of the Darjeeling and the Nilgiri Railways for comparison with the Albula/Bernina Line was based on the following criteria:

> Narrow gauge
> Innovative solutions to problems (Darjeeling: light railway, in part with joint use of the road; Nilgiri: cog railway)
> Surmounts significant differences in altitude
> Still in operation
> UNESCO World Heritage locations (Darjeeling since 1999, Nilgiri since 2005)

Darjeeling Railway

Construction history

The Darjeeling Railway from Shiliguri to Darjeeling was built in two stages. In 1880 the section as far as Kurseong (1483 m) was completed, and in 1889 the remaining track to Darjeeling (2,076 m). The valley station already had a main-line connection when the line was built. The Darjeeling Railway is licensed as the ‘Steam Tramway Company’, whose main objective was to improve the development of Darjeeling. From 1838 onwards, Darjeeling village was expanded into a mountain health resort or hill station. There were also tea plantations in the region, and by the 1870s the tea industry there was already very prominent. The cost-effective transport of agricultural goods from the mountains down to the valley promised high profits, and for precisely this reason a railway was planned that could be constructed with the lowest possible expenditure. By English standards, the Darjeeling Railway was a ‘light



Darjeeling Railway > The entire section.
H.P. Bärtschi

Darjeeling Railway > In Shiliguri there are tracks in three different gauges (610 mm, broad and narrow gauge). Photograph 1992.
H.P. Bärtschi

Darjeeling Railway > Layout as road-railway in Ghum. Photograph 1992.
H.P. Bärtschi

railway' and by German standards it had "Feldbahn in Hochgebirge" status, that is a 'light railway in high altitude, mountainous terrain'.

Rail track alignment and railway structures

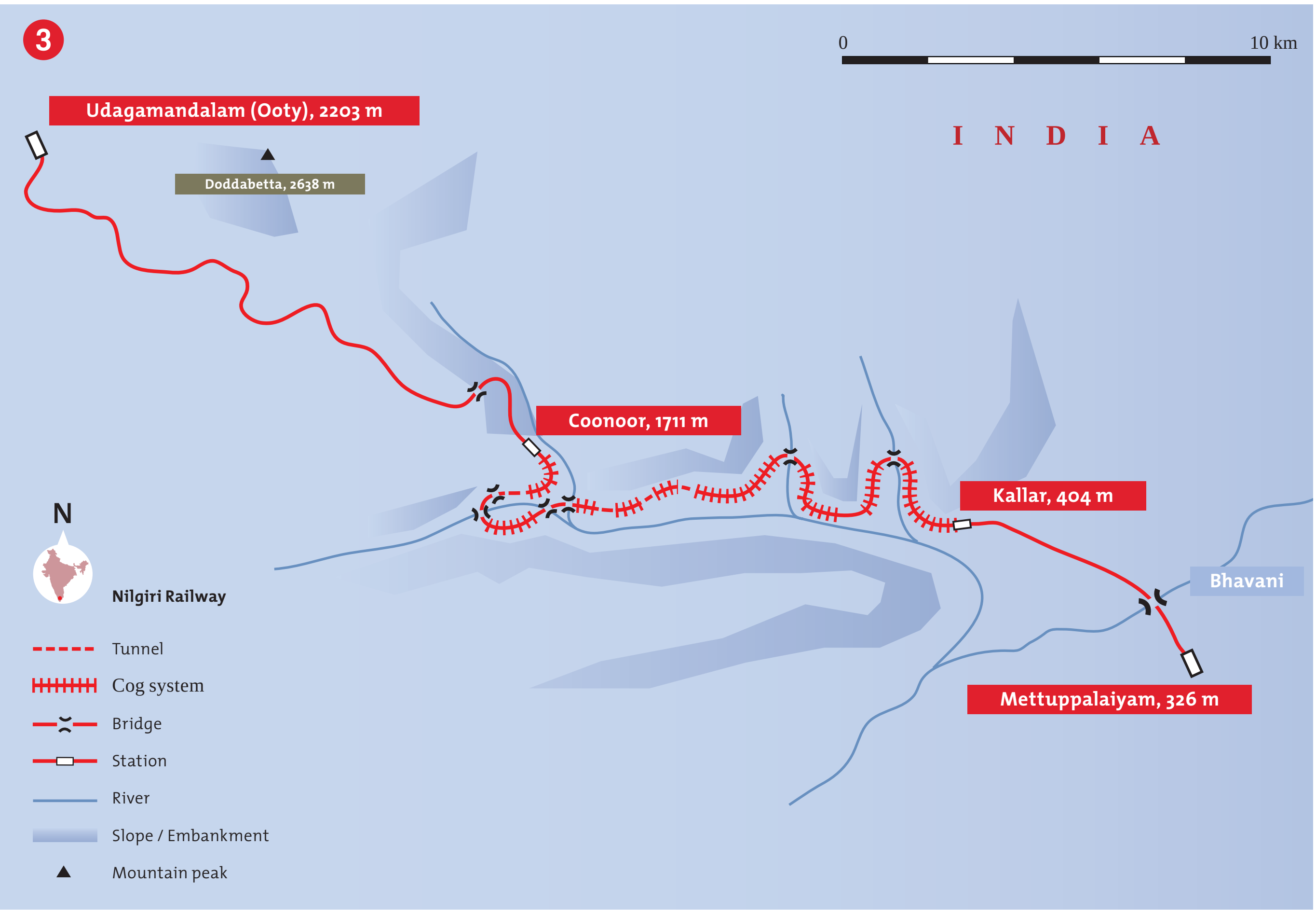
The main challenge on the Darjeeling Railway was to build a railway that surmounted a difference in altitude of 1,954 metres over a straight-line distance of 40 km. The alignment of the single track route, running for long distances alongside the trunk road, remains to a large extent the original – only in zones exposed to landslides and in areas with very steep gradients have modifications been necessary. Prolonged steep inclines, numerous curves and the routing along precipitous slopes high over the Brahma Putra plain are still as impressive today as they were in the past. Some reverse curves have a radius of a mere 18 metres; including three spiral reverse curves and the double 'Batasia Loop'; in addition, the line also features setting back tracks. The railway runs completely in the open. There are no tunnels and among the bridges – mostly small streams crossed by road and railway – there is only one substantial construction, namely the 700 metre long iron bridge over the Mahanadi near Shiliguri. The line has only a limited number of safety constructions to protect against flash floods and landslides. There are stations, workshops and depot facilities, in part with very old equipment, in New Jalpaiguri, Thindaria Ghum and Darjeeling.

Operation and Equipment

The narrow 610 mm gauge and the modest foundation permit the operation of only light rolling stock. On this line the burden of three to four loaded wagons should not exceed the weight of a standard-gauge double-axle goods wagon of 27 tons. The typical steam locomotives on the Darjeeling Railway feature two coupled axles and a saddle tank on the boiler. To help prevent wheel-spin a sander, perched on a seat to the fore of the smoke box, scatters sand onto the rails by hand. The wagon stock has been modernised since the 1980s, and generally only one or two of the remaining 20 steam locomotives from 1889 to 1925, are in daily operation to haul the school train on the Kurseong–Darjeeling segment. The train pairs that travel the entire route – with one train running in each direction – connect to the fast line to and from Calcutta and are each pulled by a diesel locomotive. Since India gained its independence in 1947, the journey time has extended from 5¼ to 8 hours. After the monsoon rains the route is sometimes interrupted for considerable periods.

Comparison

The Darjeeling Railway, which leads from lowlands to an altitude of over 2,000 metres, was constructed as a 'light railway', with a layout designed as simply as possible to run alongside roads, using open loops to gain height and thereby reducing the number of engineering structures to an absolute minimum. With its concept of minimum capital investment, the Darjeeling Railway represents a completely novel response to the needs of the 1880s. The Albula/Bernina route, constructed some 20 years later, is diametrically opposed to the Darjeeling philosophy in that, in the case of the Albula line, the parameters of a main-line railway were adopted for a narrow-gauge route and, in the case of the Bernina Railway, the risks of electrical operation through high, snow-covered mountains were recognised and accepted. Further, the Albula/Bernina line is a unique testimonial to the development of narrow-gauge railways.



Nilgiri Railway > The entire stretch.
H.P. Bärtschi

Nilgiri Railway > Transition from cog wheel to adhesion railway at Coonoor. Photograph 1988.
H.P. Bärtschi

Nilgiri Railway > Bridge at Wellington. Photograph 1988.
H.P. Bärtschi

As with the Albula/Bernina line, the Darjeeling Railway also has historical rolling stock; the modernisation of railway operations with the acquisition of new passenger carriages began in the 1990s and, in addition, four diesel locomotives have also been in service since the year 2000.

Nilgiri Railway

Construction history

The Nilgiri Railway, named after the mountain range, travels from Mettuppalaiyam over Coonoor to Udagamandalam (Ooty) at 2,203 m. Mettuppalaiyam was developed by the Indian Railway network in 1872, ten years after the nearby town of Coimbatore. As a result, a region very rich in natural and cultural attractions became more easily accessible. At that time, in Udagamandalam there were already scattered residences that representatives of the British colonial powers had had built, so they could escape the torrid, subtropical heat of the valley in summer. In 1876, Niklaus Riggenbach, a Swiss engineer and owner of a firm that manufactured cog-wheel locomotives, drafted an initial project for a cog railway into the Nilgiri Mountains but the project was not adopted. Eventually – under new sponsorship – a more economical variation using a combined adhesion and cog-wheel system (cog-wheel operation on the Abt principle) was adopted. Nevertheless, the railway construction company was forced to declare bankruptcy in 1894, while the construction work was in progress. In 1899, however, the Mettuppalaiyam – Coonoor segment was opened at last by a successor company. Completion of the route to Udagamandalam was not possible until after nationalisation of the railways in 1908.

Rail track alignment and railway structures

The construction of the metre-gauge mountain railway proved to be extraordinarily difficult, as the route led through a jungle region and had to surmount a difference in altitude of 1,800 metres over a relatively short distance. In the section between Kallar and Coonoor the railway line has a gradient of 80 ‰ and progresses along the valley slopes in sweeping rounded loops. While the construction of costly helical and spiral tunnels could be dispensed with thanks to its cog railway design, sixteen tunnel constructions with lengths of up to 300 metres and numerous rock cuttings and excavations were nevertheless unavoidable. Building measures to protect against rockfall and mudflows were adopted analogous to German and Swiss examples – the Harzquerbahn at Blankenburg in Germany was also visited for study purposes.

Near Mettuppalaiyam, the Nilgiri Railway crosses the river Bhavani by a large bridge. The Adderley viaduct with stone-arch foresections and three plate girders are located here, in the middle of the jungle. There are numerous smaller bridges along the entire route. The railway is attractively embedded in the steep slopes of the jungle and the hilly regions where the upper segment of the line runs. The Abt-system cogged sections end in Coonoor, and the 40 ‰ gradient in the upper segment is traversed using the adhesion principle. The single track layout of the Nilgiri Railway is still in the original form throughout. In the upper segment many slope stabilisation supports and some bridges have been renewed at considerable cost.

Equipment and Operation

Today, the Nilgiri Railway is primarily used as a tourist railway, while goods are transported on the roads. The rolling stock comprises a second generation cog wheel steam locomotive (Winterthur, Switzerland 1914), eleven other steam locomotives (the majority built in Winterthur, Switzerland between 1920 and 1952) and individual carriages from the founding period. The majority of the rolling stock used on a daily basis has new bodywork. Adhesion diesel locomotives are in operation on the Coonoor–Udagamandalam segment, and depending on the season, two to four tandem trains per day work there. A steam powered tandem train is in daily use (in 2005) on the cogwheel segment.

Comparison

The Nilgiri Railway, opened at almost the same time as the Albula/Bernina line, which runs from the valley floor to an altitude of 2,203 m can be divided into two segments, one with a cog wheel and the other with adhesion. In the late 1870s, this mixed operation presented an innovative method for meeting the challenge of surmounting large differences in altitude over short distances using steam locomotives. Furthermore, this mixed technology made it possible to keep the number of engineering structures to a minimum. In contrast to the Albula/Bernina Railway, the building of roads led to a shift of goods and passenger transport away from the Nilgiri route, with the result that today the Nilgiri Railway is above all a tourist railway. The railway still has historic rolling stock and carriages and locomotives from the 1920s, while the laborious steam locomotives in the adhesion segments have been replaced by diesel locomotives.

In comparison to the Albula/Bernina Railway, it should be stressed that whilst the conventional technology of steam locomotive operation was used on the Albula line, the Bernina Railway stole the limelight with its electrical operation – at the time a radically new technology. This made construction on much steeper gradients possible. The Bernina Railway created, as it were, the next level of technological development after the (steam-driven) cogged railway approach, as represented on the Nilgiri Railway. Electrical operation was introduced on the Albula route after the First World War, albeit with other technical parameters – direct current instead of alternating current. Today, with electrical railway operation having replaced steam locomotion worldwide, the Bernina Railway remains an outstanding testimonial from the early days of electrically powered railways.

Africa

The first railway line in Africa ran between Alexandria and Cairo and was brought into operation in 1856. However, due to the complicated political relationships both during and after the colonial period which prevented links being established between the large railway networks of South Africa and East Africa, the Maghreb, Egypt and the Sudan, the dream of a full railway connection between Egypt's capital city and Cape Town remained unfulfilled.

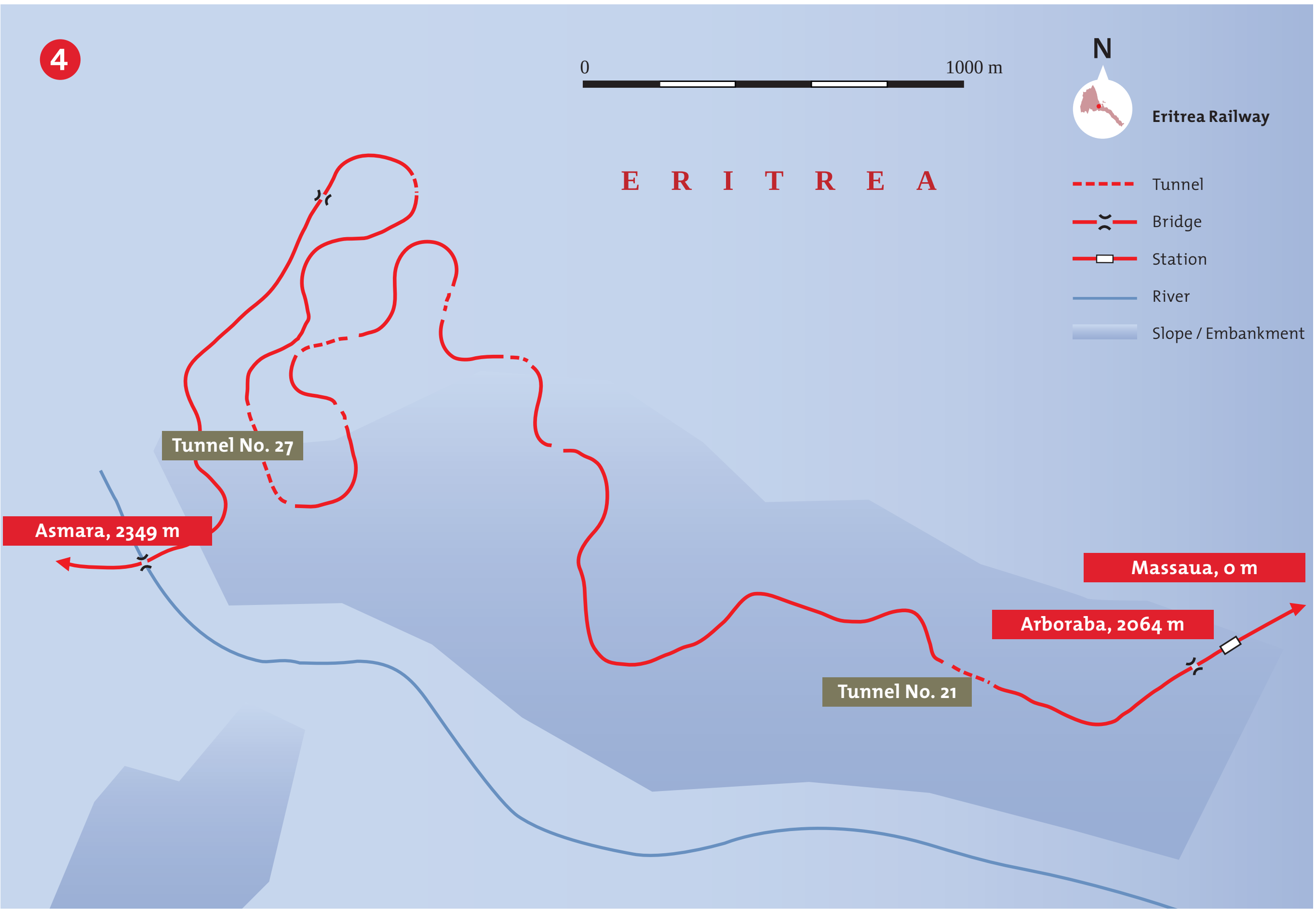
The standard track gauges in the north of the continent are normal and metre gauge, whilst the railway network constructed by the British colonial power in the South was built to the 'Cape gauge' (1,067 mm, or 3.5 feet).

During the 1890s, Britain and Germany constructed railway lines in East Africa from the ports of Mombasa, Tanga and Dar Es Salaam inland towards the west. In terms of topography, Britain had the greatest difficulties to overcome. At the time, the two countries were in a race to build a railway line up to the foot of Mount Kilimanjaro (5,892 m); in 1900, Britain completed a mountain railway which began in Mombasa and culminated at an altitude of almost 2,400 m. The section of this line close to the port, is part of the 2,000 km long Uganda Railway linking Uganda with the Indian Ocean. This was completed as far as Nairobi in 1901. The culmination point of this section of the line is at 2,658 m; its continuation in to Uganda was only completed in 1930. East of Lake Victoria, the Uganda Railway rises to 2,783 m – the highest point accessed by any railway line in Africa.

Significant heights are also reached by lines in the 'Cape gauge' networks of South Africa and the former Rhodesia Railways. The lines that have the particular characteristics of a mountain railway are those crossing the mountain massifs in the south-eastern part of South Africa. The Nigeria Railway was also built to the Cape gauge. This line runs from the northern interior of the country in two branches towards the ports of Lagos and Port Harcourt, and reaches its highest point in Mekiri at 1,370 m.

In Western Africa, only isolated colonial railway lines were built. The sole exception to this is the Benguela Railway – the trans-continental railway line running from the Atlantic port of Lobito in Angola towards Benguela and then on to the Shaba mountain area in the south of the Congo and to Zambia's copper belt. This line has a branch leading to the port of Beira (Mozambique) on the Indian Ocean, and provides a link between the coastal region and the interior of the country – an area rich in raw materials. The coastal areas of the belts of land around the Sahara have also been opened up by railway lines; in Algeria the line crosses the foothills of the Atlas Mountains where it reaches an altitude of well over 1,000 m. The Trans-Sahara Railway – which was discussed for years – was never built.

The Horn of Africa lines have a special significance. The strategic value of the region around Ethiopia rose substantially when the Suez Canal was constructed and the area fell under the domination of the three colonial powers, Britain, France and Italy. France, with the aid of the Swiss Alfred Ilg, built the Franco-Ethiopian Railway, which connects what was then the French military base of Djibouti with Addis Ababa, the capital city of Ethiopia. Its highest point is 2,470 m. By 1875, Britain had been able to extend its area of influence from Egypt as far as the Eritrean port of Massawa and into Ethiopia. Later, Italy succeeded in establishing military bases in Massawa and Mogadishu, and the Italian colonial authorities planned to construct



Eritrea Railway > An important section of the line.
H.P. Bärtschi

Eritrea Railway > Four steps above one another: railway 'acrobatics' at Arboraba. Photograph 2004.
H.P. Bärtschi

Eritrea Railway > Alignment at Embatalla. Photograph 2004.
H.P. Bärtschi

a section of 950 mm gauge railway line from Massawa to Asmara and on across the Ethiopian highland to Addis Ababa and Mogadishu. There were also plans to add a second line connecting with the British-built Sudanese railway network, through the Blue Nile region and on across the Ethiopian highland towards Somalia. In the end, the only parts built were the sections around Mogadishu and the two mountain railway lines between Massawa and Asmara, and between Asmara and Biscia.

Mountain railways in Africa with highest points over 1,000 m

Country	Connection	Gauge	Highest Point in m [1)]	Opened [2)]
Kenya	Nairobi – Kampala	Metre	2783, Timboroa	1930
Kenya	Mombasa – Nairobi	Metre	2658, Mau Summit	1901
Ethiopia	Dschibuti – Addis Abbeba	Metre	2470, bei Addis Abbeba	1917
Eritrea	Massaua – Asmara (Eritrea Railway)	950 mm	2412, Summit	1911
Kenya	Nairobi – Fort Hall	Metre	2395, Kikuyu	1900
Eritrea	Asmara – Sudanes. Border	Metre	2349, Asmara	1920
South Africa	Pretoria – Magaliesberg	1067 mm*	2095, Nederhorst	1902
South Africa	Kaapmuiden – Belfast	1067 mm*	1970, Belfast	1894
South Africa	Durban – Johannesburg	1067 mm*	1748, Johannesburg	1890
Rhodesia	Beira – Harare	1067 mm*	1688, Marandellas	1899
Madagascar	Tamatave – Tananarive	Metre	1687, Tananarive	1909
Nigeria	Ebutte Meta – Minna (Nigeria Railway)	1067 mm*	1370, Mekiri	1900
Algeria	El Kroub – Tuggert (Sahara – Altas)	Normal	1313, Batna	1882

1) various figures quoted for highest stations or culmination points
2) various figures quoted for part or generally continuous opening
* 3.5 feet, also called Cape gauge

Eritrean Railway, Eritrea

The choice of the Eritrean Railway for comparison with the Albula/Bernina line was made based on the following criteria:

- Construction at about the same time as the Albula/Bernina line
- Narrow gauge
- The line had to overcome great differences in altitude
- The 'Darjeeling of Africa' (cf. 3.c.3)
- Still in operation

Construction history

In 1890, Italy declared Eritrea an Italian colony. The relocation of the colonial administration from Massawa to Asmara (which lies at 2,349 m) led to the construction of the Eritrean Railway. The railway was built to a track gauge of 950 mm, which, at the time, was the standard gauge for railway lines in southern Italy. The first 69 km of track was completed in 1904 and reached as far as the foot of the Abyssinian highland. The Italian engineer, De Corné, was responsible for the layout of the mountain section of the line beyond Ghinda. The German railway engineer, Schupfer, was responsible for preparing the construction drawings; these were completed in 1905 and financing of the railway was secured in 1908. The first construction section was completed within about two years, and the line as a whole was inaugurated at the end of 1911.

Feeder lines

Work on extending the Eritrean Railway continued without delay, taking it from the plateau towards the west and the border with Sudan. By 1928, the section had been extended as far as Akordat and by 1932 as far as Biscia. Here again the reason for this was the desire to link the Eritrean Railway and Sudan's Cape gauge network – a link which was never achieved. The Second World War brought the work to an end, leaving the Trans-Eritrean Railway with a total length of only 337 km.
During the Second World War the British tried, unsuccessfully, to close the gap by constructing a line from Malawiya in the Sudan into Eritrean territory.

Section alignment and railway structures

From the port of Massawa the line runs on embankments past ancillary railway facilities to the mainland. The following section, through the desert, also mainly runs on embankments. Just before Dogali the track crosses a river bed by means of a stone arch viaduct. The next section is in an area of mountain foothills. As the line crosses them the height of the embankment and the height of the stone arch viaducts increase. In Ghinda the track reaches a height of 888 m. Here, a depot with a turntable and a classic station building are the only remnants of the original facilities. The line now begins its ascent towards its maximum altitude of 2,412 m. The length of this section, as the crow flies, is only 20 km. The line then dips down again towards the railway station in Asmara (2,349 m). This part of the line contains most of the 30 tunnels and 530 bridges and galleries. The gradient of the single track line has a maximum of 35 ‰, and the curve radii are nowhere tighter than 72 m. In the section near Embatkalla the line has reverse loops and tunnels and actually passes above itself three times. At one point, at the 'railway circus' near Arobraba, the line can even be seen passing backwards and forwards over itself four times, at heights of 2,133, 2,200, 2,233 and 2,266 m. In Asmara, the railway station (1910), the characteristic engine house and the workshops dating from 1928 still containing some machine tools have all been preserved.

Operation and equipment

The Eritrean Railway was largely destroyed during the war of independence in the second half of the twentieth century, but was completely rebuilt between 1994 and 2003. Since 2004 services can again run along the whole of the section between Massawa and Asmara, which was designed and constructed between 1897 and 1911. Although some isolated sections were destroyed during the war, the connecting line to Biscia has largely kept its original alignment and many of the original stone bridges have survived. Today, a train service normally operated by steam locomotives runs from Massawa to Asmara on weekdays. This service is almost exclusively used by groups of tourists; photo stops are arranged when the train makes dummy approach runs. The line currently carries no freight traffic. Besides two-axle tender locomotives (seven of them have been preserved), in 1907 the Eritrean Railway acquired two Maffei B‘B‘ Mallet locomotives; one of which still stands in Asmara today. From 1911, Ansoldo delivered 25 ‘R440’ series Mallet locomotives; three copies of which were constructed in Asmara. Five of these locomotives are still in operable condition today and at least five others have been taken out of service. Only one of the nine Fiat ‘Littorino’ diesel railcars delivered from 1935 is still in use today. Many of the original rolling stock of 2 and 4-axle freight wagons have been preserved but are no longer in use. A number of these were originally used on the narrow gauge network in southern Italy before being shipped to Eritrea. The bodies of the passenger coaches, originally dating from the 1930s and still in usable condition today, have all been modernised.

Comparison

The Eritrean Railway, like the Albula/Bernina line, was opened in the decade before the First World War. The Eritrean Railway is comparable with the Albula/Bernina line both in terms of the level of engineering difficulty (complex alignment along steep slopes high above the valley floor) and in terms of the attractiveness of its integration into the local topography. The density of engineering structures – tunnels, bridges, cuttings, embankments – can be compared with that of the Bernina line. Bridges of a size similar to those which would have been necessary on the Albula line to cross valley cuttings are not found on the Eritrea line, neither did this line require the construction of costly spiral tunnels or even a crest tunnel.

As with the Albula/Bernina line, the original section alignment has been preserved. Following the civil war the track of the Eritrean railway was reconditioned and repaired during the 1990s, but it was not altered. Compared with the Albula/Bernina line, where almost all the original structures have been preserved, in the case of the Eritrean Railway this applies only in part. Both railways possess historic rolling stock, and today the Eritrean Railway operates using rolling stock dating from the years between 1907 and 1957. In contrast to the Albula/Bernina line, at present the Eritrean railway only carries passenger traffic; freight traffic has shifted to the roads.

South America

Up till the 1980's, South America could claim a railway network of more than 100,000 km of track, spread across 12 countries, with altogether one hundred different companies involved in its operation. Some 40 % of the railway lines were located in Argentina, and another 30 % in Brazil. However, from the 1950s the privatisation of the railways and the increased level of motorisation led to rail services being discontinued in many places. The track gauge differs from country to country, and there are few international connections. Thanks to its many waterways, the gigantic basin of the Amazon has good accessibility, with the result that the area only contains a few branch terminal lines. Patagonia and the island of Tierra del Fuego also only have branch terminal lines.

The Andes Mountains form the greatest natural barrier to trans-continental transport in South America. They extend along the whole of the western side of the continent, cover a width of up to 800 km and reach a height of 6,958 m. Railway lines were built in this mountain range quite early on. The Andes railways could claim the highest point of any line in the world (a record only beaten in 2006 with the opening of the Tibet railway). They also overcome the greatest differences in altitude.

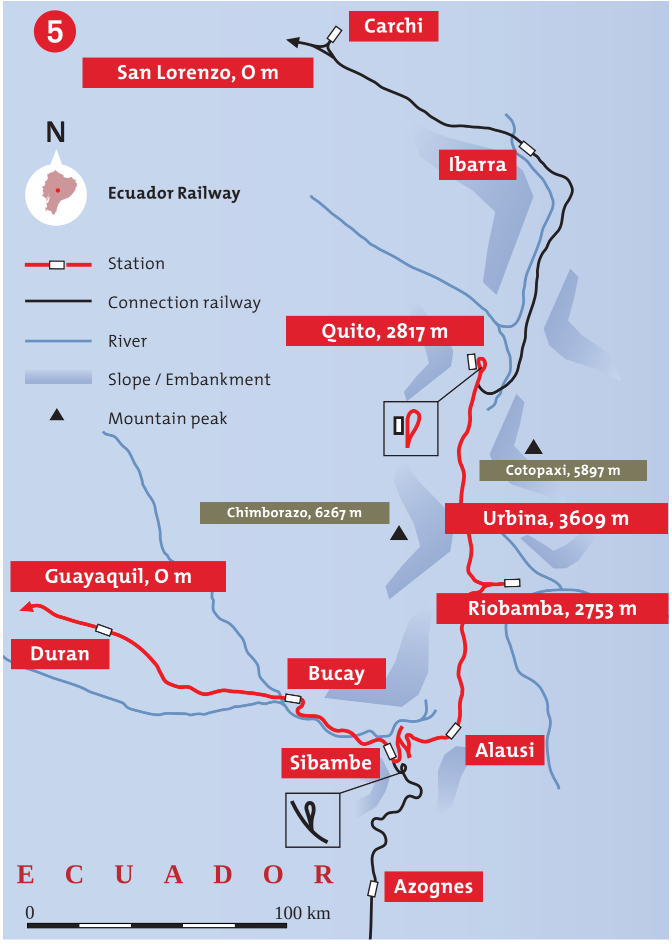
Almost all the Andes railways were designed by Europeans. Their primary purpose was to open up access to mining areas, and they had their starting point around the ports. Many were originally designed as trans-mountain links, although eventually they were not always realised as such. One of the earliest Andean railways was the line in southern Peru running from the seaport of Mollendo to Arequipa and Juliaca. One line leads off from Juliaca to Cuzco (opened in 1892) and a second towards Puno (3,850 m) on Lake Titicaca. By 1876, the line had been built as far as Crucero Alto – the culmination point of this section is at 4,474 m. In 1889, the narrow-gauge Chile-Bolivia Trans-Andean Railway began operations, linking the seaport of Antofgasta to the mining areas of Oruro; its highest point is at 3,959 m. The Collahuasi branch line (opened in 1908 and no longer in service) even reached a maximum altitude of 4,826 m. Other Andean railway lines with culmination points above 4,000 m were opened during the period from the beginning of the 20th century to the 1920s. Some – including the highest-altitude lines – were used as mine railways and have since been closed down. Others, like the Zapala railway between southern Chile and Patagonia, were never completed. Yet other lines suffered long periods when no services were operated or when sections were dismantled; for example the Argentinean railway from Mendoza to the Cumbre tunnel. Some of the sections of this line had rack and pinion traction and no longer exist today. However, the continuation of the line in Chile, running via Los Andes to Valparaiso, with no rack and pinion traction is still in operation.

South America contains several other railways besides those referred to above, for example the lines in Brazil, Colombia and Ecuador.

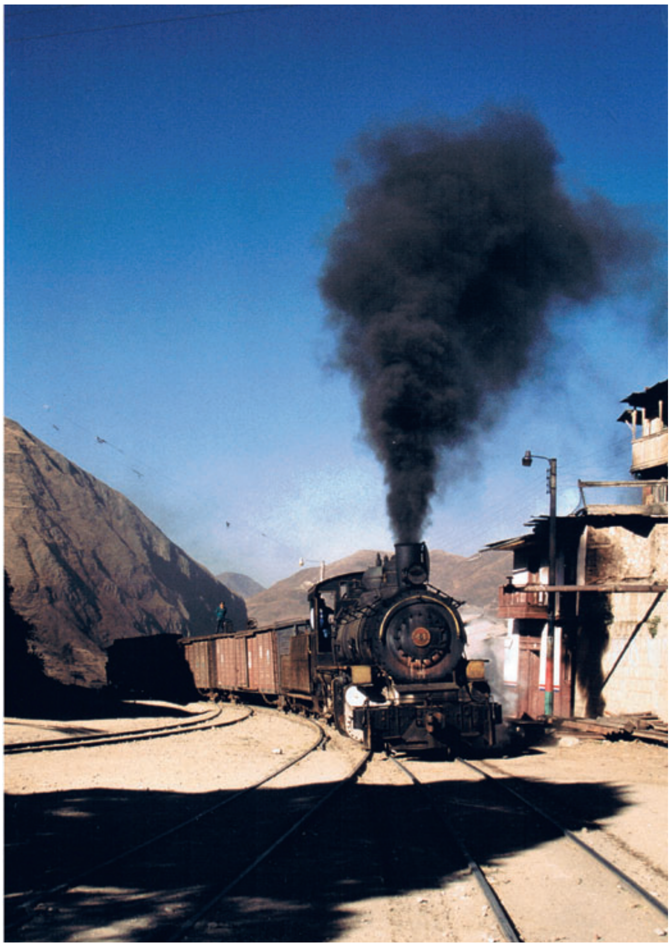
Mountain railways in South America with highest points over 1,000 m

Country	Connection	Gauge	Highest Point in m [1]	Opened [2]
Chile	Ollogue – Minas de Cobre (A&B)	Metre †	4826, Collahuasi	1908
Peru	Ticlo – Morococha (Peru Central)	Normal †	4818, La Cima	1908
Bolivia	Rio Mulato – Potosi	Metre	4787, Condor	1912
Peru	Callao – Huancayo (Peru Central)	Normal	4781, Galera	1892
Peru	Pachacayo – Chaucha	Normal †	4602, Caja Real	1904
Argentina	Salta – Socomba	Metre	4475, Chorrillos	1948
Peru	Mollendo – Juliaca	Normal, G	4474, Crucero Alto	1876
Bolivia, Chile	Antofagasta – Uyuni	Metre	4401, Yuma	1917
Peru	Cerro de Pasco – Goyllarisquisga	Normal	4385, Alcacocha	1900
Peru	Juliaca – Cusco	Normal	4314, La Raya	1892
Chile, Bolivia	Arica – La Paz	Metre	4257, General Lagos	1915
Peru	Oroya – Cerro de Pasco	Normal	4214, La Cima	1904
Bolivia	Cochabamba – Oruro	Metre	4137, Cuesta Color	1900
Bolivia	Guaqui – La Paz	Metre	4106, EI Alto	1903
Bolivia	Ollagua – Calama	Metre	4057, Ascotan	1925
Bolivia	Potosi – Sucre	Metre	4033, Potosi	1929
Chile, Argentina	Antofagasta – Salta	Metre †	4000, Munano (Soc.)	1948
Chile, Bolivia	Antofagasta – Ollague	Metre	3959, Ascotan	1889
Argentina	Ouquios – Tres Cruces	Metre †	3693, Tres Cruces	1907
Ecuador	Guayaquil – Quito	1067 mm*	3609, Urbina	1908
Argentina	Tucuman – La Quiaca	Metre	3559, Pumahuasi	1908
Bolivia	Villazon – Atocha	Metre	3447, Villazon	1924
Argentina	Mendoza – Cumbre	Metre, Z †	3191, Cumbre Tunnel	1910
Chile	Puente Alto – El Volcan (FC Militar)	600 mm †	3050, El Volcan	1910
Colombia	Medellin – Buenaventura (FC de Antioquia)	914 mm	1900, Quiebra	1914
Brazil	Campos do Jordão – Cacique	Metre	1715, Cacique	1912
Brazil	Paranagua – Curitiba	Metre	1010, Roca Nova	1885

[1] various figures quoted for highest stations or culmination points
[2] various figures quoted for part or generally continuous opening
† closed down
* 3.5 feet, also called Cape gauge
Z cog system
G freight only



Guayaquil&Quito Railway > Mountainous section.
H.P. Bärtschi



Guayaquil&Quito Railway >Arrival at Alausi with hand-braked wagons. Photograph 1990.
H.P. Bärtschi

Guayaquil&Quito Railway > Zigzag alignment at the Devil's Nose. Photograph 1990.
H.P. Bärtschi

Guayaquil&Quito Railway > Autoferro in Urbina at 3,609 m, before the Mount Chimborazo. Photograph 1990.
H.P. Bärtschi

Guayaquil&Quito Railway, Ecuador

The choice of the Guayaquil&Quito Railway as an object of comparison with the Albula/Bernina line was based on the following criteria:

> Commissioning of the whole section similar to that of the Albula/Bernina line
> Narrow gauge
> The need to overcome great differences in altitude
> Railway constructed to open up access to the country – linking the coastal region with the capital city
> The line passes through an attractive and varied cultural area
> Planned for passenger and freight traffic (in contrast to the mountain railways in the Andes)
> Extensive sections still in operation

Construction history

From the time it gained independence from the Spanish colonial power in the first half of the 19th century, one of Ecuador's principal objectives was the construction of a railway linking the coastal region with Quito, the capital (2,817 m). From 1871, government funds were used to push forward the construction of the line from the port of Guayaquil, initially with a track gauge of 914 mm. Progress with the construction work through the swamps and wetlands of the tropical lowland was very slow. From 1877, serious social unrest and the eruption of the Cotopaxi volcano further delayed work on the line. As a result, the government loan taken out in England had to be renewed and the capital increased. Initial plans proposed crossing the bay between Guayaquil and Duran (Eloy Alfaro) by ferry, but in the 1880s a rail track was set up there. By 1884, the work had reached Barraganeta and by 1888 the town of Bucay, 80 km into the interior of the country at the foot of the Andes where major workshops were erected. The construction work ground to a standstill in the humid tropic region. In 1897, a new contract was signed with a North American company. In view of discrepancies, this company decided to build the mountain section after Bucay in the British 'Cape gauge' (1,067 mm) giving the alignment a grade of 55 ‰, considerably steeper than the original project. When the line reached some 3,000 m the railway engineers found they had to struggle with some extremely difficult subgrade conditions: drift sand and volcanic ash. The whole of the line between the port of Guayaquil und Quito was finally opened in 1908, with the section in the lowland area originally built to a 914 mm track gauge, now rebuilt to the correct gauge.

Feeder lines

In 1957, a second connection was completed between Quito and the sea, terminating in the port of San Lorenzo close to the border with Colombia. Today, only parts of this line are in operation. From Ibarra onwards, 'Autoferro' railcars are used since part of the line to the port has been dismantled. Ecuador's third section of mountain railway, branching off from the Ecuador Railway towards Cuenca, completed between 1915 and 1965, has been closed down. Here again, considerable segments of the tracks have been removed. Several connecting lines were built to link up with the section between Guayaquil and Quito. These include lines to the Ingenio San Sarli sugar factory and to the Empresa de Carros Urbanos plantations.

Section alignment and railway structures

Between Guayaquil and Bucay the line runs through a flat but marshy region. The 90 km. long, mountain section begins in Bucay. Part of the line has to overcome a difference in altitude of 3,000 m; the gradient used here is 55‰. A double setting back track was constructed at a height of 2,606 m; a low-cost method of gaining height artificially. The line rises up along a mountain formation known as the 'Devil's Nose', and reaches its highest point (3,609 m) in Urbina, below Mount Chimborazo (6,267 m). From there the railway runs through the north-south valley, past Octopi (5,897 m) and down to Quito, the capital.

The mountain section of the Guayaquil&Quito Railway has prolonged, steep gradients and many curves, with the line running along precipitous slopes high above the valley floor. Despite the great altitude of the line, there is no extensive protection against rockfalls and mud flows, nor have any larger bridge structures been built to cross valleys and waterways. Tunnels are also almost completely absent. The most significant civil engineering works are the cuttings and embankments.

Since its opening in 1908, maintenance of the railtrack and structures along this single-track corridor have been minimum; as a result they are largely unchanged, but in need of repair. There have been no additions worth mentioning. There is an almost complete lack of ballast on some, and the rails are frequently simply secured to the rough-hewn timber sleepers with wrought-iron nails, without any railway-chairs.

The mountain section from Bucay to Riobamba (km 228) was rehabilitated during the 1990s; the section from Riobamba to Cotopaxi (km 386) in 2004/2005.

The structures and workshops are also still largely in their original form. In Duran, railway workshops with machinery dating from the 1880s can still be seen today. The Duran railway station has been listed as a national monument, but it is in a very poor structural condition. The workshops in Riobamba have been partly abandoned. However, in Quito the classic railway station and the depot workshops dating from when the line was constructed have all been preserved.

Operation and equipment

Violent storms have interrupted the section again and again leaving only sub-sections operable. Through services have not been run since the beginning of the 21st century. The tracks from Bucay to Milagro (km 34) have been tarred over. The central government has brought an action against the local municipalities on this and there are now plans for a bypass line. Several times since the 1980s the lack of protective structures in the mountain section has resulted in extensive damage to the line by landslides, entailing extensive repair work.

Two to three steam locomotives are used to run tourist trains in Bucay and along the Devil's Nose. Most of the passenger coaches and freight wagons dating from the time the line was constructed are now in poor condition. The trains which run on the flat sections haul five to six wagons, but only up to three on the ramp sections. Each wagon is braked by hand, even on the steep parts of the line. The section between Quito and Cotopaxi at the foot of the volcano is popular with tourists and runs a regular service at weekends, mostly using railcars. Combined passenger and freight trains run between Riobamba and Sibambe three times a week.

The original rolling stock has largely been preserved. Priority was given to modernising the locomotive fleet – a number of steam locomotives were purchased in 1927, and a further three series of diesel locomotives were delivered in 1957, 1970 and from 1991. None of the ten older ALCO diesel locomotives (supplied in 1970) and the five Alstom BBB diesel locomotives purchased in 1957 are still in service. Only three or four of the 9 Alstom BBB diesel locomotives delivered between 1991 and 1993 are still in use. The fleet of locomotives also includes two Baldwin 1'C engines dating from 1901 and twelve Baldwin 1'D engines built between 1927 and 1953. A number of railcars and freight cars are also available; these are conversions of (or built from parts of) various road vehicles, including a new, air-conditioned Mercedes coach.

Comparison

The Guayaquil&Quito Railway was opened at the same time as the Albula/Bernina line, although the first sections had been constructed as early as the 1870s. The highest point on the Guayaquil&Quito Railway is at 3,609 m – considerably higher than the Bernina railway (2,253 m) – and the line even begins at sea level. and must therefore overcome a much greater difference in altitude. With respect to the technical-constructional challenge the Guayaquil&Quito Railway is certainly comparable with the Albula/Bernina line. As with the other comparative railways beyond Europe, the alignment of the Guayaquil&Quito Railway was designed to avoid the need for any complex engineering structures. Consequently there are no major bridges and few tunnels: there is neither a spiral nor a crest tunnel, section, altitude being gained through the use of setting back tracks, a solution which was common in the 1840s.
The Guayaquil&Quito Railway is also comparable with the Albula/Bernina line in terms of the attractiveness of its integration into the topography. The spectacular section of the line with its setting back tracks in the 'Devil's Nose' area is world-famous. In contrast to the Albula/Bernina line which still operates a full service today, parts of the Guayaquil&Quito Railway have already been closed down. Where the railway is still running, long stretches of the original alignment have been preserved. The density of historic monuments along the line is, however, much lower than that of the Albula and Bernina line. Those parts of the Guayaquil&Quito Railway which still exist today – a significant contrast to the Albula/Bernina line – now only carry a very low volume of passenger and freight traffic. However, demand has increased near the capital city of Quito and on the spectacular engineering section near the 'Devil's Nose', where special tourist trains operate. Both the Albula/Bernina line and the Guayaquil&Quito Railway now operate with modern rolling stock. However, both railways also have historic rolling stock and the Guayaquil&Quito Railway still has steam locomotives dating from the 1920s.

North and Central America

In 1930, the rail network of the USA was the largest in the world, stretching over some 460,000 kilometres of track. Begun in Baltimore in 1827, it is also one of the oldest in the world. The dense expansion of the network in the northeast and southeast, which were early industrialised, was followed in the 1860s by the opening up of the West. With the breakthrough of individual transport and competition from air travel, the US rail network, which is largely unsubsidised, has shrunk to little more than half of its peak size since the second half of the 20th century. Numerous mergers since the 1970s have also reduced the once large number of private railway companies. In 1995, for example, the *Burlington Northern Railroad* and the *Atchison, Topeka and Santa Fe Railway* merged to become the *Burlington Northern Santa Fe* BNSF with a total rail network of around 51,500 km. The merger discussions begun in 1999 between the *Burlington Northern Santa Fe* and the *Canadian National* CN were broken off a year later due to the objections of other rail companies and potential difficulties in implementing the fusion.

The Canadian network, which once extended over 74,000 km, was generated by the competition between private and state railway companies. The state subsidised rail construction, via the *Canadian National*, in order to fend off US investment interests.

In Central America, in the early 1840s, Cuba, then still under Spanish colonial rule, became the first country in this region to have a railway. This operated in the area around Havana. The building of the railways in Mexico, Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica was dominated by the USA. With the exception of Mexico (greatest extent of the rail network: 24,000 km), rail no longer played a significant role in these countries; operation of the existing lines has largely been terminated.

In Central and North America, as in South America, the Cordilleras which dominate the whole length of the west of this part of the world constitute the greatest challenge to rail construction. The Appalachians, in the eastern part of North America, seem harmless in comparison with this mighty mountain system, and were conquered by mountain railways as early as the 1840s. The North American Cordilleras comprise of several mountain ranges (Rocky Mountains, Coast Ranges, Cascade Range, Sierra Nevada, Sierra Madre) which are separated from each other by basins and plateaux. The highest elevation is Mount McKinley (6,187 m) in the Alaskan chain. Between the Coast Ranges, running parallel to the Pacific coast, near San Francisco and the 4,500 km long Rocky Mountains, the Cordilleras spread over a width of 1,500 km.

The first mountain railways were built in the Cordilleras of the USA, in connection with the settlement of the West following the discovery of gold. From the later 1860s, the rival rail companies *Union Pacific* and *Southern Pacific* both opened railways which crossed what were for those times extremely high passes. A large number of high altitude railway lines are concentrated around the mineral and coal-rich mountain region near Denver, where the Rocky Mountains reach their highest elevation with Mount Elbert, which soars to 4,402 m. Denver itself came into being in 1859 as a gold prospectors' camp.

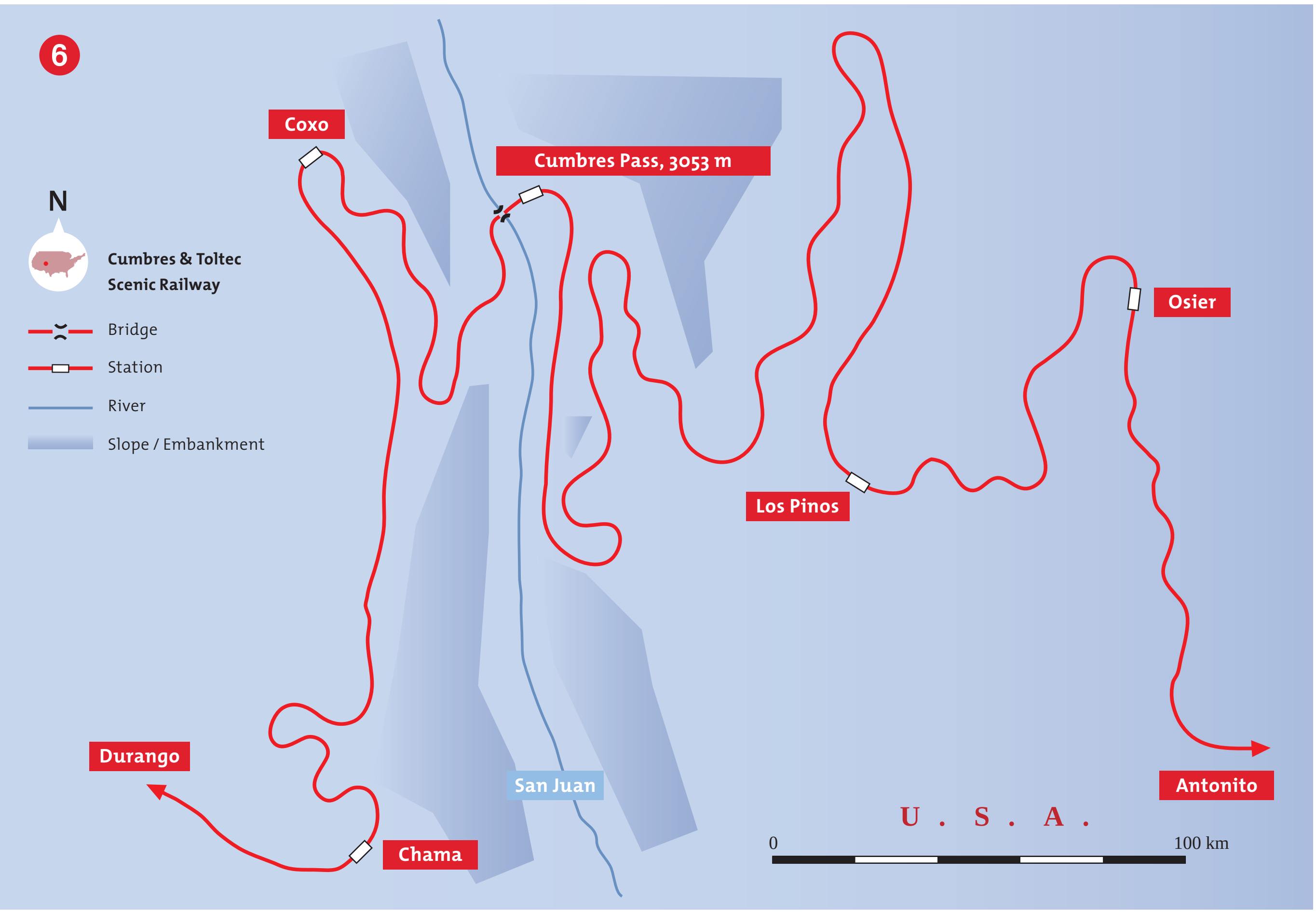
In Canada, the *Canadian Pacific* won the race for the first transcontinental through line. In 1885, the railway line from Winnipeg to Vancouver reached a high point of 1,625 m near

Great Divide at Kicking Horse Pass.
In Mexico, where rail construction was state subsidised, the first mountain railway was built in 1872. More were to follow. They served principally to open up the capital, Mexico City, situated at 2,240 m, but also the uplands to the north between the Madre Oriental and the Sierra Madre Occidental mountain ranges.

Mountain railways in Central and North America with highest points over 1,000 m

Country	Connection	Gauge	Highest Point in m [1]	Opened [2]
USA/Colorado	Denver – Kremmling	Normal	3560, Rollins Pass (1928: 2817 Moffat Tunnel)	1904
USA/Colorado	Colorado Springs – Leadville	Normal †	3515, Hagerman T. (1893: 3338 Ivanhoe Tunnel)	1887
USA/Colorado	Nathrop – Gunnison	914 mm †	3512, Alpine Tunnel	1882
USA/Colorado	Como – Breckenridge	914 mm †	3500, Boreas Pass	1890
USA/Colorado	Leadville – Dillon	914 mm †	3450, Fremont Pass	1882
USA/Colorado	Breckenridge – Leadville	914 mm †	3450, Fremont Pass	1884
USA/Colorado	Salida – Gunnison	914 mm †	3309, Marshall Pass	1881
USA/Colorado	Leadville – Red Cliff	914 mm †	3180, Tennessee Pass (1890: Tunnel, Normal)	1881
USA/Colorado	Durango – Ridgway	914 mm v	3124, Lizard Head Pass	1891
Mexico	La Cima – El Oro	Normal †	3054, La Cima	1882
USA/Colorado	Chama – Antonito	914 mm	3053, Cumbres Pass	1880
USA/Colorado	Webster – Como	914 mm †	3045, Kenosha Pass	1879
USA/Colorado	Walsenburg – Alamosa	914 mm †	2817, Veta Pass	1877
Mexico	Pueblo – Mexico City	Normal	2561, Nanacamilpa	1883
USA/Colorado	Bond – Steamboat Springs	Normal	2540, Toponas	1913
Mexico	Paso del Macho – Esperanza	Normal	2536, Maltratata	1872
Mexico	Chihuahua – Topolobampo	Normal	2460, Los Ojitos	1961
USA /Wyoming	Cheyenne – Ogden	Normal	2443, Sherman Hill	1868
USA/Colorado	Gunnison – Montrose	914 mm †	2429, Cerro Summit	1882
USA/Colorado	Trinidad – Albuquerque	Normal	2312, Raton Pass	1878
USA/Utah	Price – Provo	Normal	2268, Soldier Summit	1882
USA/Arizona	Albuquerque – Barstow	Normal	2212, Continental Divide	1883
USA/Calif./Nevada	Sacramento – Reno	Normal	2147, Donner Pass	1868
USA/Montana	Miles City – Avery	Normal †	1934, Pipestone Pass	1909
USA/Montana	Great Falls – Butte	Normal	1929, Butte	1888
USA/Utah/Nevada	Salt Lake City – Winnemucca	Normal	1799, Shafter	1906
USA/Montana	Billings – Spokane	Normal	1743, Bozeman Pass	1883
Canada	Calgary – Kamloops	Normal	1625, Kicking Horse Pass (Great Divide)	1885
USA/Montana	Shelby – Whitefish	Normal	1589, Marias Pass	1892
USA/Texas	San Antonio – El Paso	Normal	1547, Paisano	1882
Costa Rica	Puero Limon – Alajuela	1067 mm	1547, El Alto	1891
Guatemala	Puerto Barrios – Puerto Quetzal	914 mm	1497, Cd. Guatemala	1884
Canada	Lethbridge – Nelson	Normal	1359, Crowsnest Pass	1898
USA/California	Bakersfield – Mojave	Normal	1228, Tehachapi Summit	1876
Canada	Vancouver – Prince George	Normal	1208, Horse Lake	1918
Canada	Edmonton – Kamloops	Normal	1110, Yellowhead Pass	1913

[1] various figures quoted for highest stations or culmination points
[2] various figures quoted for part or generally continuous opening
† closed down



Cumbres & Toltec Scenic Railway>
Important section of the line.
H.P. Bärtschi

Cumbres & Toltec Scenic Railway >
Needleton station with Rio Grande water tower. Photograph 1974.
P. Gloor

Cumbres & Toltec Scenic Railway>
Section above Animas Canyon. Photograph 1974.
P. Gloor

In Guatemala, the Guatemala Railway (highest point 1,497 m) with its tremendous steel bridge constructions was inaugurated in 1884. In 1891, a mountain railway was also opened in Costa Rica.

Denver&Rio Grande Railroad (key focus: Cumbres & Toltec Scenic Railway), USA

The choice of the Denver&Rio Grande Railroad for comparison with the Albula/Bernina line was based on the following criteria:

> Extensive narrow-gauge network to access the region
> Mountain railway character overcoming great differences in altitude
> Attractiveness of the surrounding landscape (cf. 3.c.3)
> Presence of original substance (even if only still in operation on some sections)

Construction history

In 1870, the Kansas Pacific railtrack reached the city of Denver. At the same time, William Jackson Palmer (1836 – 1909) founded the *Denver&Rio Grande* D&RG rail company. His first objective was to establish a rail line to the coal regions around Canon City and Walsenburg in the eastern foothills of the Rocky Mountains as well as a connection to El Paso (Texas) on the Mexican border. To minimise construction and operating costs, Palmer chose a narrow-gauge design, although from the later 1880s onwards, the D&RG was, to build its track increasingly in standard gauge with a view to compatibility. Palmer himself was the founder of a coal mining company which branched out into the crude oil business, calling itself the *Colorado Fuel & Iron Company* (with a refinery in Alamosa). The discovery of silver near Marshall Pass (3,225 m) in 1877 and the silver rush that this caused allowed the D&RG to progress rapidly with rail construction in the mountains. The principal aim was now to access the Rocky Mountains in Colorado and the neighbouring states by establishing a network. In 1880, the narrow-gauge track of the D&RG led from Denver to Pueblo, and south-westwards from there via Walsenburg and Alamosa to Antonito and onwards over the Cumbres Pass in the San Juan Mountains to Chama. Another route branched off to the northwest towards Leadville, which lead through Canon City and Salida. There was also a connection between Pueblo and Santa Fe, situated to the south. In 1881, the route between Chama and Durango was opened, and one year later the silver mines to the north of Durango could be reached by rail from Silverton. Also brought into operation in 1882 was a line leading from Gunnison and Montrose to Salt Lake City and Odgen in the state of Utah. The D&RG narrow gauge network constructed in the Rocky Mountains since the 1870s eventually extended over 2,500 km. On the segment between Pueblo and Santa Fe, the D&RG had a three-rail track installed in the 1890s so that trains of the *Santa Fe* railway company, which were built for standard-gauge track could also reach the steel works in Pueblo. To the west of Leadville, also under the aegis of D&RG, the normal-gauge line from Denver via Dotsero and Grand Junction was extended to Salt Lake City and Ogden. The narrow-gauge line to Salt Lake City was then taken out of service. Another normal-gauge line from Denver to Antonito was opened in 1901.

In 1894, the D&RG took over the *Rio Grande Southern* railway company, and with it the track built in 1891 between Durango and Ridgway (near Silverton). After further mergers around 1900 with rail companies operating in the region, the main focus of the D&RG was the expansion of its normal-gauge network. The narrow-gauge

network collapsed when the construction of the three-rail track on certain sections was abandoned. In 1921, the organisation renamed itself the *D&RG-Western* in reference to the Western Railway bought up in 1901. In 1947, the D&RGW took over the important mountain railway network of the *Denver & Salt Lake Railway*, and with it the Denver – Craig line, which as a standard-gauge mainline railway includes some spectacular mountain sections. The segment between Bond and Craig is today used almost exclusively by heavy coal trains. After 1947, the changes of gauge and closures accelerated. In 1984, the billionaire Philip Anschutz bought the D&RGW only to sell it on to the *Southern Pacific* in 1992; which has since been integrated into the *Union Pacific*.
Since the great wave of line closures in the 1960s, the great majority of the narrow-gauge network lines constructed by the D&RG is no longer in service. The some 112 km of the line from Antonito to Chama over the 3,053 m high Cumbres Pass was acquired by the US states Colorado and New Mexico, which brought it back into service in 1972, four years after the closure, exclusively for tourism purposes. Since then, a museum train operation has been run there during the spring and summer months under the name *Cumbres & Toltec Scenic Railway*. No buyer could be found for the section leading on to Durango and the track there has been dismantled. At present, the now isolated narrow-gauge segment between Durango and Silverton is also being operated as a museum railway.

Rail track routing and railway structures

The Cumbres & Toltec Scenic Railway line dates from between 1878 and 1880 but the entire original track has been preserved. The line climbs some 650 m in a spectacular ascent, including several S-bends, between Antonito (2,404 m) and the Cumbres Pass (3,053 m), before making its way – negotiating a similar difference in altitude – with a 40 ‰ gradient to Chama.
The route along the curving contours, at such an altitude was very complex. In order to keep the building outlay to a minimum, cuttings and the erection of major embankments and bridges were avoided wherever feasible. There are only a few substantial civil engineering structures on the section. Among these are the two suspension bridges over Wolf Creek near Lobeto (30 m high, 94 m long) and Cascade Creek near Osier (35 m high, 131 m long) and the two tunnels in the vicinity of Toltec (Toltec Tunnel 110 m long; Mud Tunnel 104 m long). Hardly any defences against avalanche and mudflow were built in spite of the considerable altitude of the passes to be crossed. On Cumbres Pass itself, there had been more than 20 snow protection galleries, up to 250 metres long which were built in the 1880s. Many of these were lost to fires, with the result that from the 1920s there was a shift to building snow trap fences at exposed points.
In Chama, the original substance of the station buildings, water towers and depot facilities has largely been retained, while the structures at the other end of the Cumbres & Toltec Scenic Railway in Antonito were, for the most part, reconstructed in the 1970s. There are also a few station buildings and water towers along the route which are preserved in their original condition, as well as some which were reconstructed in the 1980s and 1990s. The rigorous climatic conditions and the long suspension of operation during the winter months make continuous maintenance work on the predominantly wooden structures essential.

Operation and equipment

The Cumbres & Toltec Museum Railway is in operation every day from the end of May to the middle of October. As a rule, a steam-driven train leaves from each end of the section to make the seven-hour journey along the whole route and back. As well as this, additional special excursion trips are organised. Every two years the original 'Alco' steam snowplough from 1923 makes the trip for a "photo safari". There are several 2-8-2 wheel arrangement tender locomotives (Baldwin 1903 and 1925; D&RGW 1928-1930), six of which are operational. As well as reconstructed four-axle wooden box cars, a complete fleet of goods wagons has also been preserved. The outfitting with rolling stock reconstructed from the original 1920s plans is a special attraction of this museum railway.

Comparison

The route of the Cumbres & Toltec Scenic Railway was opened a quarter of a century before the Albula/Bernina line. In contrast, at least to the Albula railway, its construction was realised with minimum investment. The topographical circumstances were advantageous in this respect, not requiring the building of any high-cost engineering structures (such as spiral or crest tunnels, or larger bridges) or calling for new technical solutions (such as electrical operation) to be tried out. As a rule it was possible to conquer the differences in altitude by making loops in side valleys (as demonstrated by the Semmering Railway). The maximum gradient of 40 ‰ corresponds to the criteria for steam locomotive operation (Albula line 35 ‰).
The original track has been retained on both railways, but in the case of the Denver&Rio Grande Railroad only one section – between Antonito and Chama – is still in operation. After it was brought into service as a tourist railway in 1972, renovation work was carried out on the remaining structures. Since then it has been necessary to reconstruct some of the, for the most part, wooden buildings due to the poor state of the substance. In contrast, the Albula/Bernina civil engineering structures have largely been preserved in their original condition, or, where preservation was not possible, have been replaced with structures designed to blend in well. On the Cumbres & Toltec Scenic Railway each of the passenger cars, with their wooden superstructures, has been rebuilt on an original goods wagon chassis. The steam locomotives date from the 1920s and some are still operational. The Cumbres & Toltec Scenic Railway has acquired a special significance thanks to the attractiveness of the landscape it runs through, and particularly from the designation 'Scenic Line of the World', which is examined in more detail in 3.c.3.

Europe (without Switzerland)

Europe was a world leader in railways until well into the 20th century. In its heyday, the European rail network – including the lines in Switzerland and the part of Russia belonging to Europe – comprised some 410,000 km of track, only around 50,000 km less than that of the USA. In Western Europe, the massive expansion in the road network, which started in the 1960s, undermined railway frequencies. A similar pattern occurred in the eastern European states after the political upheavals at the end of the 1980s.

Railways, as we know them today, had their origin in England in the early 19th century. To create a link between the industrial centres in the northwest and those on the east coast, railways were built over the Pennines as early as the mid-840s. In France, the first railway line was built in the Massif Central, in the region of St. Etienne; it was still based on a mixed operation using both steam locomotives and horses. In the course of time, all the mountain ranges of Europe have had rails laid over them, or through them in tunnels. The first European railway to exceed the altitude of 1,000 m was the Neuchâtel line, in the Swiss Jura, built in 1860. The first mainline railway to exceed 1,000 m was the Spanish North Railway. This linked the cities of Madrid and Avila across the Castilian dividing range. Planned from as early as 1858, it was opened in 1863. The first transalpine line ran over the Semmering and was brought into service in 1854. The second alpine railway, the Brenner line, was opened 13 years later. In France, two mountain railways were constructed between 1868 and 1870. More were to follow. The longest rail tunnel of the time came into operation with the opening of the transalpine Mont Cenis line in 1871. In the Carpathian Mountains of Romania, the Bucharest – Brasov main line was completed in the 1870s, with its highest point at over 1,000 m. The economic crisis of the late 1870s virtually brought major European rail projects, such as the Gotthard (see below) and the Arlberg tunnels, to a halt for some time. Further mountain railways were eventually built at the end of the 19th century under Austrian influence, in Spain, France and in Italy, where several majestic railways cross the Apennines. By the beginning of the First World War, more than a dozen other new rail lines in Europe had maximum elevations of over 1,000 m – one example is the Bergen Railway in Norway. By 1976, the number of mountain railways was to double.

Train Jaune, France

The choice of the Train Jaune (Yellow Train) in France for comparison with the Albula/Bernina line was made based on the following criteria:

> Similar construction period
> Narrow gauge
> Overcoming large differences in altitude (several vegetation levels)
> Attractiveness of the landscape through which it runs (cf. 3.c.3)
> Still in operation
> Around 2001 the Train Jaune was considered for nomination as UNESCO World Heritage; extensive documentation was prepared in this context.

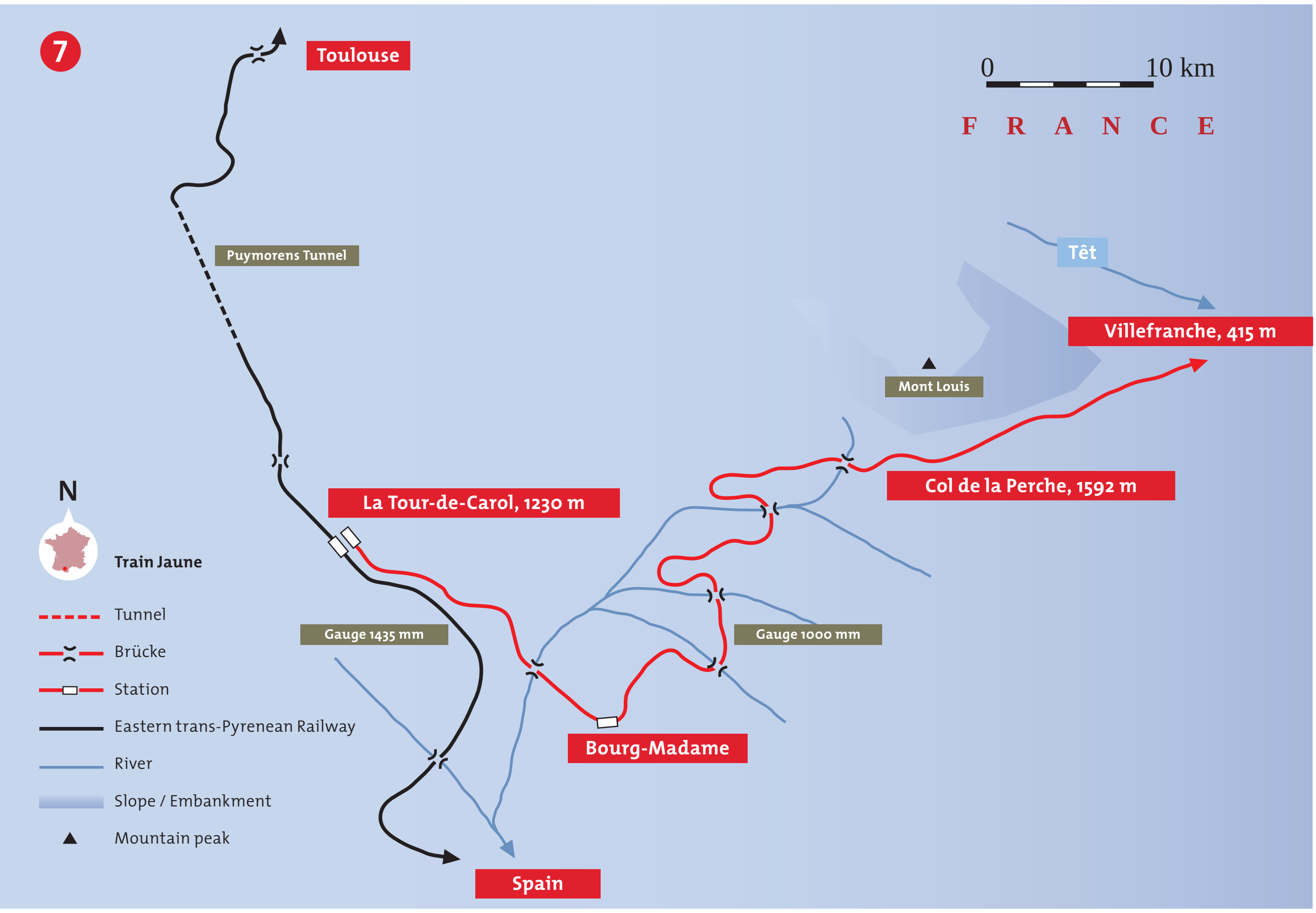
Construction history

Spain and France are separated by the Pyrenees, a chain of mountains stretching between the Atlantic Ocean (Bay of Biscay) and the Mediterranean (Gulf of Lyon). The building of trans-Pyrenean railways was considered from the late 1860s, but the actual planning for the construction of the easterly line from Toulouse

Mountain railways in Europe (without Switzerland) with highest points over 1,000 m

Country	Connection	Gauge	Highest Point in m [1)]	Opened [2)]
France	Villefranche – La Tour-de-Carol (Train Jaune)	Metre	1592, Col de la Perche	1911
France, Spain	Toulouse – Barcelona	Normal	1567, Porté Puymorens	1929
Italy	Dobbiaco – Calalco (Dolomites Railway)	950 mm †	1529, Cima bianche	1910
France	St-Gervais-le-Fayet – Vallorcine	Metre †	1386, Montets	1910
Austria	Innsbruck – Brènnero	Normal	1371, Brenner	1867
Spain	Madrid – Sierra de Ávila	1676 mm	1359, La Cañada	1863
Italy	Cosenza – San Giovanni	950 mm †	1340, Montescuro	1931
Austria	Feldkirch – Innsbruck	Normal	1311, Arlberg	1884
Italy	Torino – Modane	Normal	1306, Mont Cenis (1866: 2081, construction railway)	1871
Spain	Madrid – Burgos	1676 mm	1304, Somosierra	1968
Norway	Olso – Bergen	Normal	1301, Finse	1908
Spain	Madrid – Segovia	1676 mm	1296, Guadarrama	1888
Spain	Ujo – Pusdongo	1676 mm	1271, Perruca Túnel	1884
Italy	Sulmona – Isernia	Normal	1267, Rivisòndoli	1897
Bulgaria	Septemvri – Dobrini’ste (Rhodopen Railway)	760 mm	1267, Avromovo	1937
Austria	Schwarzach-St.Veit – Villach	Normal	1226, Tauern-Tunnel	1909
Spain	Sagunto – Zaragoza	1676 mm	1218, Escandón	1901
Italy	Fortezza – San Càndido (Pustertal Railway)	Normal	1210, Dobiacco	1871
Austria	Leoben –Hieflau (Erzberg Railway)	Normal	1206, Präbichl	1873
France	Livron – Briançon	Normal	1204, Col de Cabre	1876
France/Spain	Canfranc – Pau	Normal	1195, Canfranc	1928
Spain	Bilbao – León (La Robla Railway)	Metre	1192, Bercedo Pass	1894
Austria	Innsbruck – Scharnitz (Karwendel Railway)	Normal	1185, Seefeld im Tirol	1912
France	Grenoble – Marseille	Normal	1176, Col de la Croix	1877
France	Aurillac – Neussargues	Normal	1152, Lioran Tunnel	1868
Spain	Aranjuez – Valencia	1676 mm	1132, Palancares Tunel	1947
Spain	Almería – Linares-Baeza (Sierra Nevada-Linie)	1676 mm	1129, Huénejar-Dolar	1899
Austria	Scharnitz – Pfronten-Steinach (Ausserfern Railway)	Normal el.	1128, Lähn	1913
France	Le Puy – St. Germain	Normal	1089, Sembadel	about 1900
Spain	La Coruña – Zamora (Sierra de la Culebra)	1676 mm	1087, La Mezquita	1958
France	Bort – Neussargues	Normal	1081, Clarièrespass	about 1900
Spain	Torre – Brañuelas (La Granja)	1676 mm	1080, Divisoria Tunnel	1882
France	Le Puy – La Levade d’Ardèche	Normal †	1076, S. Cirgues	1936
Italy	Cùneo – Ventimiglia	Normal	1073, Tenda-Tunnel	1915
Romania	Bucarest – Brasov	Normal	1057, Predeal	1879
France	Neussargues – Béziers (Causses)	Normal	1056, Arcomie	1888
Romania	Brasov – Ploesti (Karphaten Railway)	Normal	1054, Predeal	about 1900
Poland	Kamienna Gora – Krzeszow	Normal	1052, Krzeszow	1899
Yugoslavia	Belgrad – Bar	Normal	1032, Kolasin	1976
France	Nîmes – Clermont-Ferrand (Cevennes)	Normal	1030, S. Laurent les B.	1870
Norway	Trondheim – Dombas (Dovre)	Normal	1025, Hierkinn	1921
France	Nice – Digne	Metre	1023, Thorame Haute	1894
France	Le Puy – Vichy	Normal	1021, Allègre	1902
Bosnia	Usice – Mostar (Bosnian Railways)	760 mm †	1000, c. Usice	1891

[1)] various figures quoted for highest stations or culmination points
[2)] various figures quoted for part or generally continuous opening
† closed down



Train Jaune > Mountainous section.
H.P. Bärtschi

Train Jaune > 'Le Viaduc Séjourné' at Fontpédrouse. Photograph 2002.
H.P. Bärtschi

Train Jaune > 'Pont suspendu Gislard' over the river Têt. Photograph 2002.
H.P. Bärtschi

via La Tour-de-Carol to Barcelona was not to begin until 1910. However, the route was not completed until 1929, just in time for the World Exhibition in Barcelona. The transnational rail line which led from the Mediterranean near Montpellier via Perpignan to Barcelona was built already in the 1860s. In 1880, the *Compagnie des Chemins de fer du Midi*, known as the Midi, was awarded a concession for the construction of a high-altitude mountain railway from Villefranche to La Tour-de-Carol over the plateau of the Cerdagne in the French part of the East Pyrenees. It was to connect with the transnational Mediterranean lowland route to Prades, in operation since the 1870s, which branched off to the west at Perpignan. By 1895, the Midi had extended this to reach Villefranche. The construction of the high-altitude section from Villefranche was originally intended – like the lowland railway – to be built in standard gauge. However, the laying of the track proved difficult, entailing lengthy delays in completion. The construction of the railway was of national significance: in the first place for military reasons, due to the border installations in the Cerdagne, and secondly with respect to securing the power supply. In the end, in order to achieve rapid completion of the construction, a franchise was awarded in 1903 for a metre-gauge railway with gradients of up to 60 ‰, that would reduce expenditure considerably. Immediately the concession had been granted for a new rail variant, the Midi began planning the section between Villefranche and Bourg-Madame on the Spanish border. Initially a steam railway with cogged sections was considered. However, as the state was at that time subsidising the construction of power stations and the electrification of the border region, it was decided to build an electrically operated railway. The 53 km metre-gauge high-altitude line began operating between Villefranche and La Cabanasse in 1910, and finally as far as Bourg-Madame in 1911, with an lateral rail being installed for the supply of electrical energy (850 volt direct current). In view of the opening of the already mentioned easterly trans-Pyrenean railway (Toulouse-Barcelona) the line was extended in 1927 to La Tour-de-Carol, increasing the length of the route known as the 'Train Jaune' to 63 km.

Feeder lines

The standard-gauge easterly trans-Pyrenean railway, which meets the Train Jaune in La Tour-de-Carol, with its highest point of 1,567 m and a spiral tunnel in France and one in Spain, together with the Train Jaune counts as one of the most spectacular mountain railways in the Pyrenean region. To the north of La Tour-de-Carol it crosses the foothills through the 5.4 km Puymorens Tunnel. Together with the transnational line along the Mediterranean and the Train Jaune it forms an H-shaped rail network along and across the principal ridge of the Pyrenees.

Rail track routing and railway structures

The individual sections of the Train Jaune, which was built in stages (1910, 1911 and 1927) – the highest continuous line in France – have all been preserved in their original condition with regard to track, power supply, and civil engineering structures and buildings. The route includes prolonged, steep gradients and an alignment with many curves, across steep slopes high above the valley floor. In the mountainous easterly section, there are many safety structures to protect against rainfall, rockfalls and mudflows. There is a total of 233 bridges, 177 of them built of stone.

The gradient begins immediately after the terminal at Villefranche, at 415 m. The route runs along the right bank of the river Têt. Before Thuès-les-Bains, it traverses several spurs of the mountains in tunnels. Tributary valley loops are provided with extensive protective structures and bridges. Between Thuès-entre-Vails and Fontpédrouse, the line crosses the main river on the great stone Séjourné viaduct. It then winds its way up the narrow gorge on the left bank. The large power station, which also delivers power to the railway is located at Fontpédrouse-Saint Thomas-les-Bains. The line has now already reached an altitude of 1,050 m. Further up, it crosses the gorge of the Têt on the unique 'Pont Gislard', a braced suspension bridge. The bridge is named after the railway commandant who suffered a fatal accident here in 1909 during the bridge trial run. The line makes another loop and passes through a short tunnel to reach the fortified town of Mont Louis-La Cabanasse, at 1,510 m. The route passes through 19 tunnels with lengths of up to 380 m on its way to its maximum altitude of 1,592 m at the Col de la Perche. It then makes its way down, with many curves, past the Spanish enclave of Llivia into the Cerdagne basin and then along the Spanish border to the station of La Tour-de-Carol.

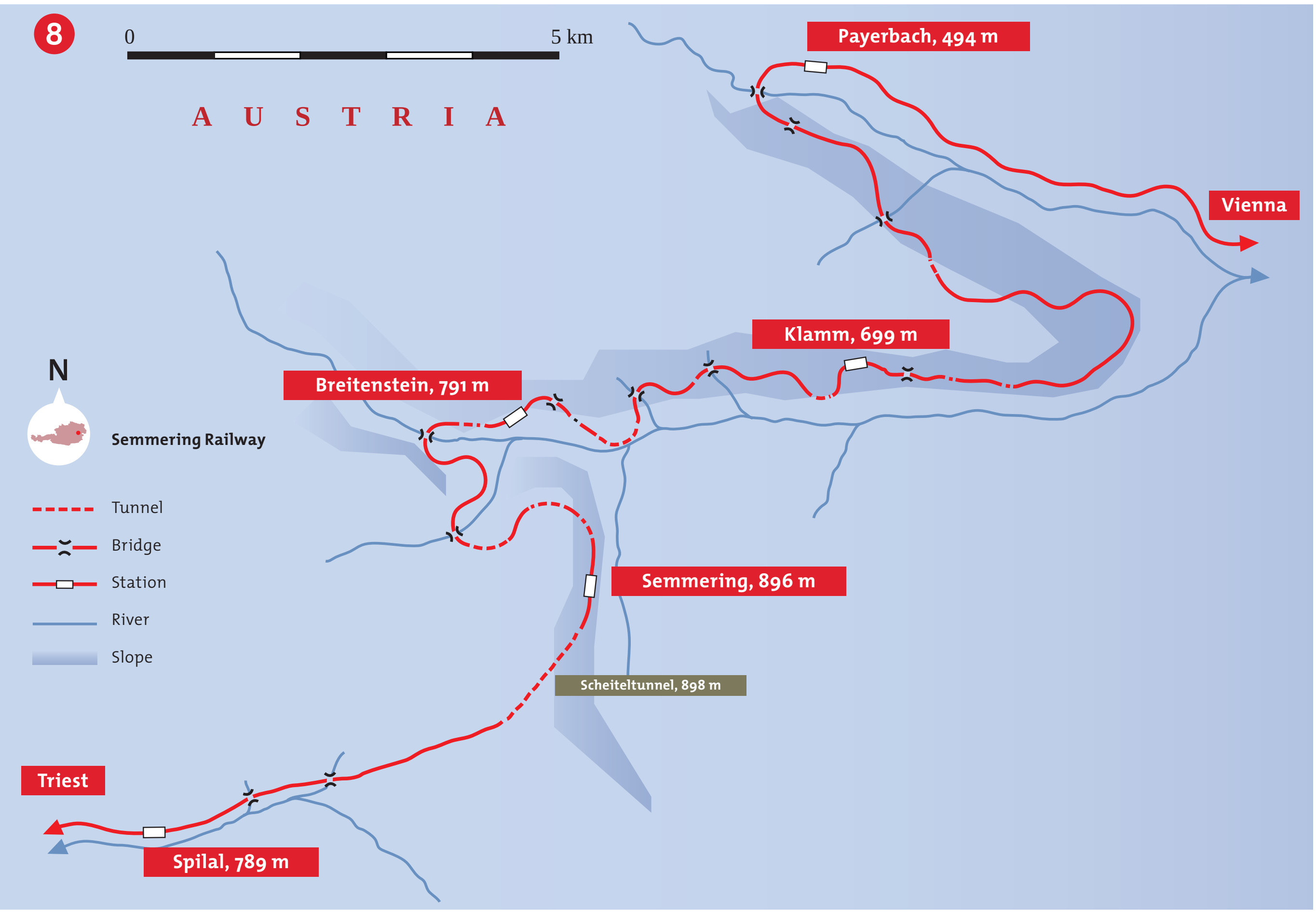
The railway installations in Villefranche are fascinating; with its standard-gauge station, platform roofs and depot, as well as the loading equipment of the metre-gauge rail at the sloping channel to the north. The station layout in La Tour-de-Carol, dating from 1927 – 1929, includes platforms in three gauges, because the metre-gauge of the Train Jaune, the standard gauge of the French national railway and the wide 1,676 mm gauge of the Spanish national railway all converge here.

Operation and equipment

Since the cessation of the generally low-level freight transport in 1974, the section between Villefranche and La Tour-de-Carol has been used only for a modest level of passenger, principally tourist, travel. Until 2002, the whole passenger operation – five to six pairs of trains per day – was run with the original rolling stock from the early days. The chassis, frames and lateral electricity take-up equipment still bear the Midi logo and the axle bushings are dated 1908. The carriage-work was renewed in the 1980s and new locomotives have been acquired since 2003.

Comparison

The Train Jaune, like the Albula/Bernina line, is one of the mountain railways which were completed in the decade before the First World War. The highest elevation of 1,592 m is significantly lower than that of the Albula/Bernina line. The topography demanded numerous complex constructions, including two large bridges. The number of tunnels is considerable, although it was not necessary to build any spiral tunnels. Overall, the degree of technical difficulty in the construction of the Train Jaune is less than that of the Albula railway. With regard to the mode of operation, the Train Jaune is identical to the Bernina railway, in that both are examples of the earliest electrical railways. The power supply by means of lateral rails used for the Train Jaune, however, did not establish itself as a means of supply in other surface railways. Nevertheless, both lines exemplify the need to consider the mode of operation in direct relation to the technically feasible route parameters, such as maximum gradient. With regard to the risk involved in building an electric railway in the mountains at the beginning of the 20th century, in view of the lack of experience, the boldness of design of the Bernina railway exceeds that of the Train Jaune, in spite of the latter's maximum gradient being 10 ‰ more and its highest elevation some 660 m higher. As with the Albula/Bernina line, the track and buildings – apart from the usual operationally necessary adaptations – have been retained in their original state. The rolling stock from the early 20th century has also been largely preserved, with respect to mechanical features, although since 2003 the locomotives have been replaced by new ones, now in modest daily use. In contrast, the Albula/Bernina railway operates a full service schedule daily using the new rolling stock throughout, while the historic cars and locomotives are used for museum purposes.



Semmering Railway > An important section of the line.
H.P. Bärtschi

Semmering Railway > Stone arch viaduct across the Kalte Rinne. Photograph 1979.
H.P. Bärtschi

Semmering Railway > East portal of the crest tunnel. Photograph 1979.
H.P. Bärtschi

Semmering Railway, Austria

The choice of the *standard-gauge* Semmering Railway in Austria for comparison with the Albula/Bernina line was based on the following criteria:

- UNESCO World Heritage Site
- World's first high altitude railway – character as prototype
- Overcomes great differences in altitude
- Attractiveness of the surrounding landscape (cf. 3.c.3)
- Still in operation

Construction history

The Semmering is one of the most easterly Alpine passes; it reaches an altitude of 984 m. In 1842, the government of the then Austrian Empire resolved to build a – standard gauge – railway from the capital in Vienna to the Adriatic port of Trieste. This meant that the Semmering region acquired new significance; comparative studies prepared before the construction of the line came to the conclusion that for a railway from Vienna to Trieste, the best route would be through the Semmering region. This assessment is remarkable because at that time there was no experience with railways in mountain ranges and massifs with deep valleys and great heights to draw on. At the end of the 1840s, the highest railways in the world reached a maximum of around 660 m. On the Semmering, a difference in altitude of almost 500 m, and a landscape cleft by deep valleys, had to be overcome within a linear distance of less than 10 km.

In 1842, the construction manager Carl Ghega travelled to England and North America to study the latest developments in railway technology as preparation for the definitive planning work for the construction of the Semmering Railway. At the same time, comparative studies were carried out to determine the best, that is, the technically and economically most advantageous type of track. Ghega, who was able to draw on 20 years of professional experience in high-altitude road construction, coupled this with the knowledge gained from his study trips in his planning and building of the Semmering Railway. The outcome was a serpentine layout between the towns of Gloggnitz and Mürzzuschlag sweeping into tributary valleys; this artificial lengthening of the route permitted a gradient which could be taken by steam locomotives (27‰ at its maximum). The planning was completed in 1844. However, it was not possible to start construction until the time of the revolution of 1848, coupled with the search for employment projects to occupy the dissatisfied population. As many as 20,000 men worked between 1848 and 1854 on the nearly 42 km route, without tunnel drilling machines or effective explosives. To overcome the topographical difficulties, 16 large viaducts (four of them two-storey) and 15 tunnels had to be constructed. In both cases new ground was being broken, and both viaducts and tunnels were laid out in tight turns, which meant special challenges with regard to the surveying (tunnels) as well as to the stress of the heavy trains (viaducts).

After only six years of construction, the Semmering Railway was successfully brought into operation, and the contemporary press reported ecstatically that there was now no mountain over which a railway could not be led, and no river over which a bridge could not be built (Lloyd Triestino, July 2nd 1854).

Feeder lines

The Semmering Railway is thus part of the Vienna – Trieste rail connection. At Gloggnitz, its northerly end point, it connects to the lowland railway leading to Vienna and the Vienna catchment area, and again at Mürzzuschlag; at the southern end the route continues on the valley floor through the Mürztal and the Murtal. In 1879, a standard-gauge auxiliary line was built through a side valley from Mürzzuschlag to Neuberg, and from 1922 an electric narrow-gauge railway led from the station at Payerbach-Reichenau as a transport line for the paper industry based in Hirschwang. From 1926, with the introduction of passenger travel, this also functioned as a feeder for the Rax cable railway up to the high mountains. The auxiliary line mentioned is now (2006) no longer functional, while the narrow-gauge line operates only a nostalgia service.

Layout and railway structures

The Semmering Railway starts in Gloggnitz in lower Austria at an altitude of 439 m and gains height by means of a wide loop into the Reichenau valley. At Eichberg station – only 2 km from Gloggnitz as the crow flies – the track is already 170 m higher. Further loops into the Adlitzgräben valley, where the famous viaduct over the 'Kalte Rinne' (182 m long, 46 m high and situated on a 180 m curve) is located, also serve to artificially lengthen the route. The highest point of 898 m is reached in the 1,428 metre crest tunnel. After the tunnel, the track leads through the Fröschnitz valley to Mürzzuschlag (681 m) in a much less spectacular fashion.

For the most part, the original structures of the Semmering Railway have been preserved until today. After the Second World War, the viaducts and tunnels were in poor structural condition and extensive renovation work was required. As part of this, the original main tunnel was downgraded in 1952 to a single-track tunnel and in 1953 a second, parallel single-track tunnel was built to retain the capacity of a double-track line. After the renovation of the structures, electrification of the line followed, reaching completion in 1959. Due to their generous dimensions, it was possible to retain the complex design of the tunnel portals in their original form when realising the electrification. In contrast, the stone parapets of some viaducts had to be removed or the masonry surfaces plastered, impairing the original clarity of line.

Over the course of the decades, with rapidly growing traffic frequency, the station and operational buildings were repeatedly adapted to changing demands with more or less architectural sensitivity depending on the period. In Semmering, which became a tourist destination towards the end of the 19th century, the station building had to be expanded several times. On the other hand, the formerly 55 quarry stone linesmen's houses required for the continual monitoring of the route and built to a uniform design have been almost completely preserved.

The structural facilities necessary for the original steam-driven operation (service buildings such as boiler houses, workshops, turntables and water supplies) in Gloggnitz, Payerbach, Semmering and Mürzzuschlag were dismantled after the electrification of the route – except for the locomotive turntable and the 'Neue Montierung' hall with the transfer platform in front of it (all Mürzzuschlag), which were declared (Austrian) protected monuments in August 2006.

The track facilities at the stations were most affected by conversion work. As it became possible to operate longer trains with the more powerful locomotives, longer sidings were required in the stations. Most of the buildings used to handle freight transport (goods sheds, loading facilities) were dismantled, particularly after the Second World War and due to the shift of focus to road transport.

Since the inscription of the Semmering Railway in the UNESCO World Heritage List in 1998, all renovation and rehabilitation work on the line has been carried out after conferring with the Austrian Federal Office for Historical Monuments.

Operation and equipment

The Semmering Railway provided both passenger travel and freight transport between Vienna and the northern Adriatic coast, particularly for the region around Trieste. Today, both inland traffic, from Vienna to the southern states of Austria, and international travel to the neighbouring countries Italy and Slovenia flows over the Semmering. Passenger and express trains are in operation daily, as well as freight trains (80 passenger trains and 100 goods trains a day in 2003). The large number of trains in operation was the impulse, in the 1980s, to demands for a base tunnel. Due to legal uncertainties and the high capital investment required, the project is still in the planning stages.
In recent years, in addition to the scheduled daily operations with the current rolling stock, passenger trains with equipment from the 1960s and 1970s have been operated at weekends and advertised as nostalgia trains. Trains drawn by steam locomotives ply the Semmering line for these excursions. No rolling stock from the construction period has been preserved.

Comparison

The Semmering Railway and the Albula/Bernina line both belong to the category of railways that cross a massif from one side to the other, even though they display an essential difference in their gauges. The Semmering Railway, established in the early 1850s as a two-track main line in standard gauge marks a milestone in the history of rail building. It was planned in the early phase of steam locomotive operation, and the track parameters, such as maximum gradient, were designed for this mode of operation. In this respect, the 27 ‰ gradient used on the Semmering was virtually standard for steam-driven high-altitude railways even in later years. The Brenner Railway, for example, had a maximum gradient of 25 ‰, the Gotthard 27 ‰, the railway through Mont Cenis 30 ‰ and the Albula line 35 ‰.
In the half century which passed between the construction of the Semmering Railway and that of the Albula/Bernina line, railway engineering had experienced numerous changes and innovations. Thus the Albula/Bernina Railway illustrates in a unique way the manifold construction possibilities at the turn of the century, both in steam locomotive technology and electrical operation, which was new at that time. While the Albula line was constructed according to the track parameters usual for steam operation, the Bernina Railway demonstrates the capabilities of electrical railway operation. Not only does it have a maximum elevation which even today is the highest in a transalpine railway, but with a maximum gradient of 70 ‰ it is also twice as steep as the Albula line opened four years earlier.
Further, with respect to the techniques adopted for artificially lengthening the distance, in contrast to the Semmering Railway, the whole range of engineering possibilities for conquering a mountain range is found on the Albula/Bernina line. As well as sweeping into tributary valleys to overcome height differences – used for the first time in the world on the Semmering – these include the (cost-effective) open loops on a slope (Bernina) and the (costly) spiral and crest tunnels (Albula). During the brief time window between the 1870s and the 1910s spiral tunnels were the typical tunnelling method for high-altitude

railways. It was not possible to construct long crest tunnels before the invention of tunnel boring machinery, which was used for the first time on Mont Cenis in the late 1860s.

The Albula/Bernina illustrates in a unique way the differing technical solutions for constructing railways in mountainous regions at the beginning of the 20th century, as the Semmering Railway does for the middle of the 19th century. In this sense, the two lines are comparable and equal.

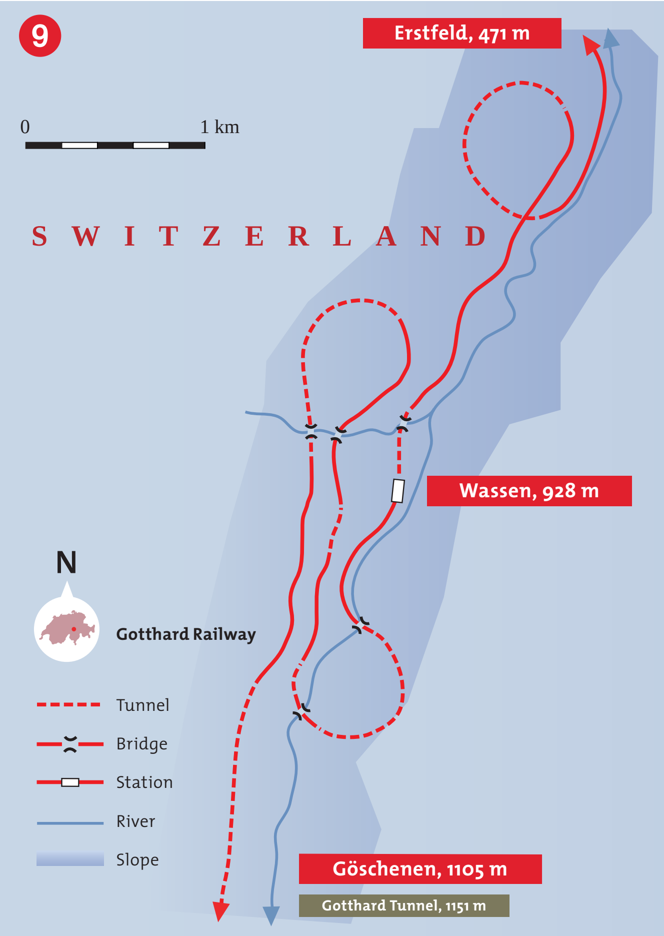
Switzerland

In comparison with other European countries, railway building began relatively late in Switzerland. The reasons for this are to be found in private rivalries, regional power struggles and in the challenging topography of large parts of the country making high capital investment essential. In 1859, the main line railway between the Lake of Constance and the Lake of Geneva was completed, with branch lines towards Basel and Lucerne. By the beginning of the First World War, a very dense network of private and state railways had been built. In 1909, the largest railway company, the *Gotthardbahn*, was nationalised and renamed the *Schweizerische Bundesbahnen* SBB (Swiss Federal Railways SFR).

The first high-altitude railway in Switzerland was opened as early as 1858, with the standard-gauge Hauenstein Railway which led in double tracks from Basel to central Swiss. However, its crest tunnel is at an altitude of only 559 m. In 1859 another railway leading into the Jura Mountains was brought into service. The starting point was Neuchâtel and it served principally to access the two high-lying watchmaking centres of La Chaux-de-Fonds and Le Locle. This is the only main line railway in Switzerland with a setting back track. It has a total of nine tunnels between the Lake of Neuchâtel (479 m) and the French border. The maximum elevation of the line is 1,048 m, at Converse, a height which was not exceeded until the construction of the Gotthard Railway.

North to south travelling in Europe must necessarily cross the Alps. In 1807, Napoleon I had the first transalpine carriage road constructed over the Simplon Pass. The Austrian and Graubünden pass roads over the eastern Alps followed. With the opening of the Suez Canal in 1869, the flow of goods was diverted from the Atlantic harbours to those of the Mediterranean, accelerating the construction of alpine railways. After railways had been over the Brenner Pass (1867) and through Mont Cenis (1871), the construction of an alpine crossing also became a top priority in Switzerland. Three versions were discussed: one through central Switzerland, another through eastern Switzerland and the third through the Canton Valais, starting from the capital, Bern. The first to be built was the central variant where, with the help of financial contributions from Germany and Italy and with construction workers from Italy, it was possible in 1882 to inaugurate the shortest European north – south connection with the Gotthard Railway, running from Lucerne to Chiasso. The route reaches a maximum altitude of 1,151 m. It was not until 1913 that the Lötschberg Railway, also standard gauge, running through Valais was opened; construction had been aided by French capital. Its highest point is 1,240 m. The Lötschberg and Gotthard railways are among the most important standard-gauge north – south links in the whole of Europe. In addition to these, by 1926 more than a dozen narrow-gauge high altitude railways with culmination points in excess of 1,000 m had been built in Switzerland.

As a result of the shortage of coal during the First World War – imports from the surrounding European states had virtually come to a standstill – in 1916 the Swiss government decided on the electrification of the rail lines, which until then had largely been operated with steam locomotives. Switzerland had plentiful water power of its own for the generation of electricity. Thus an almost 100% electrically-operated rail network was created in Switzerland – the first in the world. In contrast to most other countries, Switzerland did not suffer extensive rail closures after the Second World War. Today there are 3,700 km of standard-gauge track and 1,700 km of narrow gauge.



Gotthard Railway > An important section of the line.
H.P. Bärtschi

Gotthard Railway > North ramp at Amsteg Swiss Federal Railways power station. Photograph 1988.
H.P. Bärtschi

Gotthard Railway > Biaschina south ramp with three track levels. Photograph 1997.
H.P. Bärtschi

Gotthard Railway > Single-track access section along the Lake of Lucerne. Photograph 1988.
H.P. Bärtschi

Mountain railways in Switzerland with highest points over 1,000 m

Country	Connection	Gauge	Highest Point [1] in m	Opened [2]
Switzerland	St. Moritz – Tirano (Bernina Railway)	Metre	2253, Ospizio Bernina	1910
Switzerland	Brig – Andermatt	Metre, Z	2163, Furka (mountain section)	1926
Switzerland	Disentis – Andermatt	Metre, Z	2045, Oberalp Pass	1926
Switzerland	Thusis – St. Moritz (Albula Railway)	Metre	1823, Albula Tunnel	1903
Switzerland	Chur – Arosa	Metre	1742 Arosa	1914
Switzerland	Landquart – Davos	Metre	1633, Davos-Wolfgang	1890
Switzerland	Visp – Zermatt	Metre, Z	1605, Zermatt	1891
Switzerland	Montreux – Lenk	Metre	1275, Saanenmöser	1905
Switzerland	Spiez – Brig (Lötschberg Railway)	Normal	1240, Lötschberg Tunnel	1913
Switzerland	Nyon – St.Cergue(– La Cure)	Metre	1233, La Givrine	1917
Switzerland	Erstfeld – Biasca (Gotthard Railway)	Normal	1151, Gotthard Tunnel	1882
Switzerland	Reichenau-Tamins – Disentis	Metre	1133, Disentis	1903
Switzerland	Neuchâtel – Le Locle	Normal	1048, Convers	1859
Switzerland	Stans – Engelberg	Metre, Z	1002, Engelberg	1898
Switzerland	Luzern – Meiringen	Metre, Z	1002, Brünig-Hasliberg	1888

[1] various figures quoted for highest stations or culmination points
[2] various figures quoted for part or generally continuous opening
Z cog system

Gotthard Railway

The choice of the *standard-gauge* Gotthard Railway for comparison with the Albula/Bernina line was based on the following criteria:

> Overcoming large differences in altitude (several vegetation levels)
> Use of spiral tunnels and long crest tunnels
> Attractiveness of the landscape it runs through (cf. 3.c.3)
> Still in operation
> Of major national significance

Construction history

The construction of the Gotthard Railway was begun in 1872. The access sections in Canton Ticino, south of the Alps, were completed as early as 1874, although it was not possible to finish the northern accesses Lucerne – Immensee and Zug – Goldau until 1897. Rises in construction costs and delays resulting from hectic changes to the plans and inadequate tenders drove the company responsible for building the line into financial crisis by 1875, and in 1878 the application for additional subsidies was refused by the Zurich electorate. A new variant of the project provided for the gradient to be increased using ramps and for a track course with tighter curves. The construction of the crest tunnel through the Gotthard massif alone claimed 200 lives. After the delayed completion of the great work in 1882, the Gotthard line developed into the most modern private railway in Switzerland. The Gotthard Railway Group, which had been heavily supported by the public purse, comprised a network of a total of 273 km on the opening of the Gotthard Railway.

Due to financial difficulties, the Gotthard Railway, which had been planned from the start as double-track, was initially constructed only as single-track, with the exception of the crest tunnel. The progressive expansion to double-track on the ramps took place between 1890 and 1896. Between 1912 and 1948 – the Gotthard Railway had been nationalised in 1909 – the feeder lines in the valleys on both sides of the Alps were also given a second track. The last gap in the double track over the Melide embankment was not closed until 1965, in the course of the motorway planning. The Gotthard Railway was converted to electrical operation following the Swiss Federal Railways Board of Directors resolution of 1916. The Lötschberg Railway in western Switzerland and parts of the network of the Rhaetian Railway had already been electrified with high voltage single-phase alternating current in previous to this. Two hydroelectric power stations for the railway were built in Amsteg and Ambri-Piotta, and in 1920 the high altitude section and in 1922 the valley lines were also electrified.

Rail track routing and railway structures

The difficulties in integrating the line into the topography were extraordinary in every respect: prolonged steep gradients on both ramps, construction of numerous helical and spiral tunnels for the first time in the Alps, elaborate layout with retaining walls and rock cuttings on steep slopes high above the valley floors and very extensive structures to guard against avalanches, rockfalls and mudflows. Highly varied construction methods were employed for the bridges, on which the big, broad-spanned traverses were formed as lattice constructions of riveted, welded iron. For years, the 16 km crest tunnel was the longest tunnel in the world. The magnificent layout of the line at Wassen with one spiral and two helical tunnels is an invariably fascinating experience, similarly the Piottina ravine at Faido and the Biaschina gorge, each with its two spiral tunnels almost on top of one other.
The overall structure has been adapted to developments in technology over the years. Thus, the contact lines were modernised and the floors in the tunnels were lowered in order to increase the clearance of the profile. In particular, all the original iron latticework suspension bridges were replaced by new constructions in compressed and pre-stressed concrete, and in places with concrete with granite cladding. However, the alignment is still original and the monumental structures of the Ticino valley railways of 1875 and a large number of the simple buildings in the mountain section from 1882. The Airolo and Göschenen stations at the two ends of the Gotthard tunnel were converted and extended repeatedly between 1954 and 1980 in connection with establishing a car-loading facility. The section along the Lake of Lucerne – one of the access lines – retains the most original parts from the time of the construction, as the second track was given a separate alignment.

Operation and equipment

The primary importance of the Gotthard Railway was and is that of a European north – south transit axis. Accordingly, there have been continuous conversions, adaptations and replacements, both of the installations and the rolling stock, and consequently of the operational structures as well. As with the Semmering Railway, the mountain segment was later converted to electrical power to replace the expensive operation with steam locomotives and the mechanical signalling facilities had to give way to the current electrical systems. A selection of historic rolling stock has been preserved and is employed for special excursions. In 1992, the Swiss electorate approved the construction of a second base tunnel through the Gotthard and the Lötschberg. The breakthrough on the Lötschberg was made in 2005, and the opening of the tunnel is planned for 2007. The Gotthard base tunnel, which, with its length of 57 km, is one day to become the longest rail tunnel in the world, is scheduled to be opened in 2014.

Comparison

The Gotthard Railway was opened a quarter of a century before the Albula/Bernina line. The highest point of the Gotthard Railway, which was designed as a standard-gauge transit line, is significantly lower than that of the narrow-gauge Albula/Bernina Railway, which serves regional and trans-Alpine and transnational access. Both the degree of difficulty of construction and the attractive integration into the natural topography of the Gotthard Railway is comparable with that of the Albula/Bernina line, where the density of civil engineering structures – tunnels, bridges, cuttings, embankments – is very high. Until the construction of the Simplon tunnel between Switzerland and Italy (opened in 1906) the Gotthard Railway had the longest tunnel in the world, while spiral tunnels were used for the first time in Switzerland. The track layout, sometimes overlaying itself three times, remains to this day, like that of the Albula Railway, a marvellous attraction.

The original alignment has been preserved, and the track has had to be repeatedly maintained and repaired because of the high train frequency. In particular, the steel latticework suspension bridges typical of the original Gotthard Railway have, without exception, been replaced by concrete bridges since the 1950s. This type of bridge construction aroused great controversy among contemporary observers. The bridges of the Albula Railway, which are still to a very large extent preserved in their original condition, in contrast, were singled out by contemporaries as “adapted to the environment in an exemplary fashion”.

Many of the Gotthard Railway structures are still preserved in their original condition, even if – as is usual for railways which are in daily operation – adaptation has been carried out continually. As a high capacity European line, the character of the Gotthard Railway differs essentially from the Albula/Bernina line. Continuation of the Gotthard mountain route after the opening of the base tunnel (scheduled for 2014) is planned, but the definitive decision has not yet been taken.

3.c.3 Comparison of the surrounding countryside

Railways often traverse regions whose landscapes have a unique character – such as high mountains or industrial zones. However, the specific links between railways and their respective (cultural) landscapes, such as the significance of impressive views from the railway or on to it against its surroundings, have rarely been addressed to date. Although there have been isolated surveys with the character of an overview, such as that by Wolfgang Schivelbusch on the phenomenon of perception during a railway trip published in 1977, there is still a need for a systematic and classifying treatment of the subject. The exemplary and very comprehensive ICOMOS study entitled *Railways as World Heritage Sites* from 1998 highlights the significance of the surrounding landscape in certain cases (Semmering Railway, Darjeeling Railway). And the three publications by the German ICOMOS national committee, which document the *Eisenbahn und Denkmalpflege* (Railway and Monument Preservation) symposia of 1990, 1992 and 1997, contain *one* basic paper on the topic of railway and landscape. On the other hand, treatments of the cultural landscape always completely exclude the impact of the railway itself, although pictures of landscapes that are at least partly characterised by railways may be used as examples to explain cultural landscapes. This approach is in complete contrast to the transport infrastructures of the inland waterways of the kind outlined within the scope of the *International Canal Monuments List* of ICOMOS. Canals form industrial landscapes and are regarded as being embedded in them.

The international comparison of the cultural landscape surrounding the Albula / Bernina railway corridor will therefore be preceded by conceptual considerations as well as the creation of an appraisal scheme with a number of analysis categories to indicate the differences with respect to the surrounding countryside of the various railways.

Landscapes, cultural landscapes and...

The emergence of tourism in the second half of the 19th century and the boom in travel guides advising travellers on what they should do and see, produced a shift from the previously used word “district” to the term “landscape”. The latter is understood as the surroundings perceived aesthetically and in an ordered way. The landscape must be observed and reflected upon from a distance and is consequently subject to changes in ideologies and fashions. So it must be mediated in order to be seen and appreciated. This mediation may assume various forms: as texts in the form of travel guides or novels, by word of mouth as well as visually by means of illustrations, picture postcards or advertising posters. If these visualisations produce “standard views with variations” then the travel books designed specifically for a railway trip bring aids to sightseeing and visual choreographies for looking out of the carriage window. But they also allow the otherwise unique experience of a perceived railway journey to be replicated: the prospective traveller can take an imaginary journey even *before* the real one – by reading the travel guide or looking at the illustrations. He or she can then enjoy the "right" views *during* the trip and thus recognise particular scenes. *After* the trip, travellers can enjoy a shared repertory of images with the aid of photographs or conversations with other travellers. But we can also see how the process of mediation brings out the hidden guiding ideas and motivation structures, values and norms, in brief, all the cultural associations of a landscape. So although the term landscape focuses on natural or man-made surroundings, it requires the observer to perceive it in something like a prejudiced or "artificial" manner, promoting an aesthetic appreciation of the surroundings. In recent decades, increasing research has been carried out into landscape, which has led to an ever greater differentiation of this concept and the associated identification of urban, agricultural and industrial landscapes. All these landscapes are subsumed by the term cultural landscape, which is in turn to be understood in opposition to the natural landscape untouched by man. Expert in cultural landscapes Gerhard Strohmeier defines a cultural landscape as follows: "A cultural landscape is produced by natural and social processes. Cultural landscapes develop from certain features of the natural space by means of social appropriation and the harnessing of natural dynamics. Not only is the cultural landscape itself formed by social activities, its perception is no less mediated by aesthetic images and ideas. This construct of dominant modes of perception of a landscape is generated by certain social interest groups who appropriate the landscapes in the form of specific images."

The following study of 'cultural landscape' will start from this definition and move in two directions. On the one hand the surroundings changed by man's diverse interventions with their respective elements that structure the landscape (agricultural utilisation, structures etc.), and on the other hand the perception and appreciation of the landscape (both cultural and natural landscape).

The physical character of the cultural landscape is moulded in many ways by its economic utilisation. The restricted space in mountain regions is a central defining feature, whereas the "cultivated landscape" of more extensive regions is synonymous with uniformity, elimination of dividing elements and massive interventions by man to level the land. The cultural landscape in the mountains is characterised by the restricted spaces caused by man having to take into account the numerous differences in the natural space when exploiting it in order to assure ecological stability. An unadapted mode of land use would aggravate the potential for geo-ecological hazards (e.g. due to flooding, mudslides and avalanches).

The spatial pattern underlying the cultural landscapes was developed since the beginning of the modern age in Europe. The imagination of space is centred on the mental image that evaluates the real environment as "landscape". These mental images form the basis both for the discovery of the mountains and for the transformation of the new world from its perception as a "wilderness" to its appreciation as "landscape".

The Alps and their "emblematic core", the Alpine landscape, constitute a shared asset of European culture as a zone of widely differing and mutually interpenetrating cultural influences. Alpine researcher Werner Bätzing derives the attraction of the Alpine region for tourism from the contrast between the varied cultural landscape within a small area of the Alps and its surrounding nature: the perception of "beauty" with reference to the Alpine landscape is only partially dependent on nature: to a significant degree it is due to the cultural landscape, which was ultimately created principally by the mountain farmers.

In North America, in contrast, nature provided the gauge and standard for the representation of landscapes – a nature which, on the basis of the Christian creation myth, was seen as an untouched primeval state that contributed to the self-portrayal of America almost as a projected wilderness which the advertising industry continues to exploit to the present day, on the lines of the Marlboro advertisement. Until the 19th century, however, the image of the new world had a European bias. Thus Europe provided the model for the perception of the phenomenon of '*alpine* glow' in the Sierra Nevada, as this local name indicates.

During the colonial era and the associated worldwide spread of the railways in the second half of the 19th century landscapes in Asia, Africa and South America were generally perceived from a European perspective.

...transport routes

In the case of railway lines, the surrounding landscape must always be seen in the context of the function of the relevant railway. Railways as a means of mass urban transport are embedded in totally different landscapes to tourist railways or those used to promote the colonisation of regions outside Europe. A distinction must be made between the following railway surroundings:

> economically exploited landscapes (agriculture; raw materials; industrial landscape)
> urban landscapes
> natural landscapes (the railway can promote the aesthetic perception of the landscape it runs through)
> landscapes already appreciated aesthetically before the railway was built (e.g. tourist attractions).

Perception acquires a special significance in the case of mountain railways: whereas the visual impact of the engineering and technical features is more immediate than with any other type of railway line, the 'romancing' of mountain landscapes also accentuates the symbolic value of the technology, and with it the symbolic significance of the landscape the railway runs through. This combination was the precondition for developing the conventional topos of the harmony of technology and nature, or a railway line that is adapted to the landscape.

This is evident from the railway postcards that, besides major stations, focus primarily on mountain railways with their engineering structures.

The postcards of mountain railways show the surrounding countryside as an integral element of the motif: the viaduct across the Kalte Rinne of the Semmering Railway (Austria) with the landscape as a distant perspective; the route of the Gotthard Railway (Switzerland) winding across several levels at Wassen, the Landwasser viaduct on the Albula Railway (Switzerland), or the 'Train Jaune' (France) with the viaduct at Fondpédrouse are all 'variations on standard views'. The recurring topos is a bridge structure embedded in the landscape. A bridge essentially symbolises a linking element, so these series of images aim to mediate visually between nature and technology. What is more, the views of mountain railways in mountain panoramas, where settlements already existed before the railway was built, frequently incorporate elements such as ruins or old churches in the composition of the view. The dual image symbolism of nature and artifice is thus extended to a trinity of nature, culture and technology, the latter being highlighted as a contemporary form of culture in contrast to the historic structures.

Another category of images focuses on the panoramic perception of the landscape as seen by a passenger during a railway trip in order to promote rail travel. In contrast to the static panorama of an all-round view, such as that seen from a mountain peak or in the all-round painted panoramas so popular in the 19th century, leporello foldouts generated a linear panorama along a section of a route from a single vantage point. In Europe, bird's eye views of particularly striking sections of a line were popular from the early days of the railway age. Special panoramic carriages were in operation from the second half of the 19th century: from the mid-1870s on scenic routes in the Alps (such as on the Salzburg – Wörgl route from 1875), particularly before the First World War in the USA on sections in the vicinity of the national parks and increasingly in Europe from the 1920s, such as over the Bernina Pass or on the Semmering. Panoramic carriages still run daily, for instance on the between Vienna and Zurich and Zurich and Milan routes as well as on trans-American lines such as the Canadian Pacific. Other examples are the Bernina Express from Chur to Tirano and the Glacier Express from St. Moritz to Zermatt.

Analysis scheme for a comparison of railway cultural landscapes

In addition to the physical characteristics of cultural landscapes, it is of fundamental importance for a comparative analysis to know how the cultural landscapes are perceived, which components are emphasised and which neglected and how this mode of perception changes over time. The Semmering Railway, the first high-altitude mountain railway worldwide (cf. 3.c.2), exemplifies this change of perception. It was already given a romantic spin with aesthetic panoramas and particular views when it first came into operation in 1854. This can be seen with particular clarity on an engraving from the early 1880s: in the foreground (left), imaginary rock pillars like those in the Elbsandsteingebirge and contorted tree roots are used to dramatise the impression of nature. This visual discourse ultimately led to the observation of a 'harmonious embedding of the railway in nature' from the 1920s. However, the enormous piles of rubble left behind when the railway was under construction, and still visible at the beginning of the 21st century, were carefully faded out of the picture.

An international comparison of the cultural landscape of the Albula/Bernina railway corridor with those of other railway corridors is discussed below according to the following four-module scheme specifying the importance of the buffer zone pursuant to Article 104 of the *Operational Guidelines* for the railway property:

> **Agriculture:** economic exploitation of the land to obtain plant products and subsequently also animal products (i.e. grazing land as a basis) with the relevant changes in the original natural landscape.

> **Structures:** material manifestations designed to fulfil social needs in the broadest sense on the basis of minor or major changes (i.e. from isolated buildings to urban agglomerations).

> **Transport routes:** infrastructures to permit the transport of people, goods and energy as well as information with the formation of a linear corridor.

> **Perception:** receptive awareness of the environment – both the natural and cultural landscapes – according to aesthetic criteria that are subsequently used to create identities oriented to the relevant environment (e.g. homeland, regional, national awareness, etc.).

Oceania, East and South Asia

Yunnan Railway, Vietnam/China

The trans-border Yunnan Railway runs from the port of Haipong in Vietnam to Kunming, the capital of Yunnan Province in China, at an altitude of 1,900 m. The line can be divided into two sections that also differ in terms of landscape: the Vietnam section from Hanoi to the border town of Lao Cai (Vietnam) or Hekou (China) is a valley railway running along the Red River. After leaving Hekou, the railway begins to climb up to the high plateau of Kunming, exhibiting the features of a mountain railway of the “Gebirgsbahn” type, before running through several valleys and crossing two passes.

Agriculture

The railway runs through several climatic and hence vegetation zones. The agricultural impact on the landscape consequently also varies: broad rice paddies and banana plantations predominate in the lowlands and in the Red River valley. The further the railway climbs into the rugged mountainous regions, the smaller the agricultural areas become. Cultivated fields are now found only in the immediate vicinity of the isolated settlements and have a very limited impact on the character of the landscape. Only after the high plateau is reached at Kunming, where the landscape broadens out, does the agricultural pattern change and larger fields begin to characterise the immediate environment of the railway corridor.

Structures

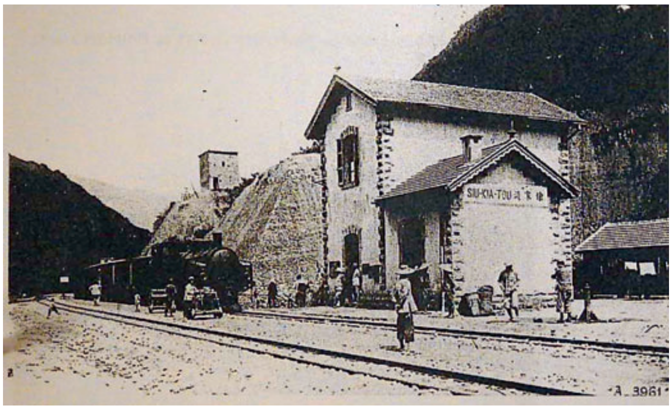
The buildings along the rail corridor display a wealth of diversity from colonial-style structures to the traditional buildings of the local inhabitants. In certain regions such as the mining areas of Lao Cai and Gejiu, industrial buildings have also had an impact on the cultural landscape. The Ta Tchen Ho valley in China is characterised both by railway structures and the trans-regional road as well as by numerous small power stations along the river that produce electricity. The valley of the Nam Ti, a tributary of the Red River, is a steep mountain valley, where railway structures play a dominant role, such as the lattice bridge over the Pei Ho gorge. The railway infrastructure makes a strong impact on the region that it traverses, especially due to the numerous bridges, which take the form of steel structures or stonework viaducts. However, there are no extensive structures to provide protection from landslides. The style of the railway structures shows French influence from colonial times; some station buildings, for example at Kunming or Kaiyuan, were replaced by new ones in the second half of the 20th century.

Transport routes

There is considerable variety in the standard of the structures along the transport routes in the various sections of the railway. The lowlands and the valley section along the Red River are well developed for traffic (roads and tracks, but also for boat transport on the river). The situation in the mountainous section is very diverse: in isolated regions with no settlements the railway is the only major transport route, whereas the Ta Chen Ho valley, for example, is characterised not only by the railway but also by the trans-regional road and the electric lines from the numerous river power stations. Again, the highland around Kunming is accessed by various roads and tracks. Another railway route, the new Kunming-Nanning standard-gauge section opened in 1997, accompanies the Yunnan Railway in the

Yunnan Railway > Between Pono-Tou and the Milati Pass.
P. Withehouse

Yunnan railway > Loop in a tributary valley at km 110. Illustration from: HULOT FRÉDÉRIC: *L'Indochine – le Yunnan* (Les Chemins de Fer de la France d'Outre-Mer, vol. 1), St. Laurent du Var 1990.



Yunnan Railway > Siu-Kia-Tou station building in the French style, about 1909. Illustration from: HULOT FRÉDÉRIC: *L'Indochine – le Yunnan* (Les Chemins de Fer de la France d'Outre-Mer, vol. 1), St. Laurent du Var 1990.

broad valley of the Si Chan Ta Ho, just before Kunming.

Perception

Perception of the landscape along the Yunnan Railway is characterised by the rugged mountain landscape and the colonial-style station buildings. The latter are usually featured on photographs as representative structures, as a rule with the rail tracks, locomotives and carriages in the foreground (i.e. station views from the track side are preferred). The section in the Nam Ti valley is particularly important for the perception of railway structures in the rugged mountainscape: major bridges cross the precipitous tributary valleys, such as the lattice bridge across the Pei Ho gorge at km 112, the steel trestlework bridge ‘pont en dentelles’ at km 83 and the stonework viaduct crossing the Nam-Ti valley at km 135. Views of the loops in the tributary valleys act as visual testimony to the efforts undertaken to surmount the great difference in altitude on this section. In both examples of views from the early period of this railway, the route marked by the railway structures is the cultural symbol of the colonial powers; their signature in a natural environment.

The Yunnan colonial railway provided access to the Vietnamese hinterland as well as to the southern Chinese province of Yunnan. The changing landscape so typical for mountain railways of this type is due to their crossing numerous climatic and vegetation zones (from sea level to 2,026 m.). The technically challenging sections and how they are overcome (e.g. by bridge structures) constitute the primary motif of perceiving the traversed surroundings as a cultural landscape.

Landslides after heavy rain repeatedly force the closing of sections of this line. Recently, the Chinese railway ministry decided to keep the narrow-gauge stretch for traffic between Kunming and Hanoi despite plans to build the new Trans-Asia railway from Kunming to Singapore.

Darjeeling Railway > Train in the upper section of the Batasia loop. The Himalayas in the background right. Photograph 2005.
A. M. Hurrel

Darjeeling Railway > The mountain section of the Darjeeling Railway runs along the road.
H.P. Bärtsc

Darjeeling Railway > A 'Toy Train' steam engine fills up with water.
M. Janich

South and West Asia

Darjeeling Railway, India

The Darjeeling Railway starting from Shiliguri (122 m) was built alongside the road as a transport railway for the tea industry in the vicinity of the British hill station at Darjeeling (2,076 m). The railway accentuated the ongoing process of increased agricultural exploitation of the region and thus led to an expansion of the local cultural landscape.

The Darjeeling Railway was listed as a UNESCO World Heritage Site in 1999. Its core zone comprises a 0.61 m wide and 87.48 km long corridor with the railway route running at its centre. A strip 3 m wide on the mountain side and 5 m on the valley side along the railway corridor was designated as the buffer zone.

Agriculture

The countryside through which the railway runs is extremely varied: it traverses the plain between Siliguri and Sukna along the first 10 kilometres, where farmland (plantations) alternates with areas of a more urban character. This is followed by a densely forested region between Sukna and Rongtong (some 11 km in length). Then comes a region of more intensive agricultural utilisation as far as Darjeeling; Himalayan spruce is an increasingly prominent feature of the landscape over the last 30 kilometres. Tea plantations dominate the view from the train. The section between Sukna and Mahanadi is particularly vulnerable to damage in the event of stormy weather so that trees and shrubs have been planted at strategic points to stabilise the immediate environs of the railway.

Structures

The structures in the environment of the Darjeeling Railway, including the road running alongside the railway, date largely from the colonial era. But local cultural traditions are also reflected in the building styles: whereas Hinduism predominates in the valley settlements, Buddhism characterises the region around Darjeeling. Consequently there are different types of sacred buildings and monuments in the railway catchment area. The railway itself manages largely without major bridges or tunnels, the structures with the greatest impact on the landscape being the coiled loops built to gain altitude (at Chambatta, Tindharia and Agony Point).

Transport routes

About 1835, just 50 years before the railway came into operation, the *British East India Company* began to develop Darjeeling into a hill station: it became a popular summer refuge from the subtropical climate of the Ganges plain for the representatives of the colonial power.

At that time, the road was built (and extended) from the plain up to Darjeeling. Upon completion of the railway route from Calcutta to Siliguri in 1878, there was a sharp rise in road traffic to Darjeeling. When the traffic increased beyond the capacity of the road, the railway was continued as far the already well-established tea planting region and summer resort of Darjeeling.

The general increase in motorisation in conjunction with the building of more roads during the second half of the 20th century led to both goods traffic and a large proportion of private transport shifting to commercial vehicles and buses. Today, the Darjeeling Railway is primarily a key element in the development of tourism in the Darjeeling region.

Perception

The perception of the landscape along the Darjeeling Himalayan Railway centres on three aspects. Firstly on the exceptional railway structures, with the spectacular engineering achievement of the looped tracks and the route running alongside the road being of principal visual interest. Secondly on the panorama of the snow-capped Himalayas as a favourite backdrop; and thirdly on the tea plantations that reflect the image of a cultivated landscape.

The colonial importance of the Darjeeling Railway becomes clear from the context of the surrounding countryside. The advent of the railway intensified the tea cultivation already practised in the region and 'Darjeeling' finally became a synonym for tea in European countries. Access by railway also led to the hill station in Darjeeling established by the British East India Company becoming increasingly popular, acting as an impetus to tourism. The railway also links various cultural regions (the Buddhist highland regions with the Hindu lowlands).

Nilgiri Railway, India

The Nilgiri Railway from Mettupalaiyam (ca. 330 m) via Coonoor to Udagamandalam (ca. 2,203 m) was built as a colonial railway to promote the economic development of this Nilgiri Mountains. The advent of the railway led to changes in the utilisation of the surrounding landscape: the higher altitude settlements were favoured by the British as hill stations in the hot season. An increase in agricultural exploitation (primarily tea plantations) followed and a gunpowder (cordite) factory was set up in Aravankadu. The Nilgiri Railway became a UNESCO World Heritage Site in 2005. The core zone comprises a railway corridor 8.5 m wide and 45.88 km long. A strip averaging 25 m on both sides of the railway line was defined as buffer zone.

Agriculture

Various forms of agricultural exploitation characterise the landscape along the Nilgiri Railway. Plantations (palms) predominate in the first section as far as Kallar, some 7 km in length. The following section of about 19 km as far as Coonoor is virtually devoid of settlements and the steepness of the terrain prohibits agriculture; nor is forestry viable. In the immediate vicinity of the railway line, however, special drainage systems have been built to assure safe operation and the steep slopes that are liable to mudslides and landslides have been stabilised by afforestation. Along the third section of the railway from Coonoor to Udagamandalam, about 18 km in length, the appearance of the landscape changes again due to greater land use. In particular, tea and coffee plantations have been established since the advent of the railway, but flax, hemp, potatoes and fruit are also cultivated. Forests of eucalyptus and acacia also characterise the mountain landscape, which rises to an altitude of 2,637 m along this section.

Structures

Most of the structures along the Nilgiri Railway date from colonial times. Among them are houses in the English country-house style (including stone houses), hotels and St. Stephen‘s church in Udagamandalam. The only industrial plant in the Nilgiri Railway corridor (a gunpowder factory) is in Aravankadu. There was also an artificial lake in Udagamandalam at the beginning of the 20th century. In view of the high costs of building the railway, major structures were avoided as far as possible. The isolated bridges and viaducts, such as the Adderley Viaduct in largely natural surroundings, are the exceptions.

Transport routes

The British began to settle in the Nilgiri highlands about 1820, or just 80 years before the railway came into operation. At this time, goods were transported by mule or oxcart along rough tracks. The first plans for a railway from Mettupalaiyam to Coonoor date from the mid-1870s, but its construction had to wait until the early 1890s.
More extensive building of roads in the Nilgiri region started after the Second World War, ultimately leading to a shift from rail to road for goods transport.

Perception

The perception of the landscape along the Nilgiri Railway is determined partly by the ‘wildness’ of the section from Kallar to Coonoor and partly by the broad panorama of the higher altitude section from Coonoor to Udagamandalam.

Nilgiri Railway > A Nilgiri Railway train leaving Kallar station. Photograph 2005.
A. M. Hurrel

Nilgiri Railway > Steam train on the cog section of the line.
A. M. Hurrel

Very soon after the railway came into operation, it began to feature in the oral folk tradition of the Todas, the native inhabitants of the Nilgiri region.

In the context of its surrounding landscape, the Nilgiri Railway primarily reflects the British colonial influence: its construction led to the extension and rationalisation of local agriculture (tea plantations); summer residences were built and a gunpowder factory was set up, the first industrial plant in the region. The railway led to a marked inland migration of people from the lowlands; it also found its place in the folk tradition of the native inhabitants soon after it came into operation.

Eritrea Railway > The alignment ensures spectacular views of the mountainscape.
H. Hufnagel

Eritrea Railway > The geographical position means that the landscape either side of the railway is rather bleak.
H. Hufnagel

Eritrea-Bahn > Train about to enter Tunnel 26 just before Asmara. Photograph 2005.
H. Hufnagel

Africa

Eritrea Railway, Eritrea

The narrow-gauge railway came into operation in 1911 and runs from the harbour town of Massawa on the Red Sea to the Eritrean capital of Asmara in the Abyssinian highlands (2,343 m; seat of the Italian colonial administration from 1897). In the ensuing period, the railway was extended westwards, towards Sudan. The line as far as Biscia, some 220 km away, came into operation in 1932, but never actually reached the Sudanese border. Operation on the 31-km section from Agordat to Biscia was again discontinued in 1940. The railway line was largely destroyed during the thirty-year war of independence but was rebuilt after the end of the war in 1993 and started operation again in 2001.

Agriculture

The Eritrea Railway runs largely through a landscape of sparse vegetation. Its catchment area contains no industry and hardly any agriculture, and it was designed primarily for the provision of Asmara. Today, goods are transported by road on trucks. The first section of the line runs from the port of Massawa through the desert to the foot of the Abyssinian plateau at Nefasit. From there, the railway winds through the bleak mountain valleys to its highest point at 2,412 m, shortly before reaching the capital, Asmara. Agricultural exploitation is largely restricted to the immediate environment of the few settlements and is on a small scale, mainly providing for local needs, with the exception of the flat valleys at the foot of the plateau. Terraces have also been built (with dry-stone walls) to allow cultivation, particularly in the mountainous regions.

Structures

A wide range of structures is found along the railway corridor, the most striking being the buildings erected during the colonial period. Besides the stations and halts in the European colonial style, these also include railway utility buildings (engine depots and work sheds), but also monasteries (for instance at Debre Bizen) and religious structures (such as the Catholic cathedral in Asmara, completed in 1917 and the mosque in Nefasit). Colonial-era administration buildings in Asmara as well as the artistically decorated commercial buildings in the port of Massawa should also be mentioned. Houses built from clay are also found in the environs of the railway corridor in the more remote regions (such as in the Mai Atol valley).
Besides the buildings mentioned above, the railway also introduced numerous bridges and viaducts built completely of stone to the landscape. Some were destroyed during the civil war and rebuilt in the mid-1990s. A few railway buildings, also destroyed in the civil war, were merely patched up, such as the engine depot in Massawa that was rebuilt in corrugated iron.

Transport routes

The railway runs from the port of Massawa up into the mountainous hinterland. A network of roads criss-crosses the environs of the settlements, primarily providing limited access (only a few are suitable for motorised traffic). Development of the region around the rail corridor to traffic has given a trans-regional importance to the road from Massawa to Asmara, which has now been metalled. It is used for regular private and goods transport (buses and trucks).

Perception

Bleak images largely colour the perception of the landscape surrounding the railway, but the picture is also characterised by scattered eucalyptus forests, as in the region between the mountain pass and Asmara. The mountainous section between Ghinda and Asmara is also known as the 'Darjeeling of Africa'. Visualisations of the railway focus on the elaborate loops and railway motifs with bird's-eye views looking down to the floor of the valley some 1,000 m below. The image of the fourteen-arch viaduct across the seasonal riverbed of the Obel Torrent features on the Eritrean 10 Hakfa banknote. However, this stone built viaduct was partially destroyed during the civil war and rebuilt in the mid-1990s.

The Eritrean Railway line running from the port of Massawa to Asmara (and on to Agordat) is closely linked to the country's colonial past. Its planning began in 1897 with the relocation of the Italian colonial administration to the plateau near Asmara. The landscape traversed by the railway is characterised by a closeness to nature and a terrain that is largely untouched by man (strips of desert, inaccessible mountains) as well as by signs of human activity (settlements, religious structures and a limited degree of cultivation). The perception of this railway route – whose most spectacular part is also known as the 'Darjeeling of Africa' – is characterised by rugged mountain landscapes, plummeting views and elaborate loops of track. An image of the Railway features on the Eritrean 10 Hakfa bank note.

South America

Guayaquil&Quito Railway, Ecuador

The Ecuadorian railway line runs from the Pacific port of Guayaquil to the nation's capital of Quito in the highlands (2,817 m). Its construction took an unusually long time – building started in 1871, but full operation did not begin until 1908. Various sections along the entire route have been successively closed down over the last few decades and in some cases roads have even been built over the old tracks. Today only certain subsections are in operation for tourists, including the technically challenging section in the 'Devil's Nose' region. Latest developments indicate a reactivation of the railway in Ecuador.

Agriculture

The railway runs through numerous climatic and vegetation zones. In the first section it traverses the partly marshy lowlands around Guayaquil where the landscape is characterised by rice, sugar cane, cacao, coffee and banana plantations. As the Cordillera is reached, the pattern changes to small mixed-farming areas (pastures, forest, crop farming). Farming is reduced to a minimum in the mountain valleys and only practised on a very small scale in the immediate vicinity of the settlements. In the highest regions reached by the railway – its culmination point is at an altitude of 3,609 m – there is no cultivation due to the arid climate and poor soils (drift sand and volcanic ash). In contrast, the climate is mild and the soil very fertile on the highland around Quito. So this region has an intensively agricultural character with extensive pastures and small fields.

Structures

There is a wide variety of structures along the railway corridor, ranging from stonework buildings dating from colonial times (e.g. Quito, Yaguachi) to wooden huts in the lowland swamps, perched one and a half meters above the ground to escape the regular flooding. The many open-cast sulphur mines in the region around Alausi have left their mark on the landscape. The rail tracks run direct on roads through numerous towns, so the railway is closely integrated in the urban landscape. However, many of these sections were dismantled from the late 1990s, for example in Milagro and Ambato, within a short time. Otherwise, the railway has impacted the cultural landscape with its spectacular layout through the mountain valleys (setting-back tracks at the 'Devil's Nose') and the small steel bridges along the line. The utility buildings are built in wood or stone, though many of the old buildings have recently had to give way to new ones. The wooden station at Durán is named in honour of the former president of Ecuador, Eloy Alfaro (in office from 1895 – 1901 and 1906 – 1911; construction of the railway to Quito was completed during his presidency). In view of the importance of this personage, the government recently proclaimed the station building a national monument. This move was sufficient to prevent demolition, but the structure is in poor condition

Transport routes

The roads in the area near the railway are mere mule tracks unsuitable for motorised traffic, particularly in the mountainous regions. In recent decades there has been a massive expansion of the Ecuadorian road network across the country. This has had repercussions on the railway, as the drop in the number of passengers and the volume of

Guayaquil&Quito Railway > Tourist train before the spectacular Devil's Nose passage.
V. Barnes

Guayaquil&Quito Railway > Fork near Alausí.
Unknown

Guayaquil&Quito Railway > Section at the Devil's Nose. Illustration from: FEUEREISSEN G.: *Dampf über Südamerika. Die letzten Dampflokomotiven im Regeldienst zwischen dem Äquator und Kap Horn*, München, 1990.

freight carried led to the closing down of several sections of the line. The course of the old railway track was often used for road building. Public passenger transport between Quito, the capital, and Guayaquil has now shifted to the air or road (buses), and freight is transported by truck.

Perception

Perception of the landscape along the Guayaquil&Quito Railway focuses on two groups of motifs: the mountain region around the 'Devil's Nose' as well as the area around Chimborasso, the 6,267 m volcano. The first motif highlights the railway engineering challenge of overcoming the natural topographic difficulties of the steep and precipitous mountain valleys (setting-back tracks to surmount the great difference in altitude over a short distance and the sheer faces of the valley walls). The second motif links up with the visual imagery of snow-covered mountains as symbols of smooth integration in the aesthetic perception of a natural landscape.

Only a few sections of the Guayaquil&Quito Railway are still in operation. Across its full length, the railway line traverses a wide range of climatic and vegetation zones (from sea level to 3,609 m); the degree of exploitation of the landscape differs considerably. Plantations, fields and even mining have left their mark on the surroundings of the railway line. Especially the setting-back tracks on the technically challenging sections in a bleak, rugged mountainscape have made this stretch world-famous. Both factors, linked by technical mastery of the environment, are also of great importance to tourism: operation is therefore maintained on these most spectacular sections. Where the railway ran on roads in the towns, operation has been discontinued and the track has been used to widen the roads.

Cumbres & Toltec Scenic Railway >
Steam train at 'Windy Point' after the Cumbres Pass.
N. Holmes

Cumbres & Toltec Scenic Railway >
Animas Canyon at Silverton, 2,800 m.
P. Gloor

Cumbres & Toltec Scenic Railway >
The natural landscapes are the attraction on the Cumbres Pass route.
N. Holmes

North and Central America

Denver&Rio Grande Railroad (especially the Cumbres & Toltec Scenic Railway, USA)

More than 2,500 km of narrow-gauge railway were built by the *Denver&Rio Grande Railroad Company* from the 1870s to 1929 in the Rocky Mountains in the west of the USA. The southern route, over 300 km long, runs from Antonito to Durango, crossing the 3,053 m Cumbres Pass in the San Juan mountains. It was opened in 1880 (as far as Chama) and in 1881 (to Durango) only a short time after a road had been built across the pass at the end of the 1870s. Today most of this line has been closed down, but a stretch of some 112 km between Antonito and Chama is still operated temporarily as a museum railway.

Agriculture

The railway runs through a sparsely populated and, in part, rugged mountain region at altitudes between some 2,000 and 3,000 m. Farming of any kind is scarce here. The regions around Alamosa and Durango are very arid and only suitable for farming in a few places. Sporadic pastures, some in high-altitude areas near the pass, provide fodder for livestock (sheep and cattle) on a modest scale. Forests, separated in places by grassland, predominate near the pass itself.

Structures

The structures along the railway reflect the conquest of the American West by white settlers following the silver boom of the late 1870s: small settlements with buildings in local stone (e.g. lava at Antonito) or wood, extensive mining installations and processing industries (e.g. in Durango). Mines also began exploiting uranium ore from the middle of the 20th century.
The hot springs of Pagosa were already known to the native Americans (Utes and Apaches) of this region, who were increasingly forced onto reservations after the 1850s. The springs were declared government property in 1880 and were developed for tourism. Their bathing facilities are still very popular, largely thanks to the therapeutic effects of the waters.
The primary impact of the railway on the cultural landscape in the Alamosa-Durango section is made by its utility structures in various styles, but also by the layout of the route over the Cumbres Pass (partly valley loops). The impact is accentuated by various bridge structures along this stretch (in particular trestlework bridges such as those at Cascade Creek and Lobato) as well as the section along the Toltec gorge. A monument to US President James A. Garfield was erected at the western portal of the Toltec Tunnel in 1881, the year he was murdered.

Transport routes

Mule trails probably existed over the Cumbres Pass even before the advent of the settlers in the latter half of the 19th century. However, the taking of the land by the newcomers also led to the industrial development of the region (mines). There is no evidence for a passable route over the Cumbres Pass before 1876. A road was then built and a short time afterwards, in the early 1880s, the railway began to weave through the natural landscape. The railway, with its regular passenger and freight traffic, ceased operation in the 1950s. Only the scenically most impressive section between Antonito and Chama was retained as a purely tourist railway.

Perception

Perception of the landscape along the Cumbres Pass route (like the entire Denver&Rio Grande Railroad) is determined by nature: enormous spectacular rock formations, a diversity of flora and the multitude of colours changing with the seasons. In contrast, the mines with their impact on the landscape (particularly the slag heaps of waste rock) as well as the agricultural utilisation are only secondary features in the perception of the landscape. The aesthetic importance of the landscape for the railway was reflected from the outset, for example in the railroad company logo. The slogan 'Scenic Line of the World' became a brand name and the company name subsequently became a synonym for any railway running through a scenic landscape. Thus the Dunedin-Cromwell route in New Zealand is referred to as the "Denver&Rio Grande" of the southern hemisphere.

The Denver&Rio Grande Railroad with its crossing of the Cumbres Pass is the prototype of a railway route that exploited the scenic attraction of the natural landscape through which it runs as a brand name from the outset. As the 'Scenic Line of the World' it became the role model for railways running through attractive natural scenery the world over.
This specific promotion of the scenic beauty of the natural landscape along the railway relegated other elements of the cultural landscape (such as agricultural or industrial use) to the background. Considerable sections of the Denver&Rio Grande Railroad were decommissioned in the 1950s and only cuttings and embankments remain to recall something of the old railway. Today steam engines run in summer on the section crossing the Cumbres Pass as a tourist attraction.

Europe (without Switzerland)

Train Jaune, France

The electrically operated Train Jaune (Yellow Train) links the Roussillon region with the Cerdagne plateau in the eastern part of the French Pyrenees, running from Villefranche (415 m) to La Tour de Carol (1,230 m). The rail corridor links the two trans-national long-haul lines running north-south from Toulouse to Barcelona (Puymorens Trans-Pyrenean line) and from Montpellier to Barcelona (a standard-gauge line runs from Perpignan to Villefranche). The thermal springs, already known in Roman times, have been of great importance for the development of the region. Their therapeutic properties were used in water cures, particularly from the mid-19th century. The bracing air of the central Pyrenean highlands also makes them a favourite destination for wellness tourism.

Agriculture

The railway links strikingly different climatic zones, ranging from Mediterranean to montane or mountain type. Accordingly, land use is also very varied along the route. On the standard-gauge section between Perpignan and Villefranche, cultivated areas predominate with the accent on fruit and vines. From Villefranche to the watershed at the Perche Pass – at 1,592 m the highest point in France with rail access throughout the year – the railway follows the Têt valley through extensive deciduous forests. Meadows and fields lying fallow are also found close to the settlements and climatically favoured areas (south-facing slopes). After the railway reaches the central Pyrenean highlands, a fundamental change is seen: the valleys are now considerably broader and permit some fruit orchards as well as grazing and crop farming. Continuous forest starts only on the higher slopes. The low stone walls surrounding the pastures and fields at higher altitudes (particularly around La Tour de Carol) reflect the small-scale proprietary and utilisation structures typical of the local farming.

Structures

The structures along the Train Jaune reflect various epochs: the ruins of medieval fortifications are encountered particularly in the Têt valley (such as Citadelle Mont Louis and the twin towers of “El Bastida Nova”), underlining the importance of the region as border country. Luxury hotels, such as that at Font Romeu, were built with the surge in tourism and the construction of the railway in the early 20th century. But the railway itself contributes significantly to an appreciation of the cultural landscape with its mighty bridges – the suspension bridge at La Cassagne and the two-tier viaduct at Fontpédrouse– as well as the Bouillouses reservoir (built to produce electricity for the railway).

Transport routes

Along with the road network that was extended during the 20th century, the railway has made a permanent mark on the landscape, not only with its bridges but also with the technical installations along the line: whereas the conductor rail alongside the track recedes into the background in comparison with the overhead catenaries usual in today’s railways, the power lines from the generating stations to the railway trace another transport corridor. Because of the low-lying conductor rails, the railway corridor must be effectively isolated from its surroundings by a wire-netting fence for safety reasons. This strict separation has left a unique footprint on the landscape. Other salient features, such as long

Train Jaune> "Pont suspendu Gislard" at La Cassagne. Photograph 2000.
UTBM

Train Jaune > Layout of the 'Train Jaune' in the Cerdagne region. Photograph 2000.
UTBM

Train Jaune > Bridge over the river Têt near Villefranche. Photograph 2002.
UTBM

high-pressure pipes, reservoirs and power-station machine houses, recall what was needed to operate an electric railway in its infancy: great differences in altitude over short distances to generate the power needed for the railway.

Perception

The perception of the landscape along the route of the Train Jaune is characterised by the settlements and marchland fortifications together with the snow-capped mountains of the Pyrenees. Seen from the railway line, the two major bridges embedded in the forest landscape represent popular motifs. The Fontpédrouse two-tier viaduct, in particular, is the distinctive symbol of the railway line and has even featured on postage stamps. In view of its location in the Franco-Spanish border country, the Train Jaune has also played a role in forging a sense of Catalan identity in the Cerdagne region.

The cultural landscape along the route of the Train Jaune is particularly varied due to the various climatic zones it crosses as well as the rich local traditions. Thermal springs, fortresses and ruins as well as an artificial reservoir built to generate power for the railway exemplify the broad range of structures that constitute this cultural landscape. Agricultural exploitation has moulded the countryside both in the Cerdagne and the Roussillon district. The construction of luxury hotels concurrently with the building of the railway gave an impetus to tourism in the region. Ultimately, the railway also played a significant role in defining the identity of the people of the Cerdagne.

Semmering Railway > Viaduct across the Kalte Rinne. Photograph taken between 1890 and 1900.
Unknown

Semmering Railway > Viaduct across the Krauselklause.
P. Glitzner

Semmering Railway > Left the viaduct across the Kalte Rinne, right the viaduct across the Krauselklause.
P. Glitzner

Semmering Railway, Austria

The Semmering Railway runs diagonally across the Alps from Gloggnitz (439 m) through a crest tunnel culminating at an altitude of 898 m to Mürzzuschlag (681 m). The cultural landscape at the Semmering Pass and its perception are linked very closely to the railway. Interest initially centred on the Reichenau valley, which could be reached much more rapidly from the imperial capital with the opening of the Vienna-Gloggnitz railway in 1842. The second phase began in 1882, when the *Südbahn-Gesellschaft*, who owned the Semmering Railway, built a large hotel at the Semmering Pass, launching a building boom for both hotels and villas. Tourism virtually came to a halt at Semmering after World War I and only recently has there been a resurgence in day trips and weekend excursions.

The Semmering Railway was inscribed in the UNESCO World Heritage Sites List in 1998. The core zone consists of a railway corridor approx. 42 km long. The surrounding landscape was also included with a special focus on the hotel and villa colony at the Semmering Pass. Up to the present (2006), however, this cultural landscape has not been recognised as a World Heritage Site because the protection zones (core, buffer zone etc.) have not yet been delimited with sufficient precision.

Agriculture

The craggy landscape on the north side of the Semmering Pass is of only limited use for farming. Cereals are cultivated on the valley floor, as they used to be on climatically favoured slopes at Eichberg or near Klamm. More hardy vegetables like potatoes were grown on a small scale in all the valleys of the Semmering district as far up as Breitenstein. Until about 1900 vines were also cultivated at Gloggnitz. The main part of the Semmering region, particularly to the south of the pass, is covered with meadows and forests: the meadows are used both for grazing and as a source of winter fodder for the animals. The forest is used for timber, and fallen wood is collected for domestic fires. Felling is localised and therefore has a significant impact on the appearance of the landscape: forest clearance opens up the line of view until the clearings become overgrown, when they impede it completely. The orchards around the scattered farms (e.g. around Breitenstein) are another characteristic feature of the landscape.

Structures

Among the varied structures of the Semmering region, those from the end of the 19th and the early 20th century are the most striking. These include several large hotels (Südbahnhotel 1882, Hotel Panhans 1888, Hotel Erzherzog Johann, Kurhaus Semmering 1909, Palace Hotel 1912) and numerous villas (26 had been built by 1900). There are isolated farms in the environs of the Semmering Pass (e.g. at Breitenstein), villages (e.g. Spital), religious buildings (e.g. the church at Klamm, Spital at Semmering, the Maria Schutz pilgrimage church and other chapels in the district), industrial buildings (e.g. Schlöglmühl) as well as a ruin (Klamm). The oldest structures in the Semmering district are found along the mule track over the pass that can be traced back to the 10th century, particularly on the south side by Spital. On the north side of the pass, Schottwien, which experienced a boom before the railway thanks to its carriers, should be mentioned. Structures associated with the iron-processing industry are found to the south of the Semmering Pass in the Mürztal, near Schottwien and Reichenau (a charcoal blast-furnace dating from the early 18th century has survived at Edlach).

The railway structures have made a major impact on the cultural landscape of the Semmering region. Thus the massive railway viaducts, especially the one over the Kalte Rinne, have become characteristic landmarks of the region. Another imposing feature of the landscape is the layout of the line with its valley loops (e.g. at Payerbach) and rugged rock faces (e.g. the gallery in the Weinzettlwand).

Transport routes

As already mentioned, a mule track crossed the Semmering Pass from the 10th century. This was part of the trade route to the Mediterranean ports of Venice and Trieste. The first effective road over the Semmering Pass was undertaken in 1728 (parts of it still exist today). The 'new' Semmering road with its serpentine course was opened in 1841 with significantly gentler gradients than its predecessor. The stone bridge over the Myrthengraben was also built at that time and is still in use today. Shortly afterwards the first railways reached the edge of the Semmering region and the 'iron road' across the pass came into operation already in 1854. The boom in tourism towards the end of the 19th century promoted the construction of new roads and footpaths in the region, for example the 'new highroad' with its numerous panoramic vantage points between Semmering and Orthof. The electrification of the Semmering Railway after the Second World War, made the construction of a power supply line necessary and therefore generated a new transport corridor. The rapid rise in motor traffic culminated in the 1990s with the construction of a motorway: its impressive prestressed concrete bridge spanning the village of Schottwien and the Mürztal valley is now the dominant transport feature of the landscape.

Perception

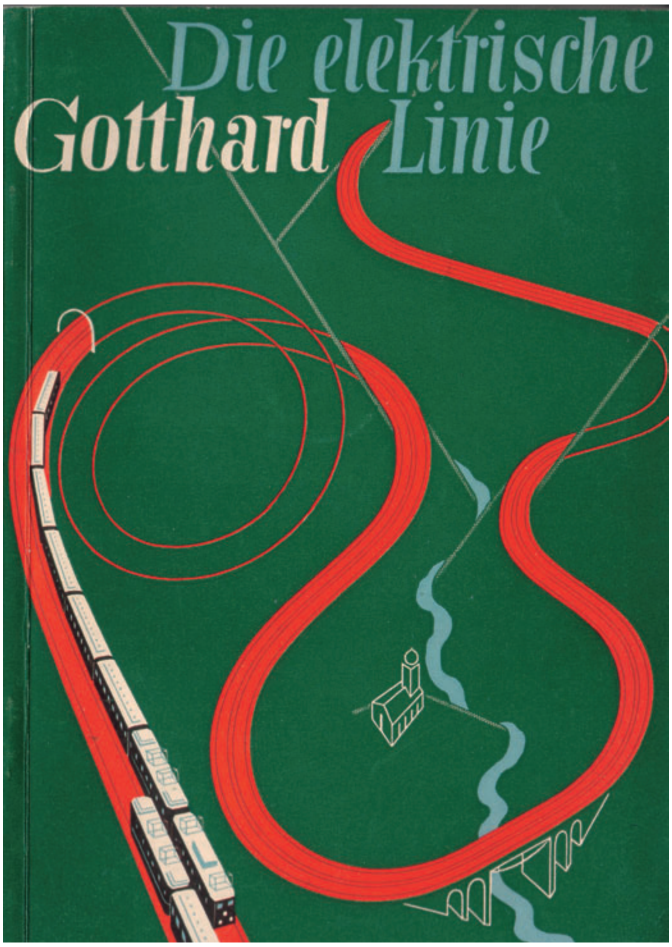
The Semmering region is a text book example of how the perception of the landscape changes in response to developments in the various modes of transport that traverse it. In the days of the mule track, the most important factor was simply to get across the pass safely. Then, Prince Liechtenstein had a garden with an artificial lake, a waterfall and a temple built in the Adlitzgraben gorge in the 1830s: these manmade features led to the raw and rugged nature in the background being seen – in their stark contrast – as the essence of wild Romanticism. Although the Prince's artificial garden was destroyed by the construction of the railway, the latter allowed a new panoramic appreciation of the mountain landscape it passed through. In this context, the Semmering route is also the prototype for the perception of mountain regions thanks to rail travel. The impression of the railway route as "linear" is reflected in the folded, linear panorama (Ghega 1854; the size and colour of this panorama may have changed over the years, but it has remained a constant element of the visual recall of the Semmering Railway to the present day). The viaduct across the Kalte Rinne seen against the precipitous landscape has become the 'trademark' of the region: this scene has been reproduced on postage stamps and bank notes. Early portrayals even included imaginary elements of the landscape such as rock columns: the addition of such dramatic props bears witness to the transfiguration of the landscape traversed by the railway. In the 1890s the Semmering region was even claimed to be on a par with Swiss tourist resorts like St. Moritz or Davos.
The region around the Semmering Pass is perceived much more as a cultural landscape than a natural one. The perception of nature is essentially limited to the representation of precipitous

crags and Alpine flora and led to the founding of the “Rax-Schneeberg” nature reserve in 1955, which also takes in the region traversed by the Semmering Railway.

The Semmering Pass, the Railway and the region as a whole also attracted artists and writers: thus Peter Rosegger recorded his impressions of the railway journey in his short story *Als ich das erste Mal auf dem Dampfwagen sass* of 1877, Adolf Loos built the Landhaus Khuner here in 1929 – 30 and Peter Altenberg left his collection of sketches entitled: “Semmering, 1912”. Arthur Schnitzler, Oskar Kokoschka and Egon Friedell also spent several summers in Semmering in the years before World War I.

The Semmering Railway is considered to be the prototype of a railway in mountainous terrain. Its advent promoted agriculture and forestry in the region and led to a surge in local tourism. Great significance has been accorded to the perception of the landscape surrounding the railway from the outset: carefully arranged scenes still characterise the image of the railway and landscape today. Travel guides draw attention to the best views in advance. Panoramas of the entire railway line stimulate the visual imagination, and the bridges or valley loops shown against the backdrop of the surrounding landscape document the integration of railway and landscape to produce an interfused aesthetic perception. Various views of railway structures (viaduct across the Kalte Rinne) became hallmarks of the Semmering region and have been used on postage stamps and banknotes. Towards the end of the 19th century, the region around the Semmering Pass developed into a hotel and villa colony that attracted and inspired artists (Rosegger, Altenberg, Loos, Schnitzler, Kokoschka, Friedell).

The cultural landscape surrounding the Semmering Railway is still not part of the UNESCO World Heritage List because the area of the protection zones has not yet been defined precisely.



Gotthard Railway > A 1932 poster with a stylised drawing of the cultural landscape.
Collection G. Dinhobl

Gotthard Railway > The transport landscape around Wassen: 19th century railtrack with loops at three different levels; late 20th century motorway. Photograph about 1980. Illustration from: EGGERMANN ANTON [et al.]: *Die Bahn durch den Gotthard*, Zurich 1981.

Gotthard Railway > Original Kerstelenbach steel truss bridge, about 1881.
Collection G. Dinhobl

Switzerland

Gotthard Railway

The Gotthard Railway runs from Lucerne (436 m), located north of the Alps, via a 15 km tunnel (highest point 1,151 m) through the Gotthard range to Chiasso (226 m) on the southern rim of the Alps. A path crossed the Gotthard Pass already in the Bronze Age. The opening up of the Schöllenen gorge in the 13th century created the shortest north – south transit route across the Alps. The Gotthard route was further improved in the 16th century, indicating its great importance as a transit corridor at that time. Goods transport on draught animals became an important source of income for the local people. The road was extended in the first third of the 19th century – just like those across numerous other Alpine passes. The railway, built at the close of the 19th century, fundamentally changed the landscape around the Gotthard. About a century later, a four-lane transit motorway virtually took over the narrow mountain valley.

Agriculture

The Gotthard region comprises mountain valleys of widely different width and character. Cultivated areas dominate in the lower reaches of the valleys (principally pastures on the higher slopes, cereals and fruit lower down). Some of them, such as in the Ticino between Bellinzona and Locarno, were only won by straightening the rivers. In the southern sections of the route in Canton Ticino, the Mediterranean climate allows the cultivation of vines, chestnuts and figs. At higher altitudes, the picture is dominated by livestock farming with meadows and pastures. More than 100 hectares of forest have been planted along the Gotthard line since 1900 to protect the railway against avalanches and landslides. Numerous other protective structures have been erected above the tree line.

Structures

The Gotthard Railway runs from the northern cultural region with its German-Alemannic character to the southern zone marked by Italian-Romance culture, each with its own architectural preferences as regards both secular and sacred buildings: the two regions differ even in the structure of their settlements. Thus scattered communities prevail in the northern part whereas nucleated villages dominate in the southern section. Numerous castles and churches bear witness to the importance already enjoyed by the region as a transport corridor in earlier times. The castles of Bellinzona were inscribed in the UNESCO list of World Heritage Sites in 2000 (Monte San Giorgio, listed as a UNESCO Natural Heritage Site, is also located in the immediate vicinity of the Gotthard Railway corridor). In its central section between Erstfeld and Biasca, the railway led to a modest development of tourism, for example in Göschenen, Airolo and Faido. However, no grand hotels were built, like those at Semmering or in the Engadin.
The railway structures make a strong impact on the Gotthard region. Thus the Gotthard Railway was the target of criticism by the Swiss Heritage, movement formed at the beginning of the 20th century (cf. 2.a.4). They objected to the use of steel supplied from other regions rather than local materials to build the bridges and to the straight tracks which prevented the railway from harmonising with the landscape. Indeed, the Gotthard Railway even became a symbol of a technological structure that failed to integrate with the natural environment. Since then, all the original steel bridges of the railway have been replaced by pre-stressed concrete bridges. The

power-station structures built to supply the electric railway are examples of industrial installations in the Gotthard region (Ritom, Amsteg). The Gotthard Railway subsequently led to the construction and reinforcement of military fortifications of national importance: they were begun in 1886 and were upgraded, especially during World War II, to become the 'Gotthard Fortress'.

Transport routes

The Gotthard holds a strategic position in the trade between Italy (particularly the port of Genoa) and the countries to the north (particularly Germany). The local transport routes are essentially prefigured by the Reuss and Ticino valleys. The Schöllenen gorge above Göschenen was always a crucial point along the route. Until the 13th century, a mule track ran above the gorge and passed over the Bätzberg. The building of the Devil's Bridge allowed the gorge to be crossed direct, and the bridge soon found an echo in local folklore.
The railway visibly changed the valleys of the Reuss and Ticino rivers with its tunnels, bridges and the layout of the line. However, the construction of the motorway in the 20th century had a significantly more invasive impact on the landscape: in certain sections, such as at Wassen, the motorway and its access roads occupy the whole floor of the valley. Today, the road has ousted the railway as the transport structure that dominates the landscape of the Gotthard region.

Perception

Before the Gotthard Railway was opened, visual and literary perceptions centred on the difficulties involved in overcoming the barriers of the rugged mountainous terrain. The advent of the railway then shifted the focus towards the cultural landscape. The travel guides gave precise instructions on how to appreciate the scenery properly. Thus the widely used *Baedecker* guide of 1909 tells its readers: "Sit on the right from Lucerne to Amsteg, on the left from Amsteg to Faido, on the right again from Faido to Bellinzona". Travellers were urged to look both at the cultural sights – and especially at churches and castles – and at the mountains. But now, views of the Gotthard region placed the railway structures like bridges or the (reverse-track) loop systems at the centre of the composition, thus focussing – at an early stage – on the embedding of the railway in surroundings moulded by man. The image of Wassen church, which is encircled by several loops of the railway, was particularly prominent. Panoramas of the railway are presented as overviews of the landscape (unlike the earlier linear panoramas like for the Semmering line).
The Gotthard Railway gained great significance as a national icon, especially in the first half of the 20th century.

In the context of its surrounding landscape, the Gotthard Railway is primarily a transit corridor running right through the mountains: it allows faster and easier transport of people and goods from Italy to central and northern Europe and vice-versa. The railway is closely intermeshed with the cultural landscape either through its direct (track route) or indirect (protective forests and avalanche barriers up to very high altitudes) impact or by being visualised as embedded seamlessly in it (route pattern, the church at Wassen). Unlike some other railway lines (such as the Semmering Railway), the Gotthard Railway has had no significant effect on tourism in the region it traverses.

Summary

The cultural landscape of the Albula-Bernina railway corridor exhibits numerous features that can be seen, from the train, as typical for regions with mountain railways. In contrast, other aspects show a complete absence of similarities, so this railway corridor can be regarded as having a highly individual character. Precisely in its combination of numerous *unique* and *typical* elements, the surrounding landscape enhances the exceptional universal value of the Albula/Bernina railway.

Typical

The typical elements will now be presented as a summary of the preceding descriptions on the basis of the familiar analysis scheme.

Agriculture

Agricultural exploitation is frequently encountered in the environs of the railway. Some forms of cultivation already existed before the advent of the railway (highland farming in the Alps, tea plantations in colonial India), but they were largely intensified and expanded following its construction (although reduced transport costs for agricultural produce had a negative impact in some cases). In this respect, the cultural landscape of the Albula-Bernina railway corridor is eminently comparable with those of other mountain railways.

Structures

The structures along the railway routes indicate whether the surrounding cultural landscape existed before the advent of the railway or was created in the course of its construction. A particularly great diversity of structures is seen where a "historic" cultural landscape is complemented by the railway line. All the railways examined here are associated with tourism. Particularly in the Alps and Pyrenees, some tourist destinations already existed before the construction of the railway: tourism had already changed the "old" cultural landscape with the building of facilities such as hotels, footpaths and hiking trails. Existing tourist destinations expanded after being linked to the railways, while other regions only became accessible to tourists with their advent (such as the hotel and villa colony on the Semmering that followed the construction of the railway). Winter tourism in the Engadin began with the coming of the Albula railway, which assured accessibility to the region throughout the year as well as a reliable line of supply for the hotels. The railway structures themselves also leave their stamp on the cultural landscape. Precisely in the case of the mountain railways, it is often the outstanding bridges and viaducts which – embedded in the landscape – express the unmistakable character of the route and find an echo as its 'trademark': the Landwasser Viaduct and the Circular Viaduct at Brusio reverse-curve viaduct define the Albula/Bernina corridor, on the Semmering it is the viaduct across the Kalte Rinne, for the Train Jaune the two-tier viaduct at Fontpédrouse or the suspension bridge at La Cassagne, on the Gotthard the (no longer existing) lattice bridges, and on the Yunnan Railway the lattice bridge across the Pei Ho gorge. In this way, the railway can be seen as a visual cultural presence in the rugged mountain landscape.

Transport routes

The railways are surrounded by numerous transport routes. In most cases these are roads, often running alongside or at least very close to the railway or even together with it (as it passes through towns, as in the Guayaquil-Quito Railway and

the Bernina Railway, for example). The railway reduces the status of existing routes while new routes gain in importance. Whereas those transport routes that run along the railway corridor tend to lose importance, local transport routes are upgraded (such as connecting roads between stations and settlements, as in the case of Stugl/Stuls in the Albula valley or tourist resorts [cf. the routes from the station at Semmering to the top of the pass and the hotels], or scenic routes, but also roads to cultivated areas). Moreover, pipelines and power lines, as well as reservoirs, are also encountered near electrically operated railways (Train Jaune, in part the Semmering and Bernina railways).
The rapid spread of motor traffic especially in the second half of the 20th century saw the start of a new development, namely the dismantling of railways, especially where these ran straight through towns and villages (such as on the Guayaquil-Quito Railway). So the way the Bernina line runs through settlements represents a typical but no longer frequently encountered example of the intermeshing of road and railway.

Perception

In all cases, the construction of the railway led to an increased aesthetic appreciation of mountain landscapes. The perception of the landscape along the railway routes is particularly significant: certain features are highlighted when the railways are used for tourism. The heightened interest in landscapes beginning in the Romantic era played a major role in the way a railway journey was experienced. the diversity of impressions it afforded meant that the perception of the landscape during an excursion could be romanticised as a “ballet of views”. The perception of the surroundings as a cultural landscape is reflected by the structures along the route: buildings already predating the railway such as churches (Mistail on the Albula, Klamm on the Semmering; Wassen on the Gotthard) as well as hotels that were built in the wake of the railway (e.g. Semmering, Albula, Train Jaune) or the bridges, viaducts and tunnel portals (e.g. Landwasser Viaduct on the Albula, Kalte Rinne on the Semmering, Gotthard Tunnel) frame the visual conjunction of railway and landscape. On routes with a relatively intact natural landscape, the railway is seen virtually as the signature of man (Denver&Rio Grande Railroad; Adderley viaduct on the Nilgiri Railway; layout of the line near the ‘Devil’s Nose’ on the Guayaquil-Quito Railway; Bernina Pass). All these examples are the expression of seeing the surroundings of railway corridors in mountainous regions as a cultural landscape.

Uniqueness

This unique character of the Albula/Bernina line is due mainly to the diversity of the landscape and the numerous vegetation and climatic zones that it traverses that can be experienced from the train: compared with the other railways considered in this section, the Albula/Bernina line is the only railway – besides the Gotthard Railway – that crosses a mountain range in its entirety. Although the distance as the crow flies is about 80 km, the maximum difference in altitude traversed by the Albula/Bernina line is some 1,550 m on the north side and some 1,700 m on the south side. In contrast, the Gotthard Railway climbs no more than some 910 m. The Semmering Railway on the eastern flank of the Alps is short in comparison: a ‘diagonal’ Alpine transit route with a distance of some 21 km as the crow flies between the stations of Gloggnitz and Mürzzuschlag. It also climbs a mere 450 m, a distance associated with significantly less scenic variety. The Denver&Rio Grande Railroad over the Cumbres Pass is located in the Rocky Mountains and also has a considerably lower difference in altitude to overcome, namely about 660 m (Chama – Cumbres Pass). All the other railways examined in the comparison certainly climb considerable distances (some 3,600 m on the Guayaquil-Quito Railway, for example) with all the technical difficulties this entails, but they run without exception from lowlands (in some case from a seaport) to destinations in the mountains and thus do not *cross* a range of mountains. This aspect of crossing an entire range is particularly important with respect to the cultural landscape: mountains have acted as a barrier since primordial times, separating different cultures and distinct cultural landscapes from each other (the Albula/Bernina corridor passes from German, via Rhaeto-Romansh to Italian (cf. 2.b.8). The railway structures represent another feature of the unique character of the countryside surrounding the Albula/Bernina route. Soon after the line was opened, the stone viaducts of the Albula line were recognised by the Swiss Heritage Society as being in harmony with the landscape and thus exemplary, whereas the iron lattice bridges on the Gotthard were cited as a negative example. This also differentiates it from the Semmering Railway, where the harmony of engineering and landscape was not expressed until the beginning of the 20th century, decades after it had come into operation. However, the building of the Semmering Railway in the 1850s made it possible for the region it passed through to be aesthetically perceived as "landscape" whereas before it had been considered merely as a "district": the Semmering Railway was seen as creating the cultural landscape, whereas the Albula/Bernina line was integrated smoothly into the existing cultural landscape.

	Technical data, condition - Year opened, originally operated by - Max. altitude - Gauge - Number of tunnels - Number of bridges - Safety structures	Reasons for building	Original and current operation	Railway type	Railway in the cultural landscape (original)	Technical innovation
Yunnan Railway	- 1910, steam operation - 2,026 m - Narrow gauge/1,000 mm - 172 Tunnels - 107 Large bridges - Few safety structures	Trans-regional development for trade and passenger traffic by French colonial administration: Link between Hanoi, on the coast, and the Chinese provincial capital of Kunming	Originally passenger and freight traffic according to timetable; today regular operation only on certain sections; plans to restore through operation	- Colonial railway - Mainline character - Narrow-gauge railway - Mountain railway, does not cross a range but climbs to a point in the mountains	No landscape forming intentions with a view to harmonically embedding the railway structures in the environs	Low to moderate structural outlay to reach a provincial capital in the mountains
Darjeeling Railway	- 1889, steam operation - 2,258 m - Narrow gauge/610 mm - No tunnels - One major bridge - Hardly any safety structures	Regional development for trade and passenger traffic by British colonial administration	Originally passenger and freight traffic according to time table; today exclusively passenger traffic, mostly for tourism	- Colonial railway - Narrow-gauge railway - Mountain railway, does not cross a range but climbs to a point in the mountains	No landscape forming intentions with a view to harmonically embedding the railway structures in the environs	Excellent example of a «light railway»
Nilgiri Railway	- 1903, steam operation - 2,094 m - Narrow gauge/1,000 mm - Section with cog system - 16 tunnels - 32 large bridges - Safety structures	Regional development for trade and passenger traffic by British colonial administration	Originally passenger and freight traffic according to timetable; today exclusively passenger traffic, mostly for tourism	- Colonial railway - Narrow-gauge railway - Mountain railway, does not cross a range but climbs to a point in the mountains	No landscape forming intentions with a view to harmonically embedding the railway structures in the environs	Example of combined system (cog/adhesion system)
Eritrea Railway	- 1911, steam operation - 2,395 m - Narrow gauge/950 mm - 30 tunnels - 532 bridges and overpasses - Few safety structures	Regional development for trade and passenger traffic by Italian colonial administration: Link from the port of Massaua to Asmara, the capital	Originally passenger and goods transport according to timetable; today exclusively tourist traffic	- Colonial railway - Mainline character - Narrow-gauge railway - Mountain railway, does not cross a range but climbs to a point in the mountains	No landscape forming intentions with a view to harmonically embedding the railway structures in the environs	Low to moderate structural outlay to reach a capital in the mountains
Guayaquil&Quito Railway	- 1908, steam operation - 3,609 m - Narrow gauge/1,067 mm - No tunnels - Only few bridges - Few safety structures	Regional development for trade and passenger traffic: Link between Quito, the capital and the ports on the Pacific coast	Originally passenger and freight traffic according to timetable today only tourist traffic on isolated sections	- Mainline character - Narrow-gauge railway - Mountain railway, does not cross a range but climbs to a point in the mountains	No landscape forming intentions with a view to harmonically embedding the railway structures in the environs	Adoption of the rarely used setting back tracks to gain altitude
Cumbres & Toltec Scenic Railway	- 1880, steam operation - 3,053 m - Narrow gauge/914 mm - Two tunnels - Two larger bridges - Hardly any safety structures	Regional development for trade and passenger traffic; in particular mining products	Originally passenger and freight traffic according to time table today only tourist traffic on isolated sections	- Narrow-gauge railway - Mountain railway, does not cross a range but climbs to a point in the mountains	No landscape forming intentions in the sense of railway buildings adapted to the environs; function as scenic railway is only recent	Low structural outlay to overcome a mountain pass
Train jaune	- 1911, electrically operated - 1,592 m - Narrow gauge/1,000 mm - 19 tunnels - 106 bridges, including 14 larger bridges - Few safety structures	Regional development for trade and passenger traffic and linking of two transnational railway lines in the Pyrenees	Originally passenger and freight transport according to timetable; today only modest tourist traffic	- Narrow-gauge railway - Mountain railway, does not cross a range but climbs to a point in the mountains	No landscape forming intentions with a view to harmonically embedding the railway structures in the environs	Track alignment adapted to electrical operation (greater upgrades than for steam operation)
Semmering Railway	- 1854, steam operation - 898 m - Standard gauge/1,435 mm - 15 tunnels (length up to 1.5 km) - 16 viaducts - Extensive safety structures	Trans-regional development for trade and passenger traffic Link between Imperial Vienna and the Mediterranean port of Triest	Originally and today passenger and freight traffic; planning of base tunnel to shift mainstream traffic in progress since 1989	- Mainline/transit - Mountain railway – crosses a range at low altitude	No comprehensive landscape-forming intentions in sense of railway buildings harmoniously adapted to the environs; link between railway engineering structures and landscape only becomes an issue in the wake of development of tourism	First example of a mainline trans-Alpine railway
Gotthard Railway	- 1882, steam operation - 1,151 m - Standard gauge/1,435 mm - 80 tunnels (15 km crest tunnel) - 79 large bridges - Extensive safety structures	Trans-regional development for trade and passenger traffic Connection linking northern and southern Europe	Originally and today passenger and freight traffic; base tunnel to shift mainstream traffic under construction; opening planned for 2014	- Mainline / transit - Mountain railway – crosses a range at moderate altitude	No landscape forming intentions in the sense of railway buildings harmoniously adapted to the environs; bridges though to be progressive when built but soon considered inappropriate	Example of a mainline railway with spiral tunnel and a long crest tunnel through a massif; the Alps
Albula/Bernina Line	- 1903/1910, steam/electrical operation - 1823/2,257 m - Narrow gauge/1,000 mm - 41/11 tunnels (Albula: crest tunnel just 6 km - 65/21 larger bridges - Extensive safety structures	Regional development for trade and passenger traffic (and tourism); integration in trans-regional railway network Bernina Railway as "side product" of electricity produced by the power stations	Originally and today, passenger and freight traffic according to full timetable	- Mainline character - Narrow-gauge railway - Mountain railway – crosses a range at high altitude	Landscape forming intentions in the sense of deliberate harmonious adaptation of railway buildings to the environs (e.g. by choice of local building materials)	Example of a (narrow- gauge!) mainline railway with spiral tunnels and lengthy crest tunnel, crossing a massif in its entirety, attaining high altitudes and operating 12 months a year from the later golden age of Alpine railway building; characteristic differences in the alignment due to choice of operating technology, particularly the electrical power system (Bernina: higher upgrades)

3.c.4 Overall view of the comparison

The analyses (cf. 3.c.2 and 3.c.3) revealed that, on a worldwide comparison, numerous features of the “Rhaetian Railway in the Albula/Bernina Cultural Landscape”, could be identified as *unique* while others are *typical*. To enhance transparency, this overall view of the comparison has been broken down into the sections “Building Period”, “Economic Importance”, “Technical Importance”, and “Present and Future Importance”. In conclusion, the most important findings are summarised in the section “International Positioning of the Albula/Bernina line”. A consideration of the “Cultural Landscape Importance” focussing on the surrounding countryside has been added.

Building Period

In the mid-19th century, mountain railway construction was still in the trial phase; the Semmering Railway was a trailblazing achievement in this respect. Tunnel building was mechanised in the second half of the 19th century. This made longer and special types (crest tunnels, spiral tunnels) feasible; a very early and most impressive example built in this period is the Gotthard Railway. Europe played a pioneer role in these technical innovations. At the same time, railways were being built to access the hinterland in various colonies; in the West of the USA the railway network spread out impressively. In the construction of all these railways political, economic (mining) and military interests provided primary impulse. At the beginning of the 20th century, railways built beyond Europe, relied on the tried and tested steam technology, whereas in Europe other sources of power for the railways were already being tested. In the first place it was electric traction that became increasingly important from the turn of the century. This had significant effects on the parameters of the railtracks, particularly on maximum upgrade. The Bernina Railway which was operated by direct current is a product of this trial phase in electric railways (like the Train Jaune or Little Yellow Train). In the 20th century, alternating current became the standard form of electrification (Albula Railway: from 1919). No later than in the second half of the 20th century, with the construction of the high speed trains (the Shinkansen in Japan or the TGV in France) electricity became the standard form of power.

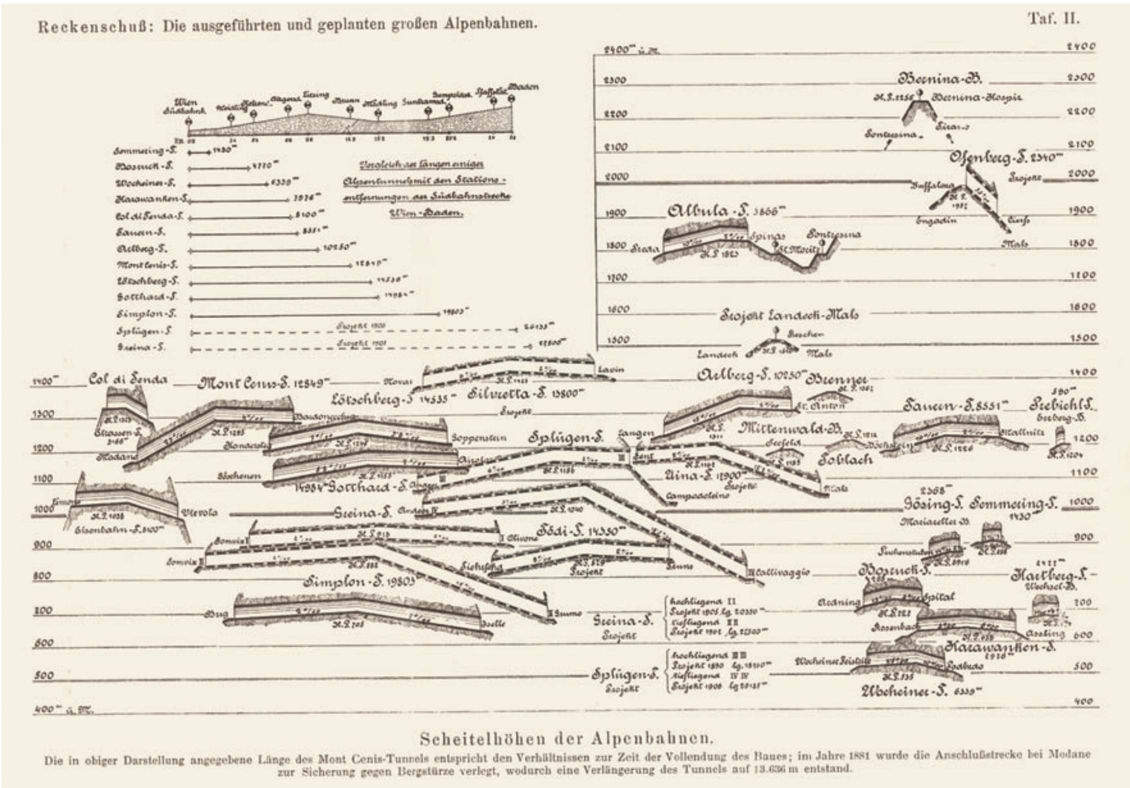
The Albula/Bernina line is rather special in the context of this development. Its ‘uniqueness’ derives from the Bernina Railway since at that time there were no precursors, no electrically powered railways at such an altitude. It is still the highest altitude transalpine railway operating all the year round and its significance for the electric railway is similar to that of the Semmering Railway in the steam operated mountain railway context. In the case of the Semmering Railway, which held the record for the highest railway culminating point for a decade, the capacity limit of steam locomotives was tested exhaustively and eventually raised, permitting access to mountainous regions throughout the world. It is the Albula line that is “typical”; the locomotion system and parameters were planned according to conventional steam-operated mainlines. A unique factor, however, is that on the Albula line all the technically extremely complicated measures like spiral tunnels or lengthy crest tunnels used for standard-gauge mountain railways were used on a narrow-gauge railway.

The Albula/Bernina railways are early 20th century highlights in the overcoming of a mountain massif by rail. The Bernina line stood out in its choice of what was, at the time, a highly innovative electrically powered system; it would soon become standard. The Albula railway distinguished itself in the perfection of a conventional yet - in view of the adoption of special forms of tunnel construction - very extravagant mode of operation and its realisation on a narrow-gauge construction. What is more both railways are among those last Alpine railways whose “golden age” came to a halt with the outbreak of the First World War; after this interruption none of the planned transalpine railways were realised. If the Semmering Railway takes is a symbolic for the beginning of the mountain railway era, then the Albula/Bernina lines are the final highlight. Together they illustrate, emblematically, the development of mountain railway construction from the mid-19th century until the eve of the First World War. Only at the end of the 20th century were new transalpine railways planned and realised, in particular the new transalpine axis (NEAT) in Switzerland. However, this tunnels right through the alpine massif (Gotthard and Lötschberg base tunnel).

Economic importance

Economic considerations provided the primary impulse to build railways. In the comparative

High altitude layout and crest tunnel of the ‘great Alpine railways’: 1912



Plan from: Robert Ritter von Reckenschuss: ***Die ausgeführten und geplanten grossen Alpenbahnen,*** **Vienna 1912.**

railways in non-European regions, colonial power and the exploitation of mineral resources and agricultural surfaces were important grounds: Thus the Yunnan Railway, running from the Vietnamese port of Haipong to the south Chinese Kunming, reflects the former influence of the French colonial authority, the Eritrea Railway reflects the colonial influence of Italy and the Darjeeling Railway that of England. The Yunnan and Eritrea Railways like the Guayaquil&Quito Railway served both to access the hinterland of the ports and of the towns (Kunming, Asmara and Quito). The Denver&Rio Grande Western was built exclusively to facilitate the exploitation of mineral resources (silver, iron and anthracite). Two of the European comparative railways fall into the category “transit railway with large catchment area (Semmering and Gotthard Railways), while the third, the Train Jaune, was clearly built as a tourist railway. Tourism added value was also achieved in the case of the transit railways; this was more marked in the case of the Semmering Railway than for the Gotthard Railway.

The Albula/Bernina stretch has certain similarities with the Train Jaune with respect to economic dimensions: In both cases an existing or emerging tourist region is accessed by a railway for the first time and connected to a greater, transregional even transnational railway network. The importance of the region for tourism is greatly enhanced by the construction of the railway (development of all-the-year-round tourism in the Engadin). However, at the same time, these railways supply the region. For the Bernina Railway, strongly influenced by tourist issues, the value added factor of building power stations on the south side of the Bernina Pass was decisive. The power station was primarily constructed to generate power for the northern Italian industrial region around Milan, and only part of the current was required to operate the railway.

Technical importance

The comparative railways cover a broad range in the technical field. The type and extent of the technical refinements, are generally a direct quotient of the economic expectations linked with the construction of the railway, but they are naturally also dependent on what was technically feasible at the time. The response to difficult topography is a sophisticated alignment and numerous engineering structures like bridges and tunnels. Large and bifurcated mountain valleys can be overcome with normal upgrades (Denver&Rio Grande Railroad, or by loops curving into the tributary valleys (Semmering and Yunnan Railways). Narrow, steep valleys, in contrast, require setting-back tracks which complicate operation (Guayaquil & Ecuador Railway) or technically very ingenious – and very costly – spiral tunnels or a crest tunnel (Gotthard, Albula). Open loops, like on the Darjeeling Railway, or cog operation like on the Nilgiri Railway are exceptional technical solutions.

The choice of alignment parameters - gradient and curve radius - depends on the technology adopted: As a rule, originally steam operated stretches were not planned with gradients in excess of 35 ‰ to 50 ‰ (Semmering, Gotthard, Yunnan and Eritrea Railways). The degree of upgrade influences the length of the railtrack in mountainous terrain. On electrically operated stretches the gradient could be raised to 70 ‰ – doubling the upgrade and shortening the length of the railtrack proportionally (Train Jaune).

The Albula and Bernina line uniquely represents typical rail stretches from the “golden age” of railway building. The railtrack of the Albula line was designed only for steam operation and therefore integrated numerous large engineering structures like major (stone) bridges or technically complicated spiral tunnels and a long crest tunnel. At the same time, the choice of what was then most innovative technology (electric operation) for the Bernina Railway led to a completely new type of railtrack and a marked increase in upgrades. The change in technology on a stretch, as exemplified by the Albula/Bernina line, is not to be found on any of the comparative railways and is therefore of unique importance worldwide.

Current and Future Importance

Despite the much quoted “renaissance of the railway” in the 21st century, the current importance of the various railways is by no means uniform. All the comparative railways are still in operation, but often only over short sections and rarely do they fulfil their original role. In view of the increasing shift of traffic from rail to road, whole stretches of some railways have been closed down after the Second World War or remain under acute threat of closure. Only a ‘survival’ as tourist railway with a radically reduced or strictly seasonal schedule, enables their continued, if uncertain, existence (e.g. Eritrea Railway; Guayaquil&Quito Railway; seasonal: Denver&Rio Grande Railroad). With the exception of the two transit lines, Gotthard and Semmering, freight transport has been abandoned. On the Yunnan Railway certain stretches were seriously damaged by storms in 2002; they have not been replaced for the time being. The structural condition – like for most of the other comparative railways – is not up to standard throughout, although the ministry responsible for Chinese railways declared in 2004 that they do want to preserve the stretch. This despite the construction of a standard-gauge Trans-Asia railway from Kunming to Singapore.

The comparative transit railways Gotthard and Semmering switched to electric operation, like the Albula Railway, at the beginning of the 20th century; this meant that power lines had to be erected. The changes entailed by electrification are essential operative measures to maintain the railway in the long term. Other modifications were also made on the Semmering and Gotthard railways. On some of the Semmering viaducts the original bricked arches were rough cast and the original natural stone parapets replaced by simple railings. At present additional, technically essential, work is in progress that will alter the appearance of the viaducts. All the steel girder lattice bridges on the Gotthard, which were built in 1880, have been replaced by concrete constructions. Base tunnels for both railways are either at the planning stage (Semmering) or under construction (Gotthard). In both cases, the continuation of operations on the historic mountain stretch after the opening of the base tunnels is uncertain. The Albula/Bernina line still operates a full schedule that is, it is still used for both passenger and freight transport. Between Thusis and St. Moritz, a daytime express runs hourly - a rarity on European narrow-gauge railways. Seven pairs of trains run daily between St. Moritz and Tirano. Further, the “Bernina Express” operates on the entire length of the Albula / Bernina line throughout the year The engineering structures along the Albula and Bernina railway lies are outstanding monuments from the “golden age” of Alpine railway building: When they were built their stone bridges were considered to be the most durable and resistant option, in contrast to the steel bridges which required so much maintenance. They were also considered well adapted to the landscape since they used materials quarried locally. Today the bridges are largely in their original state. Designed to transport motor vehicles, and running parallel to the Albula line, the some 22 km Vereina line with its Vereina Tunnel, was built in 1999 as a complement to the Albula railway.

International Positioning of the Albula/ Bernina Line

The Albula/Bernina line is the 'youngest' of the great Alpine railways and was designed as a narrow-gauge railway. Whereas the Semmering Railway marks the beginning of mountain railway building, the Albula/Bernina line represents its zenith. After the First World War, no transalpine railways were built for two generations. Only since the end of the 20th century have new Alpine railways again begun to be planned or built; all of these are long base tunnels (Semmering, Gotthard, Furka, Lötschberg, Brenner). Railway building in the second half of the 19th century led to numerous innovations in tunnel building. Two forms - the spiral tunnel and the long crest tunnel – are particularly interesting; both types are found on the Albula line. In view of the enormous outlay, both in technology and in financing, these new models were usually only adopted for standard-gauge main line railways. Spiral tunnels are no longer used in contemporary tunnel building. The construction of such complex structures was dependent on special mechanical tunnel-driving machines, as were developed in the 1860s. The Semmering Railway tunnels, for example, were still excavated by hand from start to finish.
The switch in power technique on the Albula/ Bernina line is an excellent example of developments in railway technology. Whereas the Albula Railway, which was designed for steam power, used conventional technology, the Bernina Railway is an example of a 20th century technical innovation that is standard railway practice today: electric operation. The Bernina Railway demonstrated the inherent potential of the new technology. Prolonged, very steep upgrades and tight curve radii, together with a maximal crest height at an altitude of over 2,200 m are the key features of this stretch. Today, the Albula/Bernina line is still the highest altitude, transalpine section that is operating all year round. The Bernina Railway demonstrates impressively and clearly how the adoption of technical innovations also influences the alignment: the gradient of the Bernina is double that of the Albula Railway. On the Nilgiri Railway, the adoption of cog operation in conjunction with the steam power system was chosen to overcome steep sections. The Bernina Railway underlines Europe's pioneering role in technical innovation; only one comparative railway was electrically operated from the outset: the Train Jaune in the Pyrenees.
Unfortunately, the comparative analysis confirms that many of the comparative railways are in very poor condition and that their future is very uncertain. Regular passenger traffic on the narrow-gauge railways covered in the comparison is often only possible on certain sections or seasonally as a 'museum railway'. As a rule freight traffic has been abandoned. With respect to regular passenger and freight traffic, the only two exceptions, are the compared (standard-gauge) mainline railways over the Semmering and the Gotthard. According to recent press reports the Yunnan Railway is to be preserved for all the traffic between China and Vietnam.
One feature of the Bernina Railway that is unique worldwide is the alignment that was laid out in certain stretches to provide tourists with the best possible views. This deliberate intention, which was expressed already in the planning phase, emerged under the influence of the incipient boom in Alpine tourism that became apparent

in the 19th century. At the beginning of the 20th century, year-round tourism was given new impetus with the advent of railways that were not at the mercy of the elements.

The Albula/Bernina line is also unique worldwide thanks to the enthusiasm with which it was welcomed from the outset for being “embedded in the cultural landscape in exemplary fashion”. Other railways and their structures were mostly appreciated only later as fitting into the surrounding landscape (Semmering, Denver&Rio Grande Railroad). The iron bridges on the Gotthard route were even condemned as a blot on the landscape. In some comparative examples the surrounding landscape was only appreciated once the trains had become purely tourist attractions (Denver&Rio Grande Railroad; Guayaquil&Quito Railway). Today, on virtually all the comparative railways, perception of the railway as part of the landscape is a primary feature. Unique combinations of railway, landscape and historic structures define ideal images of each line, and these images serve time and again in publicity. The Albula/Bernina line is unique above all for its engineering structures, which have largely been preserved in their original state, and for its embedding in a cultural landscape in existence long before the railway was built. The manner in which the railway traverses the mountain range, from one side to the other, establishing a link between disparate cultural areas and distinct cultural landscapes is most exceptional.

Cultural Landscape Importance

Railways and cultural landscapes are closely linked: They change already existing cultural landscapes just as they can generate new ones. In particular the above-ground railways together with civil engineering structures and buildings determine how the passing landscape is perceived from the windows of the moving train.

After the opening of all the comparative railways there was a change in the agricultural use of the surrounding countryside. As a rule, agriculture became more intensive (like the tea plantations alongside the Darjeeling Railway, as the railway made the transport of produce easier and therefore cheaper. However, the opposite trend was apparent in isolated cases, for example with the Semmering Railway, where viticulture declined when the railway began transporting imported foreign wines. The structures determining the cultural landscape – the railway structures – represent the modern as a complement to historic architecture (Train Jaune, Darjeeling Railway). In all comparative examples, the railway bridges make a significant mark on the cultural landscape and leave a lasting impression on the visual memory; in a few cases this applies for the whole alignment (Darjeeling Railway, Guayaquil&Quito Railway, Gotthard Railway). Where the railway runs through a historic cultural landscape, motifs like “railway and ruined fortress” or “railway and church” play a special part in the visual imagery, e.g. for publicity; they celebrate the link between traditional and modern.

The comparative railways are surrounded by numerous other traffic infrastructures: roads, paths and lines. Particularly in the case of electrically operated railways (Train Jaune, Bernina Railway), pipework and high tension lines are striking ‘companions’ running parallel to the railways.

The Albula and Bernina lines have their numerous individual characteristics with respect to the importance of the cultural landscape, but they also have features in common: They run through a particularly large number of vegetation and climatic zones and cross a mountain range from one side to the other; among the comparative

railways, this is only equalled, by the Semmering and Gotthard, which are also transalpine railways. However, because the Semmering has a clearly lesser difference in altitude to overcome – only about a quarter in comparison to the Bernina – it also traverses fewer distinct vegetation and climatic zones. The other comparative railways run from the plains (some from maritime ports) to destinations in the mountains and consequently also traverse a large number of vegetation and climatic zones. A railway that crosses a mountain range not only links low-lying regions at the foot of the mountains but also regions on either side of the mountains – and therefore quite distinct types of cultural landscapes. The Albula/Bernina line links the German-speaking cultural area to the north of the Alps with the Italian-speaking cultural area to the south of the Alps and runs through the Romansh-speaking cultural area in the mountains along the way.
Perception of the railway structures along the Albula/Bernina line is unique. From the outset it was pronounced “exemplary in its harmony with the landscape”. In contrast, in the case of the Semmering Railway such a verdict was only expressed decades after it had been built. Meanwhile, the original iron girder lattice bridges used for the Gotthard were considered to be an artificial, manmade contrast to the landscape and therefore disturbing. The Albula/Bernina line proves that the construction of a railway in a historic cultural landscape acknowledged as valuable was realised with more respect and tolerance than where there was no such awareness. At all events, the mode of design of the Albula/Bernina line is in sharp contrast to the style of the colonial lines, where the motive force was to open up the hinterland.
It is rare for European railways to run on roads through towns like the Bernina Railway does. Overseas, this kind of layout was once more common, but those stretches have since been rerouted or closed down. One example of a line with urban stretches that has been partly closed down is the Guayaquil&Quito Railway. However, the Darjeeling Railway still has stretches running through built-up areas.
The Albula/Bernina line shows some similarities with comparative railways in the changes in agricultural utilisation, transport paths and the role of tourism (incl. the emergence of winter tourism from the beginning of the 20th century).
The visual qualities of the cultural landscape seen from the Albula/Bernina railway and the view of the railway from the cultural landscape are therefore of significant importance for the property. Consequently, great value has been placed on the special treatment of the buffer zone.

Albula line > The Bernina Express at Bergün/Bravuogn, in the background left the village of Latsch.
P. Donatsch

3.d Integrity and Authenticity

Authenticity of the core zone

The Albula/Bernina railway is authentic. All the characteristics inherent to its exceptional and universal value are found within the defined perimeter along the route. Both the track layout and the buildings and engineering structures have been preserved almost entirely in their original state and the railway still operates a full service schedule.

In the case of historic buildings, authenticity is primarily a question of "originality" with respect to the original substance. A railway is a technical system whose authenticity is, in the first place, defined by the degree of its functional integrity. In order to fulfil its function, this system is continually exposed to new demands, so that on-going adaptations of its structure are indispensable. The railway can be seen as a "living monument", like a cultural landscape, it must also undergo continual evolution if it is to remain viable. The *ICOMOS Study Railways* as *World Heritage Sites* (Coulls, Divall, Lee 1999) comments on the specific question of authenticity in this context as follows: "No operating railway can be wholly authentic from a strictly historical point of view; items wear out and are replaced, methods of organization and operating are adapted to changing circumstances. However, arguably continuity through change is part of what makes a railway landscape or location: railways are by their very nature evolving socio-technical systems. Indeed, the drive to modernize and become more efficient appears to be an imperative of modern railway management world-wide. The key challenge is to identify just what it is about a railway location that makes it worthy of World Heritage status. A focus on the purely physical aspects of structures or technologies arguably makes it more likely that a site will be deemed 'inauthentic' as modernization proceeds than if equal (or greater) weight is given to the historical continuity of a railway's socio-economic functions. This is not an argument for any weakening of the imperative of good management of those historic features which do remain. Co-operation between railway operators and conservation bodies can make sensitive development possible and ensure that the integrity of sites is maintained, as the example of the British network over the last two decades shows (Burman & Stratton 1997). It is, we suggest, preferable to have a viable and useful railway rather than one which faces an uncertain future." The Rhaetian Railway and its Albula/Bernina line are committed to this precept: the historic original state of the cultural asset is maintained meticulously and adapted to modern requirements with the greatest sensitivity.

The Albula/Bernina line of the Rhaetian Railway has been running for over a hundred years. It continues to fulfil its functions as a full-service railway for both passenger and goods transport. The alignment has hardly changed since the railway was built. The opening up of the Alpine valley of the Engadin and the continuation of the line into Italy are still original to-

Solis Viaduct > Classic Alpine Pullman Express. The Rhaetian Railway has an impressive number of historic railway wagons and locomotives.
P. Donatsch / Rhaetian Railway

Albula line > A historical train composition, authentic in every detail, on the 100 year old Landwasser Viaduct.
P. Donatsch / Rhaetian Railway

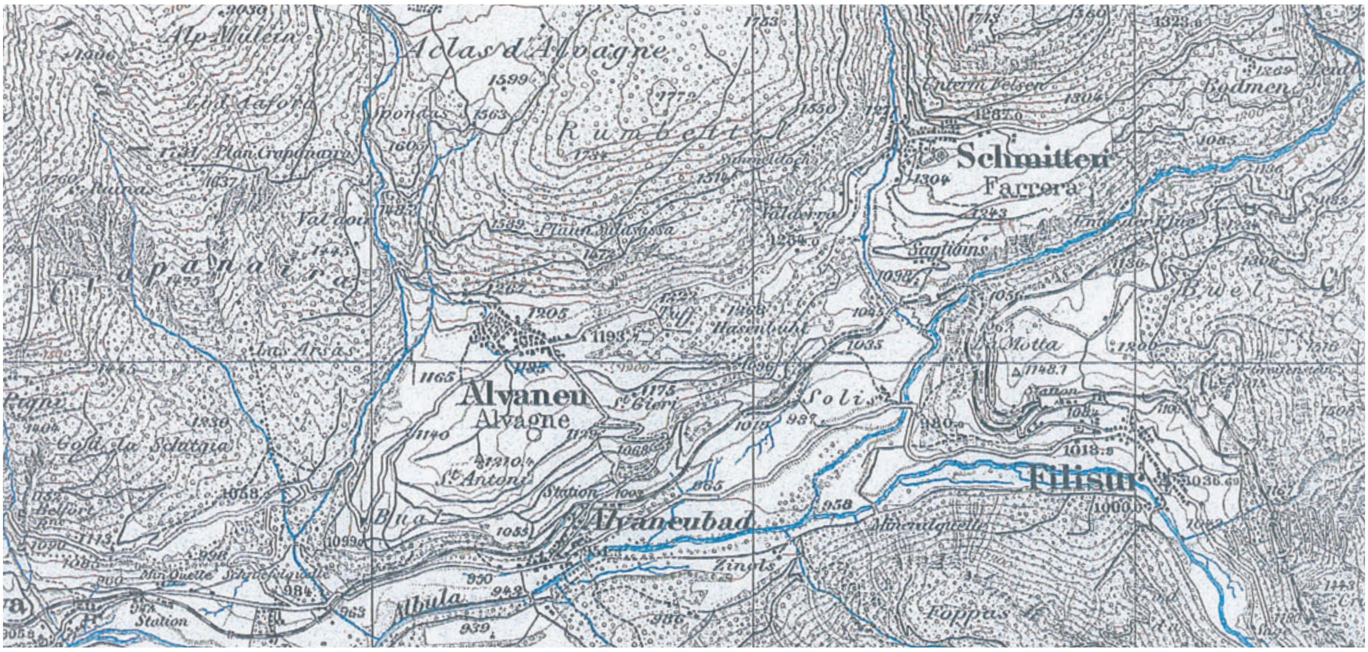
day, right down to the technical details. Only on the Bernina line were short sections realigned shortly after building was completed due to the introduction of winter operation and the associated natural dangers. The layout of this section was, from the outset, designed with a view to being changeable; the possibility of "empirical improvement" was already implied at the planning stage (cf. 2.b.6).

The engineering structures – tracks, bridges and tunnels along the entire route – have been preserved to a great extent in their original form and in the original materials (cf. 2.a.4).

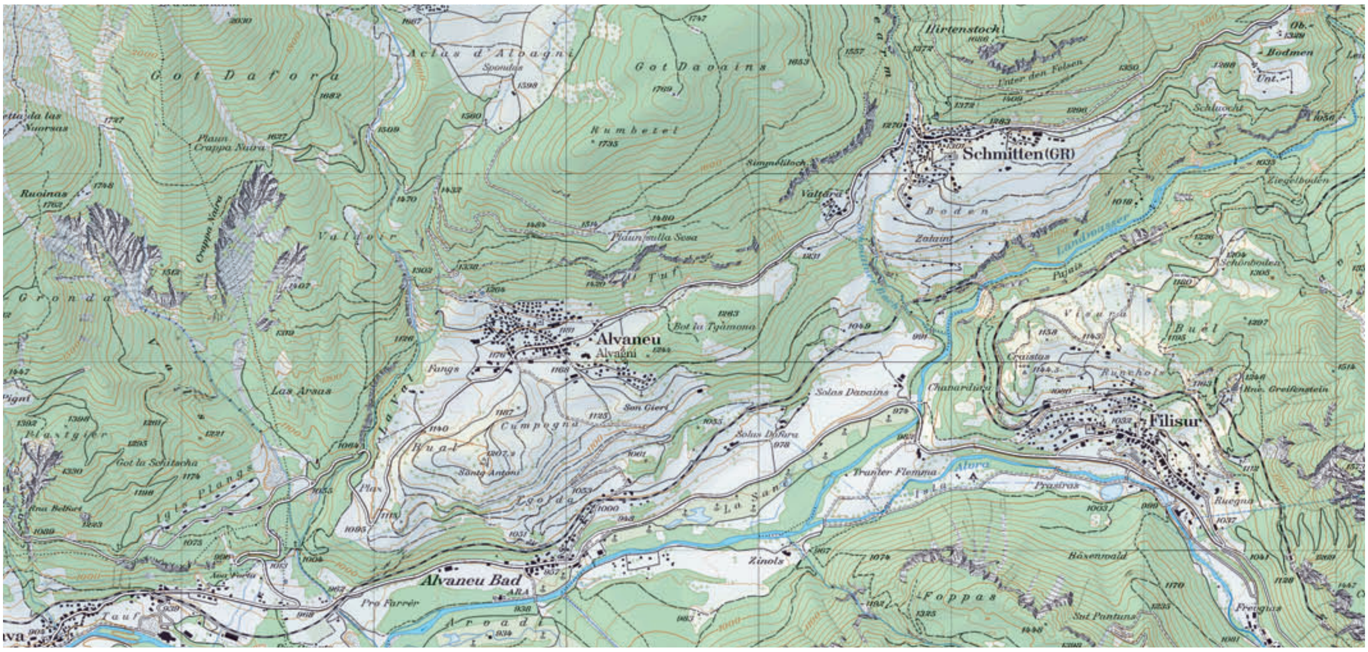
The railway buildings have also been extensively preserved as they were originally (cf. 2.a.5). The small railway stations on the Albula and Bernina line are mostly preserved in their original substance and form. However, progressive automation means that they are no longer permanently staffed. As a rule, the larger stations – like that in Bever for example – have also been preserved in their original form. The striking station building in St. Moritz was converted several times between 1902 and 2002 but is still a high-quality building complex and a special piece of railway history. The station at Samedan has been replaced by a new building. Other structures used for railway operation – halts, goods sheds as well as transformers and signalman's houses – have as a rule been preserved in the original. As they gradually lose their original function through changes in railway operation, these important witnesses of railway history are being used for new, compatible purposes.
The rolling stock includes an important number of historic railway carriages and locomotives. Thanks to the work of specialists and sponsor associations as well as the support of the railway, public funding (Graubünden Section for the Care of Historic Monuments) and private patrons, rail trips on historic trains can still be taken today on the Albula/Bernina route with locomotives and railway carriages that have been preserved and authentically restored, down to the smallest detail.

Authenticity of the buffer zone

Furthermore, the buffer zone (the surrounding landscape and the views of it) is also authentic. Protection of the landscape and nature, as well as treating existing buildings with respect, was already discussed while the railway was being built and was soon prescribed by law. Since then, the development of the landscape has, as a rule, proceeded on an appropriate scale in compliance with its character. Naturally, the landscape began to change long before the coming of the railway; we can even say it did so with the first settlement. Archaeological finds bear witness to the beginning of the cultural landscape in this sense (cf. 2.b.1). The surviving sacred and secular buildings along the Albula/Bernina route have frequently been preserved in their original material and shape, or else reflect, in their subsequently modified form, important historical periods when fundamental changes occurred in the region (cf. 2.a.6). The settlements have existed for centuries: the structure and substance of their historic cores are, to a very large extent (cf. 2.b.4), well preserved and new districts have gradually been added. The growth of settlements is characteristic of every living cultural landscape and is a sign of economic success – this is particularly true of the period after the Second World War. Today older and more recent settlement areas exist side by side and can be clearly differentiated. Modern



Map from 1938



Comparison of maps of the central Albula Valley from 1938 and 2004 > The character of the landscape is unchanged.

Map 1:25,000 > Status 2004
swisstopo, Wabern
(MB 062220)

road building with its bypasses (e.g. Samedan and Celerina) continues the development of the traffic routes that have run through the region for a very long time. They were supplemented and extended according to contemporary needs and means of transport (cf. 2.b.3): galleries, tunnels and protective structures were built, and rivers and streams realigned, to provide protection against natural hazards. Agriculture and forestry still predominate in the Albula/ Bernina landscape except in the Thusis area and in the Upper Engadin. The overall impression, the character, of the landscape is unchanged. The vistas of the natural and cultural landscape in the distance have hardly changed since the railway was built. There are a few exceptions here and there involving masts with power lines, cable railway installations or rockfall and avalanche barriers which do not impinge on the authenticity of the cultural landscape and the exceptionally varied scenic backdrop. In particular, there is no trace in the Albula/Bernina region of the widespread phenomenon of the “supermarket periphery” (urban sprawl or periurbanisation) with all its negative repercussions on the landscape that is so widespread elsewhere.

The immaterial authenticity is also safeguarded. Within a very short distance, the Albula/ Bernina railway runs through an area of exceptional cultural diversity. Various traditions and customs define the identity of the valley communities. The most striking feature is their linguistic diversity. German, Romansh and Italian are spoken in various idioms. Progressive mobility, and the consequent varied influences from outside, also partly due to the building of the railway, has led to slight changes in the language pattern. However, the disparate languages are still very much alive and much is being done to promote them (cf. 2.b.8).

Integrity

The integrity of the various sites is assured: the track of the Albula/Bernina line, with all its engineering structures and buildings, is inside the perimeter of the core zone. This covers the route from its starting point by the exit signal after Thusis station to the terminus in Tirano, Italy. As already mentioned, the surrounding landscape enhances the value of the sites with its exceptional vistas and other functional associations. The horizon traces the visual border of every landscape. Here it determines the limit of the buffer zone of the Albula/Bernina cultural landscape. In order to define practical protective regulations for the various sites in the buffer zone, this has been broken down into a primary buffer zone, a buffer zone in the immediate vicinity or ’near’ zone and a visible ‘distant’ zone. So all the characteristics of the Rhaetian Railway that define its value in the Albula/Bernina cultural landscape are fully included within the perimeter of the candidature.

4. State of Conservation and factors affecting the Property

Albula line > Solis Viaduct with the old road bridge in the background.
R. Pedetti

4.a Present state of conservation

4.a.1 Railway

The Rhaetian Railway is having a number of detailed inventories of its structures carried out which will cover the entire railway network. The bridge and tunnel inventories has already been completed (appended to the candidature documentation ["Annex" File] in electronic form); surveys of the protective structures, retaining walls, trackways and electrical installations have all been commissioned. A programme of inspection and assessment of the protective galleries is at the planning stage, whilst inspections of the stations are due to start in the near future. The aim of these systematic investigations is to assess the safety, the remaining useful life and the condition of the structures, and to ensure their conservation. The preliminary condition assessment, which is a purely visual inspection of the structures, is designed to identify the type and extent of any serious defects and damage which may be present. Determination of the causes of the damage follows in a second step; this cannot be made, in part without the aid of more detailed surveys. The results will provide the basis for identification of the rehabilitation measures required and for updating the existing, long-term investment plan (Business Plan).

Bridges

A systematic inspection of the bridges along the whole of the Rhaetian Railway network was carried out for the first time during 2003 and 2004. Here, the term 'bridges' referred to structures with a span of more than 2 m. Structures with shorter spans were defined as 'crossings' and were not included in the bridge inspection programme. The following table summarises the type and number of bridge structures on the Albula/Bernina section. There are altogether 196 bridges with a total length of 5,441 m.

Bridges within the railway perimeter

Section	Number of bridges	
Albula section (Thusis – St. Moritz)	**Total**	**135**
	Masonry viaducts	114
	Concrete bridges	18
	Steel bridges	2
	Other types of construction	1
Upper Engadin (Samedan – Pontresina)	**Total**	**9**
	Masonry viaducts	2
	Concrete bridges	4
	Steel bridges	3
	Other types of construction	0
Bernina section (St. Moritz – Thusis)	**Total**	**55**
	Masonry viaducts	23
	Concrete bridges	10
	Steel bridges	21
	Other types of construction	1

The maintenance period for modern concrete load-bearing structures in road construction is around 25 years. This figure is based on the engineering lifetime of bridge elements such as their sealing and surfacing. The lifetime of the supporting structure itself is around 75 to 100 years. The normal maintenance period for railway bridges is between 30 and 40 years.
The condition of the supporting structures has been subdivided into the following 5 classes.

Characteristics of the condition classes

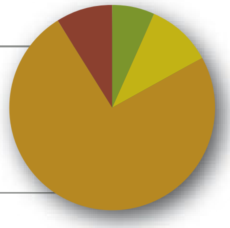
Condition class	Colour code	Measures
1 good	■	No measures required during the current maintenance period
2 acceptable	■	The bridge could (but need not) be maintained during the current maintenance period.
3 defective	■	Maintenance must be carried out during the current maintenance period. The time at which this is done can be freely selected.
4 poor	■	Rapid rehabilitation or strengthening is required over the next few years. If additional safety precautions are taken then the intervention can be postponed and/or any increase in the extent of the damage can be restricted so that the rehabilitation or strengthening will only be required sometime during the current maintenance period.
5 alarming	■	Immediate measures are needed to ensure the safety of the structure.

Condition of the bridges on the section between Thusis and St. Moritz (Albula line)

The following chart shows the breakdown of the bridges on the Albula line into the five different condition classes.

Evaluation of the bridges on the Albula line

Condition class	Bridges
good	9
acceptable	14
defective	100
poor	12
alarming	0



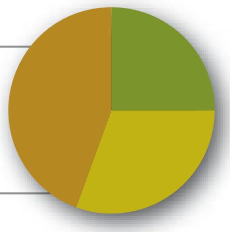
The very large number of bridges in condition class 3 stands out. All but 6 of these are jointed quarrystone viaducts dating from the time the line was constructed. The type of damage is largely the same in each case. All these structures lack bridge sealing to prevent ingress of water into the supporting structure. Without sealing, the joints in the load-bearing masonry become soaked; in winter, frost action then causes the joints to crumble. Track sealing will have to be built into all of these bridges and the joint mortar will have to be replaced. A sealed masonry viaduct with newly mortared joints can remain in service for another 50 to 70 years.
The 14 structures in condition class 4 are also quarrystone viaducts. 13 of these have been maintained as they were originally; in the remaining structure the central opening has been replaced by a concrete frame. These structures show signs of major defects and serious damage. Corrective maintenance work will have to be carried out on them during the next 10 or so years.

Condition of the bridges on the section between St. Moritz and Tirano (Bernina line)

There are a number of different types of bridge structure on the Bernina line, including masonry, concrete and steel bridges. 35 of the total of 55 structures are still standing as they were originally built, and date back to the years between 1907 and 1909. The following chart shows the breakdown of the bridges on the Bernina line into the five condition classes.

Evaluation of the bridges on the Bernina line

Condition class	Bridges
good	14
acceptable	17
defective	23
poor	1
alarming	0



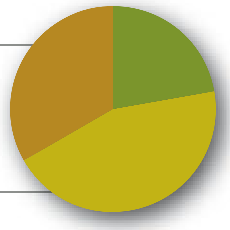
About half the bridges on the stretch between St.Moritz and Tirano fall into condition class 3; consequently mid-term, the need for rehabilitation work is higher here. Further, there is also one structure in poor condition requiring prompt rehabilitation measures.

Condition of the bridges on the section between Samedan and Pontresina

The bridges in the Upper Engadin are not all in the same condition. 5 of the total of 9 bridges date from 1907, whilst the remaining bridges are more recent. The following chart shows the breakdown of the bridges on this section into the five condition classes:

Evaluation of bridges in the Upper Engadin (Samedan – Pontresina)

Condition class	Bridges
good	2
acceptable	4
defective	3
poor	0
alarming	0



Only three of the bridges between Samedan and Pontresina fall into condition class 3, consequently a certain amount of corrective maintenance work will be required over the medium term here as well.

Main causes of damage

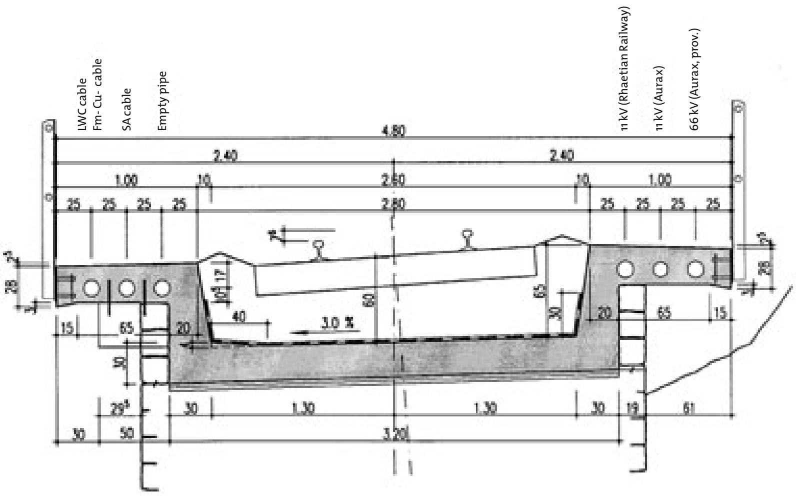
The damage and defects are largely due to the following three causes (cf. 4.b.i and 4.b.ii):

> major damage in the masonry joints resulting from the ingress of water and the effect of frost
> structural deformation resulting from ground movements
> heavy loading of the trackway, insufficient depth of ballast

Programme of works

The 15 bridges on the Albula/Bernina lines which fall into the condition class 4 range will be rehabilitated within the next 10 or so years. The following table summarises these structures.

Rhaetian Railway > Laying the concrete ballast trough on the Val Lumpegna Viaduct in the Surselva, 2005.
Rhaetian Railway



Rhaetian Railway > Standard cross section of the Val Lumpegna ballast trough.
Rhaetian Railway

Bridges in condition class 4 on the Albula/Bernina lines

Name of bridge	km	Length [m]	Causes of damage	Planned rehabilitation
Albula line				
Bändertobel Viaduct	46.991	57.40	ground movements	
Lochtobel Viaduct	47.824	121.70	trackway, masonry joints	2007
Lehnen Viaduct	51.905	72.30	ground movements	
Lehnen Viaduct	52.279	29.00	ground movements	
Lehnen Viaduct	59.270	34.10	masonry joints	
Underpass for a path	61.606	20.30	masonry joints	
Landwasser viaduct	63.070	100.00	trackway, masonry joints	2009
Val Nava Viaduct	64.954	44.50	ground movements	
Ava Lungia, farm track underpass	71.533	15.40	masonry joints	
Underpass Lower Saliaz path	73.645	13.20	masonry joints	
Underpass Old Saliaz path	74.001	13.20	masonry joints	
Blais Leda underpass for a path	78.418	13.60	masonry joints	
Albula Viaduct III	82.560	139.90	masonry joints	2008
Lehnen Viaduct	102.400	37.35	masonry joints	2007
Bernina line				
Poschiavino Bridge Rasica	59.181	23.20	bearing safety	2007

In the medium term – that is, over the next 40 years – the 126 bridges in condition class 3 will also have to be rehabilitated. Most of these are masonry viaducts dating from the time the line was built. Here, comprehensive bridge rehabilitation is the only economically sensible form of renovation. As mentioned already, the basis for the long-term preservation of these bridges is the installation of trackway sealing. This measure will be carried out together with repair of the masonry joints and renewal of the trackway (replacement of the ballast and the rails).

The pilot project for the rehabilitation of the quarrystone viaducts was completed in 2005 with the ‘Rehabilitation of the Val Lumpegna’ on the stretch Reichenau – Disentis. Installation of the ballast trough which seals the bridge was carried out with the support of the cantonal office for the preservation of monuments and with other external experts. The objective was to ensure the preservation of the original character of the bridge. Work on the rehabilitation of the Val Susauna Viaduct on the Lower Engadin section started in 2006. The construction approach developed for these first two bridge rehabilitation projects is to be further improved with the help of the specialists and the construction companies involved. The aim here is to define a standard construction approach for the maintenance of quarrystone viaducts.

Other Objects

Since 2005, the tunnels on the entire Rhaetian Railway network have been the subject of a systematic inspection programme; the evaluation results were presented in October 2006. A detailed assessment of the condition of the retaining walls should be available at the beginning of 2007. It is incumbent on the Rhaetian Railway, as the owner of the works, to maintain the protective structures, which were built with financial support from the federation and the canton, in good condition and to inspect them at regular intervals.

The Rhaetian Railway has now started in part to meet the above obligations and in part in the course of its conservation programme to carry out structural inspections of all its avalanche baffles, rockfall barriers, stream correction measures

and slope stabilisation works (mudflow barriers). One reason for this is the obligation to maintain and inspect these works (already referred to); another is to provide information for use in developing the Railway's maintenance planning programme. Work is presently underway on the inventory of these objects in the Lower Engadin (Bever – Scuol); this work will serve as a pilot project for other areas. The condition survey of the protective structures covers the entire network and is likely to be completed within the next two to three years. A programme of maintenance for the protective structures will then be developed in coordination with the cantonal office for forestry; the programme is likely to extend over several years. So far no detailed condition assessment of the galleries has been carried out, although one is planned to begin in the near future. The track superstructure along the Albula line is presently the subject of a systematic renewal programme, under this programme work on renewal of the trackway of the Bernina line started a few years ago.
The following passages, based on the information currently available, describe the condition of the various types of structure on the Albula and Bernina sections.

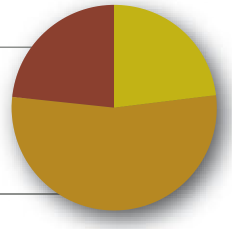
Tunnels
Condition

There are altogether 50 tunnels on the Albula/Bernina line, with a total length of 18,421 m. The key feature is the Albula tunnel which, with a length of 5,865 m, is more than 30 % of the line's total tunnel length.

The following chart shows the breakdown of the tunnels on the section between Thusis and Tirano into the various condition classes.

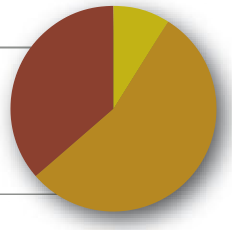
Evaluation of the tunnels on the Albula line (Thusis – St. Moritz)

Condition class	Tunnels
good	0
acceptable	9
defective	21
poor	9
alarming	0



Evaluation of the tunnels on the Bernina line (St. Moritz – Tirano)

Condition class	Tunnels
good	0
acceptable	1
defective	6
poor	4
alarming	0



More than three-quarters of all the tunnels fall within condition class 3 and 4 (assuming the ranking of the Albula Tunnel as class 4). Considerable corrective maintenance work on these tunnels is essential over the short to medium term to guarantee operation.

Types of damage and their causes

The main types of damage to the tunnels are:
> crumbling of the joint mortar and bulging of the masonry
> deformation of the structures

The damage to joints and masonry is caused by the ingress of water and the effect of frost, the deformation of the structures is the result of differential ground movements. Other damage is due to the design, whereby the vaults of the tunnels are mostly lined with quarrystone masonry but without any strengthening provided for the sole. The tunnel profiles are usually horseshoe-shaped – a form which in structural terms is quite unfavourable. In most cases no measures were taken to seal the vaults or to drain off the mountain water.

Programme of works

The programme of works will largely be based on the results of the main inspection. A comprehensive rehabilitation is planned for the 100-year old structure of the Albula tunnel, giving it an additional lifetime of 70 more years. The rehabilitation work will include all aspects of current railway engineering technology, such as track superstructure, track substructure, catenary system and cable installations; it will also include implementation of the safety requirements in the existing railway tunnel. The Swiss Federal Office for Transport (BAV) is currently preparing a guideline on a classification system and safety requirements for existing railway tunnels.

A number of other improvement measures are also to be considered for inclusion in the next larger-scale rehabilitation projects. In general, the clear cross-sectional area of the tunnels is roughly 18 m^2 to 20 m^2, however, in many places the actual dimensions are less than the theoretical railway loading gauge.

Condition of the protective structures

Protective galleries

The galleries along the Albula and Bernina lines are all avalanche and/or snow protection galleries. Those on the Albula line are massive stone-built structures with masonry vaults which were built when the line itself was constructed. The galleries on the Bernina line have very light steel structures and a roofing of timber planks or corrugated iron sheets. These galleries were designed to resist much smaller falls than would be designed for today, when more stringent safety specifications are applied. This is particularly true for the light structures on the Bernina line.

Between 1983 and 1985, the Maliera gallery between Bergün/Bravuogn and Preda was replaced by a new and longer protective gallery. This has a framework structure on one side with steel supports set in concrete on the valley side. Some of the galleries on the Bernina line have been rehabilitated, but only minor additional strengthening was incorporated at that time.

The maintenance condition of the protective galleries is likely to be the same as for the tunnels. On the Albula line it is probable that damage will be found in the masonry joints; much more serious damage is likely to be found in the lighter galleries on the Bernina line which have not yet been renovated.

Other protective structures

The Albula/Bernina section is protected at several points by avalanche baffles, rockfall barriers, stream containment and slope stabilisation measures (mudflow protection). Many of these protective structures – mostly avalanche baffles – date from the time when the line was built. In recent years many of the structures between Filisur and Bever along the Albula section which protect the line from rockfalls and avalanches have been renewed. In some cases the structures have been extended or additional new structures built to meet the potential level of risk which exists today. The work was carried out in close cooperation with the cantonal Forestry Office. The focus of the work on the Albula line includes Sils i.D./Schin Gorge, Filisur – Bergün/Bravuogn (Surmin rockfall

barrier), Muot (avalanche baffle with approximately 500 protective structures) and the Val Bever, where in 2005 a mudslide barrier was built near Spinas to protect the south portal of the Albula tunnel, and where the Alpetta avalanche baffle is currently being renewed and extended.
The focus of the work on the Bernina section is on the upper part of the line. The inventory of the avalanche baffle on the Pila slope between Alp Grüm and Cavaglia has already been completed. The baffle consists of some 450 protective structures. A first stage of the rehabilitation work is due to begin in 2007. The Poschiavo rockfall barrier (built in 2005) and a number of other rockfall shelter walls along the Miralago – Brusio – Campocologno (the Li Geri protective embankment) – Tirano section are additional structures exposed to a high level of risk and must be monitored carefully.
The steadily increasing concern for safety and the continuing climatic change will soon lead to the need for the construction of additional protective barriers, primarily as protection against rockfall and landslides. The measures which might be used here include massive reinforced concrete protective galleries or the use of flexible protective catch nets. The selection of one or other type of barrier will depend on local conditions.

Condition of the retaining walls

During the construction of the railway a distinction was made between proper retaining walls which provide support to the trackway on the valley side and revetment walls along the sections of the line on a mountain slope and which protect the slope on the mountain side of the trackway from erosion. The retaining walls on the Albula section consist of either vertical or inclined (1:5) gravity walls in mortar-jointed masonry. The retaining walls on the Bernina section were built as dry stone walls with an inclination of 1:3 or as mortar-cemented walls with an inclination of 1:5. The revetment walls on the Bernina section are of a similar type of construction; these walls are either dry stone with an inclination of 1:3 or mortar-cemented with an inclination of 1:5.
Today, retaining walls and revetment walls are almost always built in concrete. In the nominated area, new concrete retaining walls of this type, to a design based on the existing structures, with an advance wall are already being built.
Retaining walls are often overburdened by water running down from the mountain side and building up behind the wall. This results in bulges forming in the masonry and could entail the risk of partial collapse. Frequently, damage to the masonry joints is also caused by the ingress of water and the effect of frost (see the description of the condition of bridges). Masonry joints can be further damaged or even destroyed by plant growth.
Massive retaining walls are relatively insensitive structures. Localised damage to this type of wall does not entail a direct threat to the structure as a whole. Extensive plant growth and gaps in the masonry where individual stones or bricks have dropped out can, however, give the structure an unkempt appearance and in the long term lead to a loss of structural safety. Over the next few years, partly due to the age of the structures, a substantially increased volume of maintenance work will be needed for retaining and revetment walls. The work should result in these supporting structures remaining in good working condition for a long time to come.

Condition of the trackway

Trackway on the Albula section

By the end of 2007 all of the section between Thusis and Tiefencastel will have been largely renewed, as will 85 % of the section between Tiefencastel and Filisur. Over the next 10 to 15 years large sections of the track between Filisur and Preda and between Spinas and Bever will become due for renewal. Special cases are presented by the section between Tiefencastel and Surava in the area of the “Brienzerrutsch” (an instable slope near Brienz) and by the Albula tunnel. Here, the broad Brienzerrutsch pushes the terrain (and consequently also the trackway) southward towards the Albula by up to 10 cm each year. One of the results of this is that annual inspections and corrective measures have to be carried out in order to maintain the safety of railway operations. In the Albula tunnel there is a conflict between the aims of providing adequate track bedding/track height and maintaining sufficient clear vertical profile. In parallel to the renewal of the track superstructure, work will also be carried out on the trackway shoulder and track drainage, maintaining, extending or improving them to bring them up to modern standards and requirements. Where necessary renewal of the cable conduit blocks will be included in the projects.

Trackway on the Bernina section

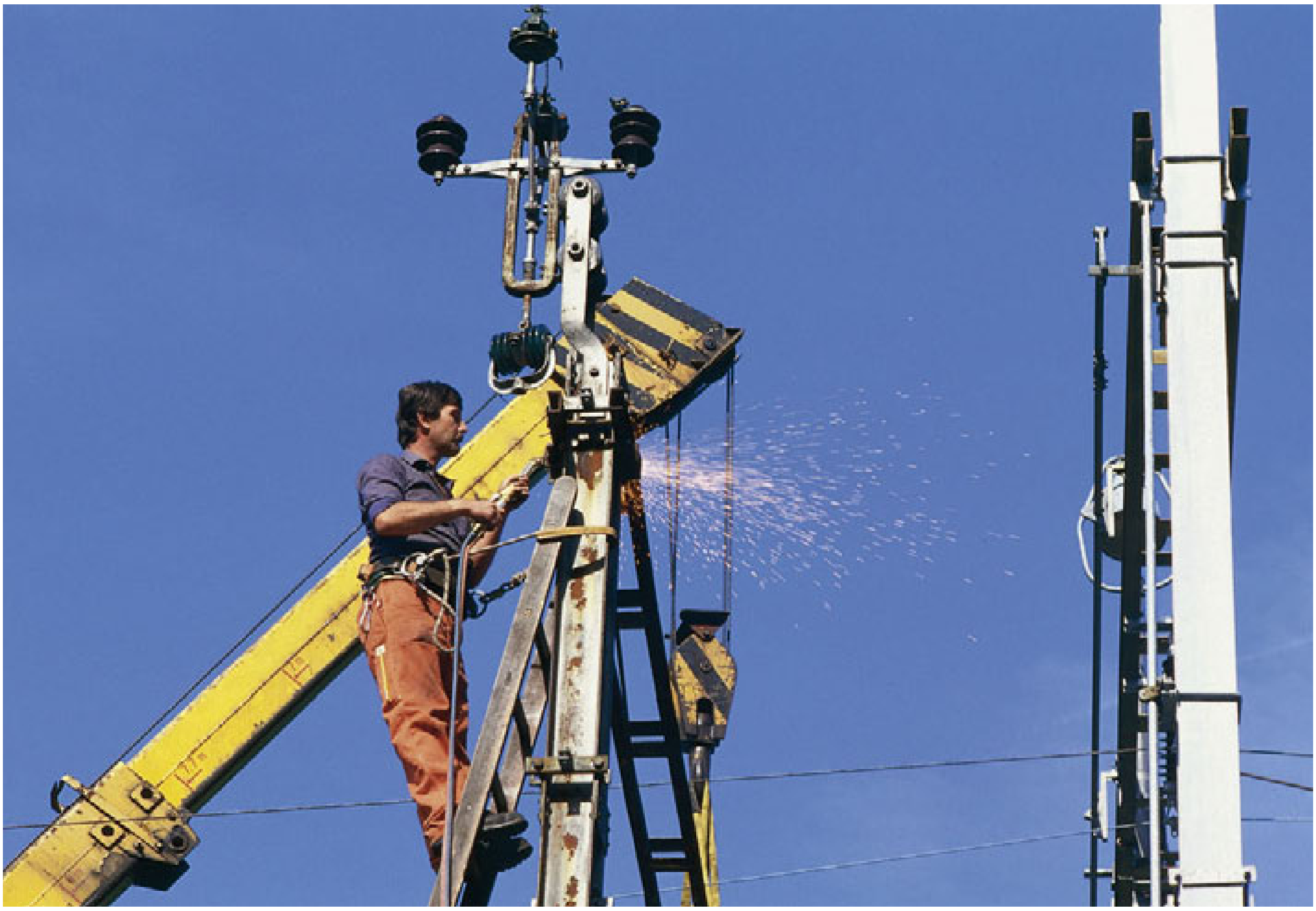
Work on the systematic renewal of the superstructure installations on the Bernina line only began a few years ago. There is a considerable backlog to deal with here. The priority work, which involves renewing the track on the section to meet latest standards, will take at least another 8 to 10 years to complete. For a number of operational reasons it was decided to carry out the work on the station facilities (length of passing tracks, safety facilities and so forth) early in the overall programme. For this reason, the facilities will soon have been brought up to a good standard throughout to cope with today’s traffic volumes. The Bernina line is located at quite a high altitude, it has many gradients, a difficult geometrical alignment with many tight bends and much of it runs through difficult terrain. Maintenance and renewal work to this line therefore present much greater logistical and constructional challenges than do the other sections in the Rhaetian Railway’s main network. Here, engineers planning work on the higher reaches of the line have to deal with the additional problems of frost and the short construction season.

Electrotechnical installations

An initial systematic inspection of the Rhaetian Railway’s electrotechnical installations was carried out in 2004. This preliminary condition assessment is presently being updated. The work covers the following main sub-systems:

> safety facilities (such as points and derailers, barriers, blinker systems, signals, track switching systems, axle counters, train protection) and

> low voltage, power and telecommunications facilities (LT facilities) – such as track lighting, points heating, potential equalisation, earthings, lightning protection, internal facilities installations (light, heating, ventilation, air-conditioning, electricity supply, telephone and telecommunications installations, data transfer facilities, data communication, train radio and marshalling radio, automatic ticket machines, ticket cancelling machines, parking meters, customer information systems, loudspeaker systems, fire detection systems, rectifier equipment,



Rhaetian Railway > Renewing the catenary installations.
P. Donatsch / Rhaetian Railway

coach preheating systems, static frequency converters, substations, switch gear and network control stations).

There are 27 locations on the Albula section with electrotechnical plant and systems. 15 % of the LT facilities and 45 % of the safety installations on the Albula line are in good condition. The condition of a further 85 % of the LT facilities and 50 % of the safety installations have been classed as acceptable; the general condition of these installations is good, although individual parts and components have defects; operational safety, however, is assured in every case. The only installation which is in poor condition is the 54-year old safety installation in St. Moritz; this will have to be replaced within the near future. There are 37 locations on the Bernina section with electrotechnical plant and systems. Here, 16 % of the LT facilities and 36% of the safety installations are in good condition. On 78 % of the LT facilities and 55 % of the safety installations individual parts and components have minor defects, these do not, however, present any risk to operational safety. 3 % of the LT facilities and 9 % of the safety installations are in poor condition: increased investment is needed here to assure operational safety. The facilities classed as defective will have to be replaced in the near future. The only facility in condition class ‘poor’ is the Charnadüra tunnel portal LT facility in St. Moritz (on the Pontresina side). However, if special measures are taken, operational safety can also be assured for this facility.

Catenary systems

Large sections of the catenary systems on the Albula line are in good condition. Those sections which have not been rehabilitated are due to be renewed, with work planned to be carried out in stages over the next few years. For some years now, work has been ongoing on a systematic renewal of the catenary systems on the Bernina section, where the continuing growth in train services has meant that the power supply capacity had to be increased. The rectifier equipment was modernised at the time the catenary system was renewed. The renewal work is being carried out in stages, with sections of about 1.5 to 2 km being dealt with each year.

Buildings

The station buildings are generally in a relatively good condition, with no immediate need for renovation work. Most of the buildings contain technical installations related to the railway, which has meant that the buildings have been maintained regularly. When restoration work is carried out, care is taken to ensure that as much as possible of the original features are preserved and, where necessary, even recreated. Some of the original auxiliary buildings have lost their nominal function. Only the most essential maintenance work was carried out on these buildings to ensure that the appearance of the buildings is preserved.

Albula line > A Rhaetian Railway train at Tiefencastel. In the background, to the right, the village of Stierva.
T. Keller / Rhaetian Railway

4.a.2 Cultural landscape

Graubünden (Switzerland)

The condition of a cultural landscape depends on its economic exploitation; if this is abandoned then the cultural landscape changes significantly as the natural processes take over. In the long term, economic exploitation can only be assured if it provides the people involved with an adequate means of existence.
General changes in society entail changes in the demands placed on the living space and so to the demands placed on the cultural landscape; the changes also affect the way in which the cultural landscape is exploited. As with all living cultural landscapes, those in the Albula/Bernina area are subject to dynamic change, which is in turn a reflection of cultural development. Some of the activities which affect the area and so the cultural landscape have more widespread effects. Most of these are recorded in the Cantonal Structure Plan (cf. 5.b) where they are assessed, giving due consideration to the interests affected. The Structure Plan is subject to continuing elaboration and updating and thus provides a basis which can be used to guide the development of the cultural landscape and to facilitate realisation. The Management Plan does not include financial flows which affect a wide area (e.g. acreage contributions to the farming industry) or the level of compensation for services provided by farmers in the public interest. These concerns are defined by law; however, taking them into consideration involves mutual coordination and agreement.

Waterways – Realignment of the River Flaz

The most striking change in the cultural landscape of the Albula/Bernina region in recent times was caused by the realignment of the river Flaz, in the Upper Engadin. The Flaz has its catchment area in the Bernina region. Until recently the river ran parallel to the railway from Punt Muragl to Samedan, where it flowed into the River Inn. The change in the course of the river was made with the idea that the built-up areas of Samedan, located on the floor of the valley, would then be protected from high water levels. These areas used to lie in the major high-water flood zone (100-year flood level). Today, the river runs from Punt Muragl along the foot of the slope of Muotta Muragl towards Gravatscha, where it joins the Inn. At the time the Flaz was relocated, work was also carried out to renaturalise the River Inn between Samedan and Gravatscha. The relocation of the river was designed to meet ecological and environmental demands, earning the scheme a number of prizes as a project of outstanding quality.

Agriculture and forestry

The whole of the cultural landscape of the Albula/Bernina region is well managed with respect to agriculture and forestry. Melioration measures, such as those carried out in recent years, provide the structural conditions which allow the cultural landscape to be managed with the means available today (mechanisation and modernisation) and in a way that ensures its continuing preservation. Such land improvement works are still in progress in some areas of the Val Poschiavo.
Over the last 20 to 30 years agricultural operations

Samedan > The River Inn has been 'renaturalised' between Samedan and Gravatscha.
Tiefbauamt Graubünden, Chur

Samedan > The Flazbach now flows naturally into the Inn at Gravatscha.
Tiefbauamt Graubünden, Chur

Samedan > Renaturalisation of the river has created natural habitats.
Tiefbauamt Graubünden, Chur

Samedan > Historic view of the village; with the lazy meanders of the Inn.
Rhätisches Museum, Chur

have been relocated out of the villages because of problems with the emissions caused (noise, air, dust and so on). This has occurred along the whole section of the railway line. In relocations of this type the new location for the agricultural operations is selected with due attention being paid to the various interests involved (integration into the landscape, ecological aspects, operational processes, protection against natural hazards, future extensions, and so on). As a consequence of the development of the laws and standards relating to animal husbandry, the production of foodstuffs, and so forth, which are applicable to the whole of Switzerland, the farm buildings too have changed. The new animal quarters are much larger than their predecessors and therefore stand out more in the landscape. The aim is to integrate any changes to buildings and structures related to the agricultural use of the land into the landscape carefully. In doing so attention is given to preserving (and even renewing) special features of the cultural landscape such as dry stone walls, hedges and narrow paths. These modifications are carried out in accordance with the existing legal and planning conditions and with due consideration given to land tenure regulations and to what can be reasonably expected of the farmers.

Access ways have recently been constructed in the forests; these make economic exploitation of the forests possible even in areas with steep slopes. In recent years, there has been a 'renaissance' of objects constructed with wood from the region's forests (e.g. a timber bridge in Tiefencastel, a forestry centre in Bergün/Bravuogn). Local timber is also used for energy recovery (e.g. for wood chip heating systems).

In future the primary focus will be on the regular maintenance and preservation of the infrastructure provided for the management of the local agriculture and forestry.

Settlements

Settlements are constantly changing, although to different degrees; outwards, through expansion of the area covered by the settlements, internally, through construction on vacant plots of land in the heart of the villages, through continuing renewal or through measures aimed at increasing density. The villages and hamlets in the Albula valley, as in the Val Poschiavo, are developing less markedly than those in the Upper Engadin – a difference which is largely determined by the unequal weighting of spatial policy in these regions. In 2005/2006, a survey of the building zones was conducted with a view to better comprehension of the quantitative changes taking place in the villages. A geographic information system (GIS) was used to collect details of the building zones, aggregate them and compare them, using standard criteria, with the official survey of built-up area coverage. This work now forms the basis for a reporting exercise that is carried out and presented to the federation and parliament at periodic intervals. In turn, the obligatory reporting exercise ensures that the surveys are carried out at regular intervals.

In striving for high quality settlement development, one decisive factor is the way that historic buildings are treated in those parts of the settlements/villages most worthy of protection. An overview is available which indicates how the local authorities deal with the historic centres of their settlements/villages in their building laws; the overview shows whether the measures implemented are in keeping with the specified legal and structure planning principles. This overview was last updated in 2006 and will be updated at specified intervals in future; it forms part of the reporting process referred to earlier. It is established that the planning conditions have been created in all the local authority areas within the

nominated World Heritage Site, to allow meticulous treatment of the village nuclei worthy of protection. But it is not only the external appearance of the villages or the façades of the buildings which are being protected and preserved. The valuable fabric of the interior of the buildings and the typology of the buildings is also being preserved. Civil works on historic monuments, significant in terms of the history of art and culture, are carried out after conferring with specialists from the cantonal office for the preservation of monuments; the specialists also accompany the entire work process in detail. In special cases this technical department can arrange for financial contributions from the canton and even from the federation.
Every building application received for construction outside the building zone is recorded, dated and coded and the site concerned georeferenced. This database provides an opportunity to obtain an understanding of the quantitative changes taking place in the cultural landscape.

Infrastructure (roads, transport facilities for tourists, the production and transport of electricity)

Various types of infrastructure characterise the cultural landscape of the Albula/Bernina region. The road network will remain in its present form long term; there are no plans for the construction of any new, continuous, longer-distance transport axes. Existing roads are regularly maintained, renewed and brought in line with today's requirements. These works include measures taken to protect against natural hazards; examples include the rehabilitation of the road through the Schin gorge (land slips) or the road across the Bergünerstein (rock falls). Larger-scale renewal work and new franchising work is due to be carried out for a number of transport facilities for tourists. These do not involve new access links but rather the renewal and improvement of existing facilities which are coming to the end of their working life. These facilities were built during the tourism boom of the 1960s and 1970s. In some cases the renewal work has already been completed.
Other infrastructure features in the Albula/Bernina area include the numerous hydropower stations and the overhead lines needed to transport electricity. The power stations have always been the source of power for the operation of the railway and are frequently the subject of new concessions. The overhead line has been renewed in recent years (the Bernina axis). In terms of the use of hydropower, the project to increase the storage height of the Lago Bianco is worthy of mention (cf. 4.b.ii).

Quarries and gravel pits

Quarries and gravel pits are also elements which are important for the preservation of the cultural landscape today. The supply of gravel, sand and stone for the next 20 years is largely assured.
The relevant sites are included in the Cantonal Structure Plan (cf. 5.b). Along the Albula and the Bernina lines, culturally-relevant changes to three of these sites can be expected short to medium-term; the remaining sites will continue to shape the cultural landscape as long as they are in use. The quarry near Sils i.D. is a source of hard stone that is used as track ballast. The operation of this quarry – hidden in the scenery – will be closed down over the next few years, as any further extension of it would lead to the destruction of valuable elements of the cultural landscape (the ruins of the Campi fort – a cultural monument of national significance and an element of the core zone). Studies have shown that stone of appropriate quality is available in the Farrirola area, near the railway line between Filisur and

Bergün/Bravuogn. This is a location were material was quarried and processed in earlier years. The preliminary work (incl. modification of the Structure Plan) on the realisation of a new quarry is almost complete. However, the facilities in the area of the Cambrena delta (Bernina axis, Lago Bianco) will be closed down and not replaced should the planned increase in the storage height of the Lago Bianco be realised

Tirano (Italy)

The agricultural economy

Agricultural businesses like the cooperative dairies and the fruit and vegetable consortia provide economic activity throughout the region through the production of goods and the sale of services. There are others which might be better defined as "micro-businesses" since they are owned and run by the members of one family in most cases. The agricultural sector is historically important in mountain areas. Indeed, in spite of the difficulties imposed by the nature of the mountain terrain, which is difficult to access and not conducive to intensive exploitation, agriculture has always played an important part in the culture and economic structure of the villages in the area. In recent years, however, there has been a gradual decline in the sector. There are currently 189 agricultural businesses in Tirano, 175 of which operate on an area of less than 5 hectares. These figures are a significant reduction on those for 2000, when there were 476 farms. Furthermore, there has been a reduction in the area given over to vineyards in the town and its surroundings. As a result, some areas have been changed into fields and pastures and have not been replanted, therefore requiring less work. There are several livestock-breeding farms, mainly rearing cows and pigs, but also sheep, goats and horses, as well as poultry and bees.

Infrastructure

The area has an extensive network of roads, but this presents several problems. Geographical factors and the effects of national and international decisions over the years have meant that the area, and the Valtellina or Veltlin as a whole, continues to play a marginal role in the overall scheme of transport infrastructure and, therefore, in the movement of people and goods through the Alps. There is one main road, the Strada Statale 38 dello Stelvio, which runs along the floor of the valley and is joined by a series of secondary roads connecting the various villages. This creates heavy traffic and has a negative effect on access to the area. In comparison with other parts of Italy, the Valtellina region has a high density of commercial vehicles due to the poor coverage provided by, and the limited use made of, the railway network – which only goes as far as Tirano and is only a single track – and the resulting dependence of commercial traffic on road transport. In addition to the local bus services, there are two different railways in the area, the Milan – Lecco – Tirano railway and the Chur – Bernina – Tirano railway (both on only one track), and they meet in Tirano. To reach other communities from there, one has to use the local buses, operated by STPS (Società di Trasporti Pubblici di Sondrio).
Other service infrastructures include transmission facilities (TV, radio, radio relay and telephone), power lines and hydroelectric stations, which make Valtellina a high production area of hydroelectric and biomass energy. There is also a wood biomass plant in Tirano, which was

built in 2000 for the production of thermal energy. It has been enlarged since then and can now produce about 7,500 MWh of electricity per annum. It supplies a network of 300 users, spread over an area of nearly 20 kilometres, as well as sports and leisure facilities.

Settlements

The municipality of Tirano encompasses several frazioni (localities) – Baruffini, Cologna, Madonna di Tirano and Roncaiola – which have seen an increase in the number of houses used as main residences, second homes or holiday accommodation.

Bernina line > The railtrack is exposed to the elements, particularly in winter.
P. Donatsch

4.b Factors affecting the property

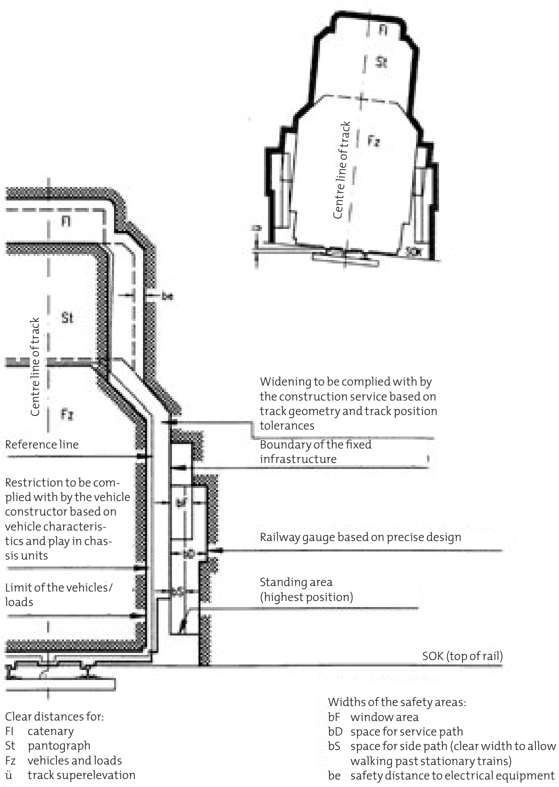
As a service provider, the railway is subject to constant change. The development of tourist offers, changes in commuter and leisure transport and the continuing adaptation of rolling stock to user needs attest to socio-dynamic influential factors. Even the cultural landscapes traversed by the railway are in a process of constant change although their historic and traditional use is still recognisable in the landscape and settlement pattern. Furthermore, state agricultural and energy policy, the endeavours with regard to nature and heritage protection, and the efforts to manage spatial planning are reflected in the cultural landscape. The forces of nature affect people, the environment and the railway infrastructure. Both at company level in the Rhaetian Railway, as well as at authority levels, the monitoring, assessment and use of suitable protective measures with respect to the risk of natural dangers is legally and financially assured. Methods and procedures are subject to appropriate regulations. Climate change, which has become increasingly more apparent over the past ten years, is a further influencing factor. In the Albula/Bernina region, as in all other Alpine regions, the consequent increase in extreme meteorological occurrences and the thawing of the permafrost affect all areas of life as well as development perspectives.

4.b.i Development Pressures

Railway

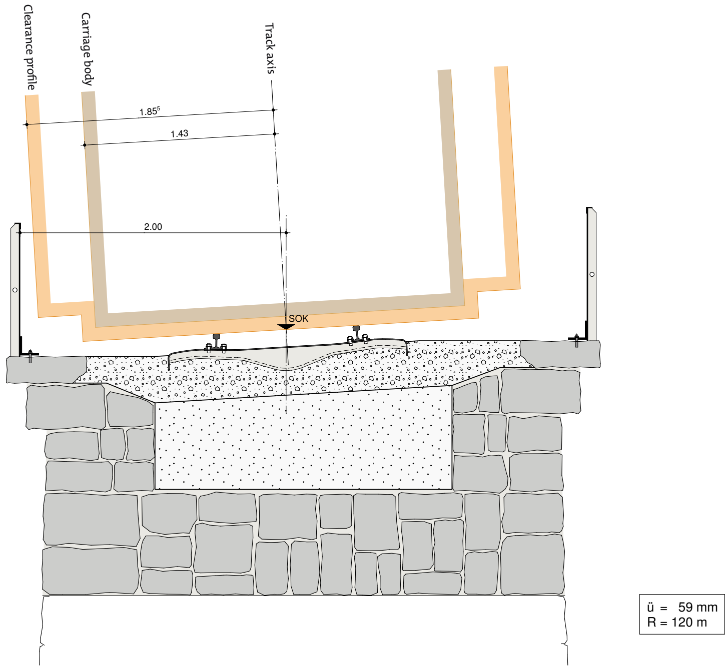
The constant modernisation of rolling stock corresponding to state-of-the art technology and the changing needs of rail passengers has an influence on the railway infrastructure. Thus, the increase in travelling speed requires adaptation of track banking (ü) and the longer carriages necessitate adaptation of curve radii (e); vehicle width directly affects the radius of the reference curve and the clearance gauge.

The following diagram shows the realisation of the clearance profile according to the provisions of the railway decree:



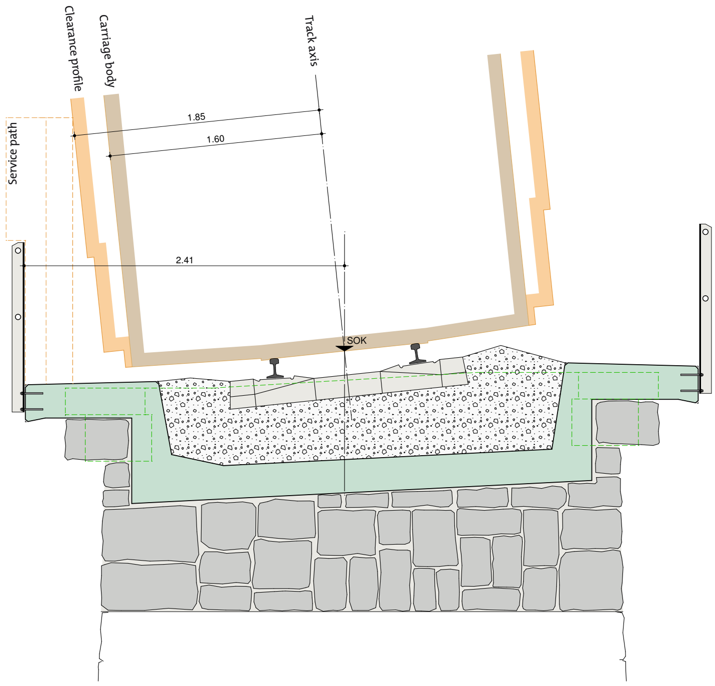
The clearance profile was defined as follows when the railway was built:
(ü=track banking; e=curve radii)

$b_{min} = 1.775 + e + 2.0 \text{ x ü}$
(without service path)



Today the clearance profile is calculated as follows:

$b_{min} = 1.85 + e + 2.0 \text{ x ü}$ (without service path)
$b_{soll} = 2.05 + e + 2.0 \text{ x ü}$ (with service path)



At the time the railway was built, trains ran at 30 km/h; the longest carriages were 14.30 m long and 2.70 m wide; on bridges, the minimum distance between the carriage body and the railings was 60 cm on either side. On straight line sections, there was therefore a minimum width of 3.90 m between the railings. This width was increased to 4.0 m on the Albula line for snow blower operation. In curves, the modified position of the vehicles, both horizontally and vertically, was taken into consideration according to the legally established standards. If, the same safety standard is to be reached as at the time the railway was built with today's rolling stock and speed, the minimum width between the railings for bridges in the arc radius (R = 100 – 130 m) has to be increased to 4.52 m. This corresponds to a widening of around 25 cm on both sides (curve radius +10 cm, track banking +7 cm, rolling stock width +5 cm).
Increased speed also leads to a greater load on the single-track system. The original ballast depth of 35 cm is only just sufficient for today's needs. When renewing the track, the sleepers and rails, as well as the old ballast, will be completely replaced and the ballast depth increased.
Today, in contrast to early days, the safety of railway personnel has also become a primary focus. Crossing the rails is classed as dangerous if the sighting time is less than 6 seconds. Assuming about the same sighting time for the Landwasser Viaduct, a railway worker caught off guard by a train approaching at 45 km/h must be at least 75 m from the entrance of the Landwasser Tunnel in order to still be able to make his way to safety. If he is closer to the tunnel entrance, his safety can no longer be guaranteed. In contrast to the tunnels there are no niches on the bridges, which is why a service path (safety zone for employees) must be created if the construction work exceeds a certain length. Taking a service path of 40 cm into account, the target width between the rails according to the above explanations is 4.92 m (4.52 m + 40 cm). In the interest of a compromise between conservation of a historic monument and technical safety demands, the Rhaetian Railway is fundamentally aiming at a minimum bridge widening to only 4.80 m in curves. Furthermore, the service path need not extend over the whole length of the bridge, but can be reduced in places. Increased safety requirements make constant adaptation of the installation inevitable. In order to guarantee the safety of passengers, structural measures in the Albula Tunnel will have to be addressed in the near future. Amongst other things, the Federal Department of Transport will shortly issue new guidelines for the classification and safety requirements for existing railway tunnels.

Cultural Landscape

Graubünden (Switzerland)
Spatial development

On the basis of demographic development, settlement structure and key economic data, four regional types can, in principle, be distinguished in the Alpine area, each with different development tendencies. However, these dovetail in some places and, by their interaction, have a significant influence on landscape development:

> *Central regions* with densely urbanised centres and periurban agglomerations. As well as tourism and other services, industry and

Diavolezza mountain station > In the background, to the left, Piz Bernina and the Biancograt.
C. Sonderegger> / Graubünden Ferien

Bergün/Bravuogn > Haymaking mountain style.
R. Pedetti / Graubünden Ferien

business are also often considerably developed in these areas.

> *Periurban regions* with high proportions of commuters to agglomerations within, or frequently outside, the Alpine centres. This regional type is characterised by population growth with, at the same time, a lack of independent economic dynamism.
> *Rural areas* with a dispersed settlement structure and, as before, strongly marked by agriculture. Business and tourism play only a marginal role. This type shows a more or less balanced population trend.
> *Depleting regions* with marked decreases in population and a very high proportion of agriculture.

The Thusis-Domleschg region, with the once important service centre of Thusis on the north-south route, can be characterised as a periurban region. Under the influence of the economically powerful Chur-Rhine Valley agglomeration, it shows population growth but is losing economic dynamism because the orientation to the magnet of Chur appears increasingly determinant.

The Albula valley is an agricultural region, fighting against the phenomena of ageing and migration, and economically subject to the influence of the neighbouring tourist centres of Lenzerheide, Savognin and Davos.

The Upper Engadin is a focus region experiencing steady population growth. Here, tourism is the principle economic sector and the most important influential factor with regard to spatial planning. The Rhaetian Railway had an influence on the development of tourism and, in the early days, even played a leading role in promoting it. The Bernina Pass countryside has been formed both by the development of tourism in the Upper Engadin and by the infrastructure of the Rhaetian Railway. It owes its attractiveness to the Bernina Group and the Biancograt, always a magnet for climbers.

In the rural area of Val Poschiavo, the population and regional economic structure has, to a large extent, remained stable thanks, amongst other factors, to innovative industrial and tourism projects as well as to the economic advantages arising from the proximity to the Italian Veltlin and to the Upper Engadin.

In general, nature and cultural landscapes are increasingly coming under pressure from changed usage demands. In the Alps, natural living areas are endangered by increasing traffic, over-development and the ‘correction’ of rivers and lakes. As a result, biodiversity is steadily diminishing in the Alpine region, as it is elsewhere. Nevertheless, the Alps are the largest remaining ‘natural’ region in central Europe. Thirty thousand animal and thirteen thousand plant species bear witness to a great natural variety. Nature reserves are a successful tool for maintaining the Alpine biodiversity. In the Albula/Bernina region too, numerous nature reserves of the most differing categories have been established. The Upper Engadin lakeland and the Bernina massif are listed in the federal Inventory of Landscapes and Natural Monuments of National Importance (cf. 5.b and 5.c). Amongst other things, Swiss spatial planning law lays down legally binding provisions, and various planning tools, at cantonal and local levels, for all spatial development trends. In principle, spatial planning focuses on sustainable development. In particular, economical management of the limited surface resources has priority (cf. 5.b).

Agriculture

By and large, the farming sector still plays a major role in the Alps, particularly in the northern regions, where a structure-conserving agricultural policy, as well as specific regional and sector policies, ensure that agriculture remains viable. Low-yield mountain farming is coming increasingly under pressure against the background of global liberalisation. The organic production of local specialities and marketing them in collaboration with the tourist sector, offers one possibility for the future. In the Albula/Bernina region, there are various successful agricultural initiatives in this direction, such as, for instance, the "ansaina" product label in the Albula valley. Swiss agricultural policy supports this development. Instead of the price and product subventions practised until the 1990s, today, surface-related direct payments are made to agricultural enterprises which, for their part, are linked to ecological strictures. This helps to compensate for the disadvantages of farming in mountain regions. The consequent assurance of care and conservation of the cultural landscape has positive effects not only on biodiversity, but also on tourism. In Graubünden, over half of the agricultural enterprises already operate according to the guidelines of the "Bio Suisse" (organic) label, which is recognised throughout Switzerland. As well as the incentive created by the agricultural policy, market demand is also responsible for the high number of enterprises that have switched to organic production.

Hunting and fishing

In Switzerland, hunting and fishing are legally regulated at federal and cantonal levels. Both are important for the preservation of species, the careful management of natural resources and the sustainable ecological development of the fauna in general. In particular, regulation of the animal populations requires human intervention, since the damage to mountain forests, for example by foraging, would be excessive if there were no control. The regular hunting season in Graubünden, is restricted to three weeks in September. But special hunting regulations are applied in the event of very large populations, small animals or particular species, such as the Alpine ibex. Along the Albula / Bernina route, designated federal hunting-ban areas (no hunting allowed) and various game reserves are also factors influencing the World Heritage perimeter.

Closed seasons have also been established for fishing. The stretches of water and the periods when fishing is permitted are clearly defined. The cantonal office for hunting and fishing constantly monitors and regulates fish populations.

Forestry

Forests fulfil diverse functions. Mountain forests, in particular, offer indispensable protection for settlements and traffic and, as ecologically sensitive nature areas, require particular care and active management. The ecological stability of mountain forests is adversely affected by various factors. These include, for instance, ungulate foraging which prevents natural forest rejuvenation and renewal, the ingress of atmospheric pollutants (ozone, nitrogen), natural disasters, which are occurring more and more frequently as a consequence of global warming, and the growing demands of leisure and sporting activities.

As well as the protection and leisure functions mentioned, forests also have a supply function; the work-intensive management of the mountain forests is carried out by the local forestry services. Today, the cultivation of timber is not very profitable and is consequently dependent on public funds. Graubünden and regional players are working to position wood more favourably on the marketplace as an ecological and renewable raw material.

Quarrying

Stone or gravel is quarried at various locations in the Albula/Bernina region, for example by Sils i.D. at the entrance to the Schin Gorge and in the Flazbach river bed between Pontresina and the Morteratsch station. Quarrying is extremely important both for the regional economy and for the supply of hard rock beyond the region. This is used, for instance, in the construction of protective structures against natural dangers (barriers, weirs etc.) and also for the Rhaetian Railway, where it is used, amongst other things, as track ballast. When the resources at a location have been exhausted, restitution or re-greening is carried out, taking ecological and scenic aspects into account. In the interest of regional autonomy and guaranteeing supply beyond the region, a few new quarries will be opened up in the future.

The use of hydroelectric power

The relationship between constructing a railway and the use of hydroelectric power on the Bernina has already been dealt with in chapter 2.b.7. The use of hydroelectric power clearly marks the Albula/Bernina cultural landscape, be it through the installations for producing electricity or technical constructions, such as high-tension cables and catchment reservoirs. The use of hydroelectric power in mountainous regions is of great importance both from energy technology as well as ecological and economic considerations and, because of increasing energy requirements, it will continue to be so in the future. In view of the generally anticipated shortage of power and efforts to use less constant sources of energy such as wind or photovoltaic solar power, high-efficiency pump-fed power stations are extremely important to balance supply and demand. Consequently, the present hydroelectric power stations will be modernised and upgraded. This will also have an influence on, and modify, the cultural landscape in the future. The Graubünden cantonal authorities approved the water-rights franchise for the hydroelectric works in the upper Poschiavo valley by a resolution of 15th August 2006. This ensured that the current Rätia Energie AG complex can be operated for a further 80 years. Approval of the franchise also gives Rätia Energie AG the option to extend the power station. For example, there are plans to raise the water level of the Lago Bianco reservoir to increase its storage capacity. This would entail realigning the existing dam walls and increasing their height by about 17 m. Realisation of this project would result in an insignificant shift in the layout of the railway track, which runs immediately alongside the lake. A working group led by the well-known architect Aurelio Galfetti, in collaboration with representatives of the Federal Commission for the Protection of Nature and Cultural Heritage, the Rhaetian

Railway and Rätia Energie AG, has drawn up a design for the dam wall and for the layout of the railway line at the location concerned taking care to ensure that the historic railway route along Lago Bianco retains its character. In addition, compensation measures with regard to both nature and landscape (protection and utilisation planning) were agreed during the concession procedure for the higher water level project.

Traffic infrastructures (roads, tourist transport facilities, electricity production and distribution)

Besides the railway infrastructure, the other infrastructures in the Albula/Bernina cultural landscape are affected by social change, inasmuch as the constantly increasing demands with regard to speed, capacity, safety, efficiency, aesthetics, comfort, etc. also have repercussions. No major road network measures are foreseen today beyond routine upkeep. At local level, the aim is to construct bypasses in locations where protection of the population, cramped conditions in old village nuclei and road capacities necessitate them. In the next few years, relevant measures are only due on the Bernina axis, namely ring roads to bypass Poschiavo and Le Prese, as well as San Carlo and Campocologno. In connection with Poschiavo and Le Prese, tunnel solutions are also under discussion. With regard to tourist transport facilities, the general renovation requirement was mentioned (cf. 4.a.2). Thus, for instance, renewal of the Darlux cableway facilities in Bergün/Bravuogn, which run above the loops of the Rhaetian Railway, will soon be realised. This example demonstrates the previously mentioned conjunction of various factors. In view of its attractiveness for tourism, renewal of this cableway is extremely important for Bergün/Bravuogn. Should it not be realised, jobs in the tourism sector would undoubtedly be lost. In the winter season, it is precisely these employment opportunities that make it possible for people in the farming sector to earn additional income and thus secure their livelihood. If this were to cease, there would be consequences with regard to the continuation of farming and consequently for the cultural landscape of the region as a whole. Renovations of cableways and ski lifts in the Upper Engadin are also scheduled to begin soon.

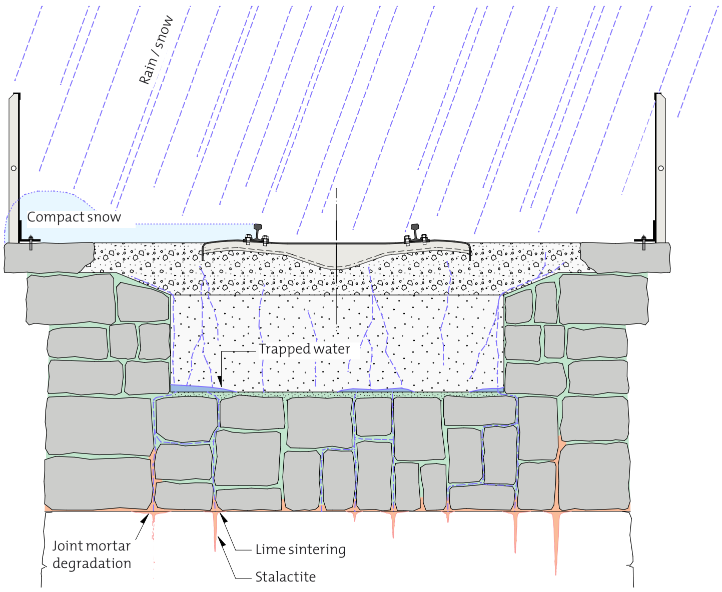
Tirano (Italy)

While the province occupies a privileged position in terms of natural beauty, the same cannot be said in economic terms: there is no overall predominance of one sector over another and this puts a limit on development. The majority of companies are family-owned and managed or collective businesses like cooperative syndicates, while companies of more substantial size are concentrated in the lower valley. In the last few decades, there has been a shift from the agricultural sector to the tertiary sector and service industries. Historically, the agricultural sector has been important in mountain, particularly alpine, areas. In recent years, however, people have gradually abandoned the sector because it did not generate enough income. Also, the structure of society had changed and, with the improvement in educational standards, the young preferred to seek employment in the service sector or leave the valley altogether to work in the big cities. The number of agricultural businesses is much lower now than it was in 2000: in fact, there are only 189 farms in Tirano today, 175 of which operate on an area of less than 5 hectares. In addition, there has been a reduction in the area used for growing vines, a reduction that can be seen in every community belonging to what is known as the Tirano Mountain Community (Comunità Montana Valtellina di Tirano) and that is most evident in Teglio and Tirano, the two communities which had the largest area of vineyards. Villa di Tirano is the sole municipality in which the cultivation of vines, linked to the production of DOC (Denominazione di Origine Controllata) and DOCG (Denominazione di Origine Controllata e Garantita) wines, has shown signs of recovery in recent years. The secondary sector in Tirano comprises: 82 businesses in the field of manufacturing, 54 in construction, 209 in commerce, and 39 in transport, making a total of 384. Industry and handicrafts in the area are two closely-related sectors which, while representing a significant proportion of local production and employment, do not put it into the categories of "intensively industrialised" or "pronounced craft industry presence". Natural resources in the province are scarce, limited to a few quarried products (granite and serpentine stone, located in Val Malenco, Val Masino and the area of Novate Mezzola), forest assets (despite the size of the forests, these assets do not constitute a particularly valuable source of income), and various sources of mineral water (Bormio and Val Masino). There is also intensive exploitation of water resources for hydroelectric purposes in Valtellina, but the energy produced is used elsewhere. The region has transport infrastructure problems which have dragged on for decades. While the infrastructure has been used more and more, the province has seen no corresponding modernisation of the road network, resulting in traffic problems at peak tourist periods. The Bernina railway, which connects the famous resort of St. Moritz with Valposchiavo and terminates in Tirano, is essential for tourism in the area. In the case of broadcasting installations and electricity power lines, accelerated technological development has brought an increase in infrastructure supplying electrical power and in transmission facilities for radio, television and telephone. There is also a wood biomass plant in Tirano, which was built in 2000 for the production of thermal energy. It has been enlarged since then and now produces some 7,500 MWh of electricity per annum.

4.b.ii Environmental Pressures

The average temperature in the northern hemisphere has increased by around 1°C in the past century entailing a 10 to 20 cm rise in sea level; worldwide, approximately 10 % of the ice and snow mantle has melted since 1970. The principle cause of global warming is the constantly increasing amount of fossil fuel being burned and the release of the associated greenhouse gas CO_2 into the atmosphere. Various climate models have simulated the effects climate change will have on the Alpine economy and habitat. Extreme weather situations (e.g. storms, excessive precipitation) will occur more frequently, the snow line will recede making numerous winter sport areas unprofitable, the vegetation line will rise, glaciers will melt, the permafrost will thaw making high-altitude slopes unstable and increasing the danger of mudslides and

Pontresina > Two protective embankments have been built above the village; the thawing of the permafrost made this measure necessary.
E. Süsskind



Damage mechanism of water ingress - frost damage

- Ballast
- Filling material
- Mortar coating
- Joint mortar
- Degraded joint mortar

Rhaetian Railway

rockfalls. A research project in Pontresina examined the permafrost problem on the Schafberg. Consequently, as the first municipality in the Alpine region to react to global warming and thawing of the permafrost, Pontresina built two protective barriers above the village. Within the Albula/Bernina perimeter, glacier shrinkage can be particularly well documented using the example of the Morteratsch glacier at the foot of Piz Bernina. When the railway was constructed, the glacier tongue reached to within a few meters of the track. In the meantime, however, it has receded by almost 2 km into the Morteratsch Valley. The loss of volume has accelerated since the 1990s. On average, the glacier's rate of retreat is 17–20 m per annum.
Environmental influences not only affect the cultural landscape as such, they also have an influence on the bridge constructions of the Albula/Bernina railway line. Thus, rain and melt-water seep down in places where the ballast trough is not watertight and the drainage no longer functions correctly, into earth-filled structures, where it collects along the side walls and at the low points between two neighbouring vaults, forcing its way into the masonry joints. Temperature fluctuations and frost subsequently lead to sintering out of the chalk into the soffit and decomposition of the joint mortar (cf. 4.a.1).
Temperature fluctuations are also responsible for changes in the length of straight masonry bridges. The crown rises in winter but dips in summer. In the case of curved viaducts, changes in length can be compensated by displacement towards the outside of the curve (summer) or towards the inside of the curve (winter). Terrain shifts also have a similar effect on bridges, but deformations to supporting structures are much greater than those caused by fluctuations in temperature. Buckling is more frequent in the longitudinal direction whereas tilting or torsion is more likely to occur laterally. These deformations are also inevitably linked to serious cracking in the masonry. Terrain shifts mostly occur to one side of a bridge element entailing asymmetric stress in the construction.

4.b.iii Natural disasters and risk preparedness

Natural dangers, such as terrain shifts, avalanches or mudslides threaten settlements, people and the traffic infrastructure. This is particularly pronounced in mountainous regions in view of the topographical conditions. That these natural hazards are increasingly escalating into real disasters is not only a consequence of accentuated weather extremes as a result of global warming, but is also connected with the expansion of residential areas and new infrastructures. The elaboration of measures to protect against natural dangers is regulated by law. In Switzerland the bases are set out in hydraulic engineering and forestry legislation. The cantons have to produce danger-risk maps, and the construction of technical protective measures is subsidised. Since 2002, a land register of natural dangers has been introduced throughout Switzerland. In the Albula/Bernina region the data serves as a basis for drawing up and verifying danger-risk maps, zone plans and expert opinions. The zones in the populated area of the cultural landscape are plotted according to this data, determining whether homes and sta-

Muot avalanche baffle > Photograph 1905.
Rhaetian Railway

Muot avalanche baffle > Photograph 1938.
Rhaetian Railway

Muot avalanche baffle > Photograph 1957.
Rhaetian Railway

Muot avalanche baffle > Photograph 2006.
M. Weidmann

bling for animals or installations for public use may be constructed; whether reinforced constructions are necessary or whether building is prohibited. Further, valuable information for projecting protective measures is obtained from the comprehensive damage review after violent storms.
Various forms of natural hazards can be seen along the Albula/Bernina railway line. The stretch of line through the Schin gorge has always been unstable, since the underlying lamellar Graubünden slate is prone to landslides and rockfalls. In the Albula valley, a broad unstable slope between Tiefencastel and Surava influences the operations of the Rhaetian Railway. The effects of this deep-seated, progressive landslip is spectacularly visible in Brienz/Brinzauls with its leaning church tower. Between Filisur and Bergün/Bravuogn, above all problems with rockfall incidents occur. This danger is countered, amongst other measures, by installing rockfall catch netting. The Bergün/Bravuogn-Preda stretch of track is exposed to the risk of avalanches. The avalanche baffles on the Muot slopes are particularly impressive. They were erected already 100 years ago when the railway was built and are maintained by the railway's own specialists. The section of track in Val Bever is exposed to various avalanche courses, which explains why the track was laid on a dam in the middle of the valley. Mudslides are also a constant cause of concern for the Rhaetian Railway engineers in Val Bever. For this reason, a large protective dam was constructed at the south portal of the Albula Tunnel.
The landscape, railway infrastructure and the settlements between Samedan and Pontresina in the Upper Engadin were frequently affected by serious flooding. The Flaz river, in particular, which has its catchment area in the Bernina region, caused significant damage on several occasions. A major correction project, diverting the Flaz via the south easterly side of the valley, has largely eliminated this danger (cf. 4.a.2). The stretch of track from Pontresina via the Bernina Pass to Cavaglia is exposed primarily to dangers from avalanches, rockfalls and snowdrifts. Immediately after Morteratsch station, enormous boulders alongside the railway line bear witness to earlier rockfalls. In the Arlas section, the dynamics of these natural dangers are visible; the alignment of the track had to be modified here to ensure safety. The snowdrift baffles are a striking feature on the Bernina Pass and the Poschiavo stretch. Here again, the alignment has already been modified and adapted to present conditions.
The stretch in Val Poschiavo is exposed to potential risk at various points from landslides, avalanches, rockfalls, mudslides and flooding. In 1987, the whole valley and railway infrastructure was affected by serious flooding. The Rhaetian Railway, together with the federal government and the canton reacted to this event with enormous investments in protective measures. The Rhaetian Railway employs its own specialists who, in collaboration with experts from federal and cantonal offices, constantly monitor, assess and, if necessary, implement suitable protection measures. The necessary resources for this are 80 % covered by cantonal and federal subsidies (these contributions may vary according to the measures required and the degree of danger).
Where there are trees bordering the railway

Val Tasna Viaduct > In August 2005, the old bridge collapsed in a great storm before the new parallel structure was finished. The new bridge was not damaged by the storm.
Rhaetian Railway

Bernina line > The lower Cavagliasco Bridge. The original stonework bridge had to be replaced by an army emergency bridge in 2002 due to earth movements.
Rhaetian Railway

track damage must be reckoned with, particularly during storms, along the entire Albula/Bernina line. This kind of risk can be minimised by continuous monitoring and tree thinning.

4.b.iv Visitor/tourism pressures

In Graubünden, tourism is the principle economic activity, generating around a third of all revenue. The demand is generally dependent on the time of year, winter being the highly frequented peak season. In the Albula/Bernina region, tourism plays a prominent role, particularly in the Upper Engadin; the hotel and self-catering industries here account for over 3 million overnight stays per year. The attractiveness of the area for tourists has clearly been enhanced by the construction of the Albula and Bernina railways. Its excellent international reputation is the outcome of active planning over many decades. Naturally, tourism brings more traffic, entailing an above-average increase in the amount of motorised private transport. This in turn necessitates an extensive infrastructure and detracts from the quality of living, due to air and noise pollution. The Rhaetian Railway, as the main public transport carrier, has an extremely important role to play in alleviating these effects.

In connection with tourism, the construction of second homes should also be mentioned. There was a boom in second homes in the wake of social and socio-economic change in the 1960/70s. In the Upper Engadin today they account for around 60 % of the overall dwellings in Graubünden, corresponding approximately to the proportion in other well-known tourist destinations. Overall in Graubünden, the percentage of second homes has been kept steady over the past two decades by strict spatial planning measures. In the Upper Engadin, between 1980 and 2000, it increased by a mere 1 percentage point. The cantonal spatial development planning office is determined to continue keep this development under control.

Complementary to the concentration on tourism, as can be seen in the Upper Engadin, numerous small tourism initiatives, oriented to regional economies, have been created in the past few years. These are based on an intact natural and cultural landscape, and on cooperation. Thanks to rising demand, a dynamic regional economy can be counted on in this tourist segment, which is so closely linked with nature and culture. In the Albula/Bernina region this primarily involves the two more rural areas of the Albula valley and Val Poschiavo. Here, the offer for visitors is centred on natural and cultural values. The landscape, as the capital stock of tourism, is protected, well looked after and used very carefully. In the Albula valley, the first regional nature park in Switzerland, the “Parc Ela”, was opened in June 2006. Besides the Albula valley, it also includes large parts of Oberhalbstein (Julier axis).

In general, tourism can be counted as one of the strongest influential factors in the nominated asset. Tourism has a positive effect, offering the regional population a source of income and promoting the economy; above all the question of whether the Albula/Bernina region would be “overstressed” if admitted as a UNESCO World Heritage Site is of prime importance in assessing the possibility of negative consequences.

In this respect it is interesting to note that the number of overnight stays (tourism indicator) in Graubünden has decreased since the beginning of the 1990s. Fundamentally, the capacity of the

Rhaetian Railway is largely limited by the single-track layout and the rolling stock, and is only occasionally used to capacity during the peak tourist season. With regard to the appearance of the villages and landscape, the legal and planning measures curb any possibility of exceeding the “capacity limit” in tourism. In future, the focus will be on maintaining the position in the important and highly competitive tourism sector. This will also require modification of the services and facilities offered to tourists. Where these changes involve buildings and installations they will be realised with all due respect for the various interests involved (cf. 5.b and 5.c).

4.b.v Number of inhabitants within the property and the buffer zone

Population data
Population in the core zone:
7,715 persons
Population in the buffer zone
(near and distant area):
59,805 persons

Full time job equivalents
Workplaces in the core zone:
4,384 jobs
Workplaces in the buffer zone
(near and distant area):
8,460 jobs

5. Protection and Management of the Property

Albula line > The Glacier Express leaving Celerina.
A. Badrutt / Rhaetian Railway

5.a Ownership

The rail infrastructure of the Albula/Bernina line is owned by the Rhaetian Railway. The remaining ownership structures within the nominated World Heritage perimeter are also clearly defined, and the applicable terms and conditions are set out in the land register.

Real property

The land and buildings in the core zone directly serve rail operations and are, for the most part, owned by the Rhaetian Railway. In some cases the ground beneath bridges is privately owned. Most of the land overlying the tunnels is owned either by the municipalities or private individuals whereas built-up embankments and cuts rising to the top edge of embankments normally belong to the Railway.

The land in the buffer zone mostly belongs to the municipalities or citizens' councils, especially pastureland and forests, as well as so-called unproductive areas in rocky regions and alpine terrain. Most properties and objects in the localities and on open farmland are privately owned. Servitudes of real property are based on the existing planning regulations (cf. 5.b). In Switzerland, real property servitudes in the immediate vicinity of the Rhaetian Railway property, pursuant to Art. 18 of the Railway Act (cf. 5.b), require the permission of the Rhaetian Railway.

Company property

All structures in the core zone are owned by the Rhaetian Railway. The necessary legal basis, equivalent to the legislation governing real property rights, is extant if these structures are located outside the Railway's real property zone.

Albula line > Rhaetian Railway train at Bever station.
A. Badrutt / Rhaetian Railway

5.b Protective designation

The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" is protected by several legal provisions: On Swiss territory, the core zone i.e. the railway installations (engineering structures, buildings, civil engineering) are subject to Swiss legislation on the protection of nature and the national heritage; beyond this, the Rhaetian Railway is also committed to more extensive measures. The buffer zone is already protected by various existing laws; further provisions have been anchored in the legislation in the context of the World Heritage Candidature. The protection and definition of the perimeter of the site as a whole (core and buffer zones) will be integrated in the Cantonal Structure Plan which is binding for federal, cantonal and communal authorities. The Cantonal Structure Plan is the central instrument of coordination and management for spatial development in Switzerland. Thus the special protection and sustainable development of the World Heritage Property in Switzerland is guaranteed. There are also provisions to ensure this protection for the part of the property which is located in Italy.

Principles of Swiss legislation on the protection of cultural monuments and landscapes

The principle of the federal obligation

Pursuant to Art. 78 of the federal constitution and the federal law of 1 July 1966 on the protection of nature and the natural heritage (NHG; SR 451) based thereon, the federal administration shall, in exercising its obligations, ensure that the national landscape and urban heritage, as well as historic sites, cultural and natural monuments are preserved. They shall also be maintained in their unimpaired state wherever the general public interest predominates. Such federal obligations include the granting of concessions and authorisations for the construction and operation of traffic facilities and transport installations (such as the railway) as well as all other tasks of the federal government involving authorisations, the granting of concessions or financial participations (Art. 2, NHG). Within the context of its own tasks, the federal government details its obligations in the 'federal inventories'. These are defined by law in the decree of 9 September 1981 on the federal inventory of Swiss architectural heritage worthy of protection (VISOS; SR 451.12), the decree of 10 August 1977 on the federal inventory of landscapes and natural monuments (VBLN; SR 451.11) as well as the decree on the federal inventory of historic routes (VIVS; implementation in progress). This implies a fundamentally integrated protection of monuments for all objects covered by the principle of the federal obligations. It is incumbent on the *Federal Office of Culture*, the federal office responsible for the protection of monuments, archaeology and the urban heritage to examine all plans and projects that could impair the country's natural and cultural heritage.

Legal framework and most important spatial planning instruments in Switzerland

Beyond the federal obligations numerous legal foundations for the sustainable development of the area and its cultural monuments are available for the Cantonal Structure Plan, as the instrument of coordination, to draw on. The nominal legislation, which regulates the actual planning, should be differentiated from the functional legislation that regulates the various sectors to be coordinated (protection of nature and the national heritage, protection of the environment, infrastructures etc.). In accordance with the Swiss system of federal government various competences are delegated to the various state levels (federal – cantonal – regional – community) each with its own planning instruments.

Nominal spatial planning legislation

As a cross-sectional task spatial planning aims to control and guide spatial organisation and development as a whole and ensure coordination between the various relevant policy-making sectors. Spatial planning has been an integral element of Art. 75 of the federal constitution (BV) since 1969.

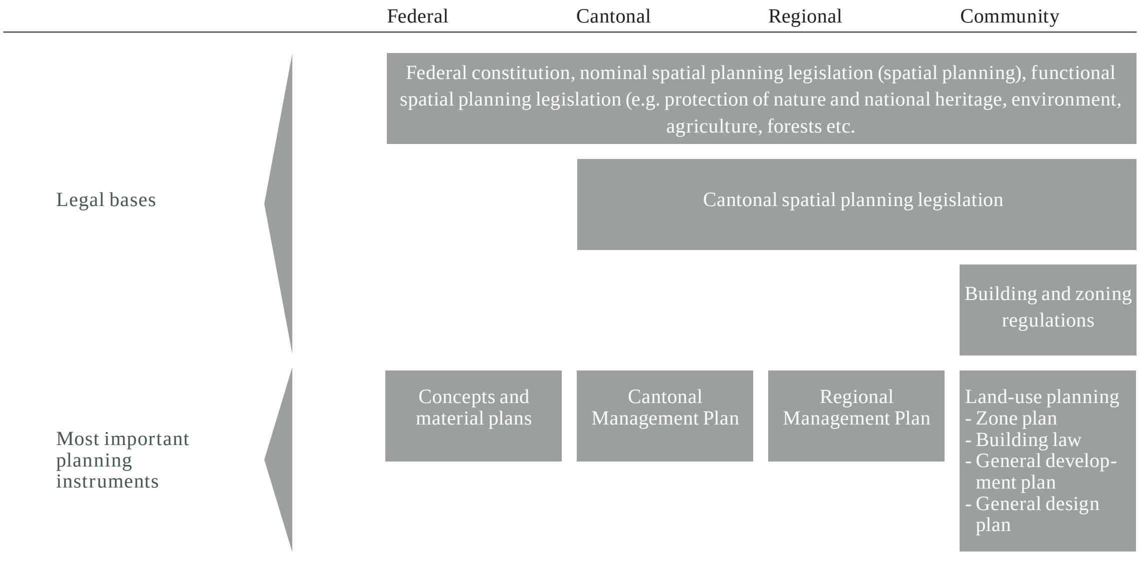
Art. 75 BV Spatial Development

[1] The federal government defines the principles of spatial planning. The cantons are responsible for implementing these principles which ensure the expedient and economical stewardship of land and the well ordered settlement of the country.
[2] The federal government supports and coordinates the efforts of the cantons and works in cooperation with them.
[3] The federal government and cantons take the demands of spatial planning into account in the performance of their duties.

The objectives of Swiss spatial planning are stipulated in Art. 1 of the federal law on spatial planning (RPG) of 22 June 1979 (SR 700). This law is defined in the federal constitution as a “guide line” law.

Art. 1 RPG Objectives

[1] Economical stewardship of the land is assured at federal, cantonal and community level. These au-



thorities coordinate their spatial development activities and implement settlement policies geared to the desired development pattern of the country. Due consideration is given to the natural conditions as well as the needs of the inhabitants and the economy.
[2] they apply spatial planning measures to support the following efforts, in particular,
a. to protect the natural resources essential to life such as soil, air, water, forest and the landscape;
b. to create and sustain residential settlements and the spatial requirements for the economy;
c. to promote social, economic and cultural life in the various parts of the country and to promote an appropriate decentralisation of settlement and economic activity ;
d. to safeguard a sufficient degree of self -sufficiency for the country;
e. to safeguard overall defence.

Art 6 ff RPG stipulates that every canton is obliged to draw up a Structure Plan.

Art. 6 RPG Foundations
[1] The cantons prepare an outline of the spatial development of their area for setting up their structure plans.
[2] they determine which areas are:
a. appropriate for agriculture
b. are particularly beautiful, valuable and important for recreation or the natural environment;
c. are significantly at risk from natural hazards or harmful influences.
[3] they provide information on current status and desirable development of:
a. settlement
b. transport, supplies as well as public buildings and installations.
[4] They take into account the concepts and specific plans of the federal government, the structure plans of the neighbouring cantons as well as the regional development concepts and plans.

The relevant legislation at cantonal level derives from this obligation: the spatial planning law for the canton of Graubünden of 6 December 2004 (KRG; 801.100, see annex) and the relevant spatial planning ordinance for Graubünden of 24 May 2005 (KRVO; 801.110).

Functional spatial planning legislation

Art. 78 of the federal constitution on the protection of nature and the national heritage as well as the law derived from it of 1 July 1966 on the protection of nature and the national heritage (NHG; SR 451) have already been mentioned. Besides the principle of federal commitment, the above law also regulates public spending for objects worthy of protection (Art. 13 ff NHG), the possibility of urgent measures (immediate protective measures, compulsory purchases, Arts. 15 and 16 NHG) as well as the protection of the native flora and fauna (Art. 18 ff NHG) and of moors and wetlands of outstanding beauty (Art. 23 ff NHG). The detailed provisions of the federal law are set out in the decree of 16 January 1991 on the protection of nature and the national heritage (NHV, SR 451.12).
At cantonal level, the cantonal ordinance on the protection of nature and the national heritage of 27 November 1946 sets out the provisions for the protection of nature and the national heritage as well as for the care of public monuments, archaeology and the protection of the architectural heritage.

Art. 1 Cantonal ordinance on the protection of nature and the national heritage: purpose
The canton and the communities shall safeguard the interests of nature and the national heritage according to this ordinance. This shall be assured especially by the following:
1. Protecting landscape areas of outstanding natural beauty against any defacement or unnecessary impairment due to public or private structures, advertising facilities, storage sites, quarries, gravel pits, landfills, subsidence, clouding or pollution of water, obscuring and closing off vantage points;
2. Maintaining artistically or historically valuable buildings or their remains, architectural heritage and road of value as well as planted areas;
3. Protecting places and monuments of particular scientific interest (unusual geological formations,

mineral springs, woodlands, plant communities, rare or unusual trees, animals, erratic blocks, fossils, relicts of historic or prehistoric people, animals and plants);
4. Preserving valuable antiquities (parts of buildings, inscriptions, armorial bearings, furniture, implements, tools, weapons, jewellery, textiles, coins, manuscripts, books, paintings, cult objects, prehistoric monuments such as burial sites, caches or priest's holes, remains of settlements and defence installations, formerly inhabited caves and sacrificial sites) from destruction, disappearance or leaving the canton;
5. Professionally excavating and recovering prehistoric and historical finds as well as safeguarding excavated buildings and other installations;
6. Repurchase of natural monuments, antiquities and local art and artefacts which had been sold out of the canton. The canton and the municipalities shall support relevant private initiatives in the sense of points 1 to 6 above.

The legislation on the protection of nature and the national heritage is complemented by numerous legal provisions relating to activities influencing spatial development and functional spatial planning law (forestry laws, agricultural and environmental legislation, legislation on traffic infrastructure etc.). These are listed in detail in an overview at the end of this chapter.

Key planning instruments

The importance and function of the Cantonal Structure Plan as central management and coordination instrument has already been considered. The Structure Plan coordinates all legal provisions with a view to their influence on the spatial environment and also interacts with federal concepts, specific plans and existing regional Structure Plans and development concepts as well as community planning initiatives.

Federal concepts and specific plans

The concepts and specific plans stipulated by Art. 13 of the federal law on spatial planning (RPG) are the most important spatial planning instruments. In these instruments applicable for the whole of Switzerland, the federal administration shows how it fulfils its spatially-effective obligations in the various topics and fields, the objectives it pursues, how it proposes to act, and what demands and specifications it takes into account. The concepts and specific plans back up the spatial planning efforts of the authorities at all levels. The directives set out in these and in the Cantonal Structure Plan are mutually complementary, but are proposed from a different angle.
A summary of the federal concepts and specific plans is reproduced in the overview at the end of this chapter. The Specific Plan on traffic, transmission cables, aviation infrastructure (Samedan regional airfield) and the national sports facilities concept (there are sports facilities of national importance in the Engadin) are particularly significant for the nominated site.

Regional Structure Plan and the Forest Development Plan

In Graubünden the regions act as supra-communal planning entities in public law that exercise planning obligations and compile structure plans (Art. 18 KRG). These plans cover specific subjects of regional importance, such as land use (cf. Chapter 5.d). The regions are bound by the Cantonal Structure Plan in carrying out their spatial planning activities. The specific adjustment of the Structure Plan for the protection of the UNESCO World Heritage (cf. the relevant chapter below) thus exerts an influence on the regions. The regional structure plans are subject to approval by the cantonal government and are thus binding on the cantonal authorities. The regional structure plans, like the Cantonal Structure Plan, are updated continuously in line with new developments.

The forest development plan (WEP) may be seen as a kind of forestry structure plan. It contains the generally valid principles for the management and care of the forests and outlines the objectives and development plans for the entire forested area. A forestry development plan is set up for an entire planning region, overriding individual forest boundaries and ownership limits. Special areas are set aside for the following sectors:

> protection from natural hazards
> timber production
> nature and landscape
> recreation and tourism
> agriculture
> game and hunting

The specific forestry objectives linked with the particular land use are then defined together with the measures needed to achieve them. Besides these special forest areas there are extensive tracts of forest where no particular provisions are called for. The general forestry management principles have sole application in these cases.

Community land-use planning

In Graubünden, the communities are responsible for planning land use. They control the type and extent of land use in their territory by issuing regulations that are binding on the owners and cover every property and plot of land. Community planning for land use comprises the building law, zoning plan, the general architectural style plan and the general development plan.

A community building law comprises at least the building regulations, the zoning provisions and other provisions stipulated by cantonal law. According to local requirements, the building provisions focus on the specifications for buildings and installations with respect to their execution, operation and upkeep; the design and maintenance of buildings, installations and open-air facilities; construction of community installations such as playgrounds, green areas, parking facilities, communal aerials; the provision of parking spaces for motor vehicles and bicycles; the utilisation of common ground and air-space by private individuals as well as of private property for public purposes as well as additional requirements on buildings and installations. The zoning provisions determine the purpose of the zones, the permitted type of land use and also regulate the style of construction in the building zones.

The zoning plan divides the territory of the community into various utilisation zones. The 'basic utilisation' zones generally determine the permissible land use. Additional land-use provisions are issued for zones where types of land use overlap. The communities designate building zones, agricultural zones, protection zones and others according to local needs. The building area is also called the settlement area, and the area where is building prohibited is the agricultural area. The zoning plan may define areas for a follow-up planning phase (property planning). Follow-up planning has the effect of making the area concerned a planning zone. It is initiated either by the authorities or, on application, by the party concerned.

The general organisation plan outlines the fundamental aspects (conservation, renovation, further development) of the settlements and the landscape. The communities may also issue design and style provisions instead of a general organisation plan (cf. Art 22 KRG; 801.100). The general development plan outlines the fundamental principles governing transport and utilities installations as well as waste disposal plants for the development of building zones and other utilisation zones. It covers at least the installations for elementary and primary utilities and, where

there is no follow-up plan, it also regulates the detailed development for utilities involving several properties.
The community land-use plans are updated as necessary.
Due to space restrictions, it is not possible to include copies of all the land use plans. An electronic version of the utilisation plan of one community, namely Bever, has been included in the candidature dossier to serve as an example (File, Annex). A detailed summary of the land use plans can be found in chapter 5.d.

Protection of the site (core zone)

Legal protection provisions

Legal protection of the sites ensures that changes to the railway, i.e. the alignment, engineering structures and buildings above and below ground may only be made with the approval of the *Federal Office of Culture*. This is done in the course of a railway planning procedure that constitutes a federal obligation (cf. chapter 5.c). In Switzerland the railways are regulated at the highest i.e. federal level. Art. 87 of the federal constitution (BV) stipulates that railway traffic comes under the jurisdiction of the federal government.

> **Art. 87 BV: Railways and other means of transport**
> The federal government is responsible for legislation on railway traffic, cableways, shipping, aviation and space travel.

Pursuant to the railway law of 20 December 1957 (EBG; SR 742.101), based on the above constitutional article, all changes to the rail infrastructure are subject to planning approval under federal law:

> **Art. 18 EBG**
> II. Planning approval procedure
> 1. Principle
> [1] Buildings and plant serving entirely or predominantly the construction and operation of a railway (railway installations) may only be erected or modified subject to planning permission.
> [2] The authority issuing permission is:
> a. the Federal Office of Transport [BAV];
> b. in the case of major projects the department specified in the annex.
> [3] All authorisations required under federal law are granted with the issue of planning permission.
> [4] Cantonal authorisations and plans are not required. Cantonal law shall be taken into account insofar as it does not unduly restrict the rail company in the performance of its duties.
> [5] Pursuant to the federal law of 22 June 1979 on spatial development planning, submission of a structure plan is a basic prerequisite to planning permission for projects having a significant impact on space and the environment.
> [6] Railway installations include the plant and facilities related to construction and operation as well as locations for the recycling and storage of excavated material that are closely connected, spatially and functionally, with the planned installations.

Under Swiss federal law, the so called “monument assumption” applies to any object whatsoever – whether it figures in an inventory or not; the “monument value” is determined in the event of proceedings. The Albula/Bernina line infrastructure is therefore basically subject to the legislation on protection of the national heritage, which in turn, is based on Art. 78 of the federal constitution. “Protection of the national heritage” is used as a blanket term in Switzerland for issues such as care of monuments, archaeology and the protection of townscapes and landscapes. It is derived from a civil society initiative, institutionalised as the “Association for the Protection of the National Heritage” in 1905 (cf. 2.a.4 – 2.a.6). Thus use of the term has been conditioned by historical events. In earlier days, the German word “Heimat” meant nature and cultural heritage within an area defined by the national borders; accordingly "protection of the "Heimat" or heritage was synonymous with the conservation of nature and cultural customs and traditions within that territory. The national heritage movement generated significant impulses for enacting legislation on the above issues thereby ensuring that the relevant protection efforts were recognised as an integral part of government policy.

Art. 78 BV Protection of nature and the national heritage

[1] The cantons are responsible for the protection of nature and the national heritage.

[2] The federal government takes the requirements pertaining to the protection of nature and the national heritage into account in the performance of its duties. It respects landscapes, architectural heritage and historic sites as well as natural and cultural monuments; it ensures their unimpaired conservation when this is in the public interest.

[3] It can support efforts for the protection of nature and the national heritage and acquire or safeguard objects of national importance contractually or by compulsory purchase.

[4] It issues regulations for the protection of flora and fauna and for the conservation of their habitats in their natural diversity. It protects endangered species from extinction.

[5] Moors and wetlands of outstanding beauty and national importance are protected. Installations may not be built and changes may not be made to the land in these areas. Installations for the protection or for agricultural use of the moors and wetlands shall be excepted.

Together with its implementing ordinance, the federal law of 1 July 1966 (NHG; SR 451) on the protection of nature and the national heritage based on Art. 78 BV of the constitution, guarantees protection of the railway installations; the federal authorities' obligation in this respect is implicit in the provisions governing the federal duties.

Art. 2 NHG Performance of federal duties

[1] Performance of a federal duty pursuant to Article 24^{sexies}, paragraph 2 of the federal constitution implies in particular:

a. the planning, construction and modification of works and installations by the federal government, its agencies and enterprises, including federal administration buildings and installations, national roads, Swiss Federal Railways buildings and installations.

b. the granting of licences and authorisations, e.g. for the construction and operation of transport facilities and enterprises (including planning permission), works and installations for the transport of energy, liquids or gases or for the transmission of news as well as authorisations for forest clearance;

c. the grant of contributions to planning, works and installations such as melioration projects, renovation of agricultural buildings, corrective measures to rivers and lakes, water protection plants and traffic installations.

[2] decisions by cantonal authorities on projects that can probably only be realised with the support of contributions pursuant to paragraph 1, letter c, are equated with the performance of federal duties.

Art. 3 NHG Federal and cantonal obligations

[1] In performing their duties, the federal government, its agencies and enterprises, as well as the cantons, ensure that the country's landscape and architectural heritage, historic sites and natural and cultural monuments are looked after and preserved unimpaired when the public interest is predominant.

[2] They fulfil this obligation by

a. designing and maintaining their own buildings and installations appropriately, or refraining from their construction altogether (Art. 2, letter a):

b. only granting licences and authorisations subject to conditions or provisos or by refusing to grant them (Art. 2, letter b);

c. only granting contributions conditionally or refusing to provide them (Art. 2, letter c).

[3] This obligation applies regardless of the importance of the object pursuant to Article 4. A measure may not go beyond what is necessary for the protection of the object and its environment.

[4] The federal authorities conduct a consultation procedure with the cantons concerned before taking their decision. The Federal Office of the Environment (BAFU), the Federal Office of Culture (BAK), the Federal Office for Roads (ASTRA) and other federal agencies involved assist in enforcing this law pursuant to Articles 62a and 62b of the governmental and administrative organisation law of 21st March 1997.

Paragraph 4 of Art. 3, NHG is particularly important in the context of the nomination. It ensures that the specialised federal agency for the protection of monuments, archaeology and architectural heritage – the *Federal Office of Culture* BAK – will be called upon by the *Federal Office of Transport* BAV, the agency responsible for all railway matters, to give an expert appraisal and approval of any building project. As a World Heritage Site, the Albula/Bernina line will acquire the highest legal status. It will, in its entirety, be treated as a monument of national importance.

The articles governing this cooperation between the federal authorities, in the above-mentioned organisation law, are worded as follows:

Art. 62a and 62 b RVOG

Art. 62a Consultation

[1] If a law provides for the concentration in a single authority (the Primary Authority) of decisions to be taken on plans for buildings and installations, then the latter shall obtain the expert opinions of the specialised agencies concerned before taking its decision.

[2] If several specialised agencies are involved, the Primary Authority shall hear them together; it may, however, hear them separately if this is justified on special grounds.

[3] The Primary Authority shall set the specialised agencies a deadline for submission of an opinion; this term shall normally be two months.

[4] The Primary Authority and the specialised agencies shall jointly determine cases where, exceptionally, no opinions have to be obtained.

Art. 62b Reassessment

[1] If the opinions submitted by the specialised agencies are contradictory, or if the Primary Authority does not agree with the opinions, it shall conduct a reassessment with the specialised agencies within 30 days; it may call in other authorities and experts to take part in this procedure.

[2] If the reassessment is successful, the result shall be binding on the Primary Authority.

[3] If the reassessment is not successful, the Primary Authority shall decide; in the event of significant differences between administrative units of the same department, the Primary Authority shall instruct the latter on how to decide. If several departments are involved, they shall reach an understanding. The differing opinions shall be recorded in the document stating the grounds for the decision.

[4] The specialised agencies shall be entitled to provide information on their opinion independently to a court of appeal even after a reassessment procedure has taken place.

Moreover, a special feature of Swiss legislation is the associative right of appeal that entitles certain non-governmental organisations to file complaints against administrative decisions, mostly in the context of building permission and planning approval proceedings. It was incorporated in the federal law on the protection of nature and the national heritage (NHG; SR 451) in 1966, and later in the law on the protection of the environment (USG; SR 814.01) and in the federal law on foot paths and hiking trails (FWG; SR 704).

Art. 12 NHG Communities and Organisations' Right of Appeal

[1] The communities as well as Swiss organisations dedicated to the protection of nature, protection of the national heritage, conservation of monuments or to similar, purely idealistic, objectives, and which have been established for at least ten years, have the right of appeal. It applies, insofar as appeals against cantonal decrees or decrees issued by the federal authorities may, in the last instance, be made to the federal council, or in the case of appeals to the administrative court, to the federal court.

Additional protective obligations of the Rhaetian Railway

The Rhaetian Railway undertakes to apply additional protective provisions for the entire nominated line. For the construction, conversion and renovation of the railway infrastructure it consults experts or uses building methods it has developed in cooperation with specialists (cf. 4.a.1).

The consultations with professionals ensure that the specific character and the striking appearance of the Albula and Bernina railway are preserved and that new buildings or installations will blend in well with local architectural styles and the landscape. This additional commitment of the railway is anchored in the protection provisions for World Heritage Sites defined in the Cantonal Structure Plan (cf. the relevant chapter below) and therefore binding.
The railway installations in Italy (including the station), also belong to the Rhaetian Railway. As the owners and business operation are identical, the same applies materially for the Italian part of the nominated railway as for the Swiss part.

Protection of the environs of the site (buffer zone)

According to its function and importance as a "backdrop" to the site, the buffer zone was broken down into several categories: a primary buffer zone, a buffer zone in the 'near' area and a buffer zone in the ‚distant' area (cf. chapter 1.e). The existing and additional protection provisions safeguard the preservation of the authenticity of the surrounding landscape and its importance and function for the nominated World Heritage Site. The protection status of settlements and landscape in the buffer zone of the Albula/Bernina line, as specified in the structure and land-use plans, are listed in the Annex, according to line sections. Chapter 7.b. lists plans from the site area that reflect the detailed regulations of the Cantonal Structure Plan.

Protection of the primary buffer zone

The settlement areas in the primary buffer zone are protected as key areas of national importance (Federal Inventory of Protected Sites in Switzerland ISOS, cf. chapter 5.c) corresponding to special village protection zones in community building law. In these zones, the regulations on possible interventions and building projects are even stricter than in other settlement areas. The important buildings in these areas are listed buildings (for which every intervention requires approval by the cantonal heritage authorities). The Cantonal Structure Plan also implements the architectural consultancy obligation with respect to any intervention in the core zone.

The single buildings included in the primary buffer zone but located outside the settlement areas (e.g. churches, castles) are protected as listed buildings under cantonal and federal protection provisions. The landscape elements included in the primary buffer zone are protected by the Federal Inventory of Landscapes of National Importance or cantonal landscape protection zones.

Protection of the primary buffer zone in the 'near' area

Building in the settlement areas of the buffer zone is regulated by the communal building laws and land-use plans. They define precisely the possibilities for new constructions and their use: residential, commercial or tourist use of every plot is prescribed as well as the maximal exploitation (proportion between built surface and surface area of the plot), the maximal possible height of new buildings, both in storeys and meters (mostly 2 to 3 storeys and 15 meters), the minimal distances between the construction and the boundary of the plot, the form of the roof , the materials used and colours of façades and roofs as well as the mounting of aerials, number of possible parking lots etc. For example, any change in the façade of a building such as piercing a wall for a new window or a change in the colour of the house, requires building permission. Community building law is subject to approval both by electorate vote and by the cantonal authorities. It must respect the Cantonal Structure Plan with its special World Heritage provisions: the Cantonal Structure Plan advocates architectural consultancy in the settlement areas close to the railway ('near' buffer zone).

Protection of the buffer zone in the 'distant' area

No building is permitted in the non-settlement areas of the buffer zone. Forest, special natural sites, agricultural land as well as rivers are protected by federal law. In these areas, only constructions that cannot be located elsewhere in view of their function are feasible. In order to avoid any impairment of visual appreciation of the core zone by such interventions (for example power lines) the cantonal structure plan specifies that they must be harmoniously embedded in the landscape (situation, dimensions, architectural quality, etc.).

Protection of the buffer zone in Italy

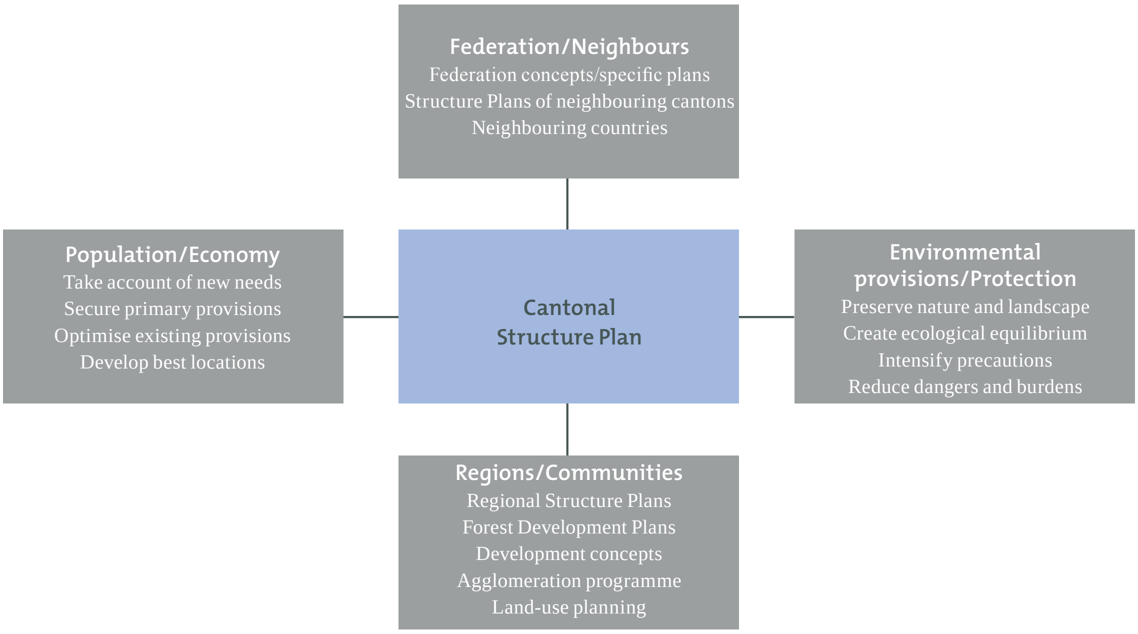
In Tirano, the only Italian community included in the World Heritage nomination, sensitive stewardship of the buffer zone is assured by the *Piano regolatore generale del Comune di Tirano* PRG which is the equivalent of the community land-use plans in Switzerland (cf. chapter 5.c). However, the PRG is subject to the overriding regulations of the province plans and national legislation. According to Italian law, no new buildings may be erected within a 150 m strip along a river; there is consequently a 300 m band (150 m on each side of the river) where new building is prohibited. The basic or primary buffer zone/buffer zone in the 'near' area lies within this 300 m strip along the Poschiavino river.

The existing buildings and installations in the buffer zone are subject to communal legislation as stipulated in the PRG. On a par with building legislation in Switzerland, restrictive provisions apply to utilisation as well as typology, characterisation, appearance and finish (lines, colours, materials etc.) for buildings and installations in the "centro storico" zones. The forms of utilisation and dimensions are also set out in detail for each plot of the other PRG zones. The building regulations for the entire province are also laid down in the *Piano territoriale di Coordinamento della Provincia di Sondrio* (PTCP) for areas with historic settlement nuclei and districts ("centro storico"). This plan was approved on 9 September 2006, by the mayors of the municipalities in the province of Sondrio and passed for approval by the region of Lombardy. Moreover, it is based on numerous legal provisions that contribute to the protection and sustainable development of the cultural landscape (cf. chapter 7.b). The PTCP protection provisions relevant to the property are appended to the candidature dossier ("Annex" File) in electronic form.

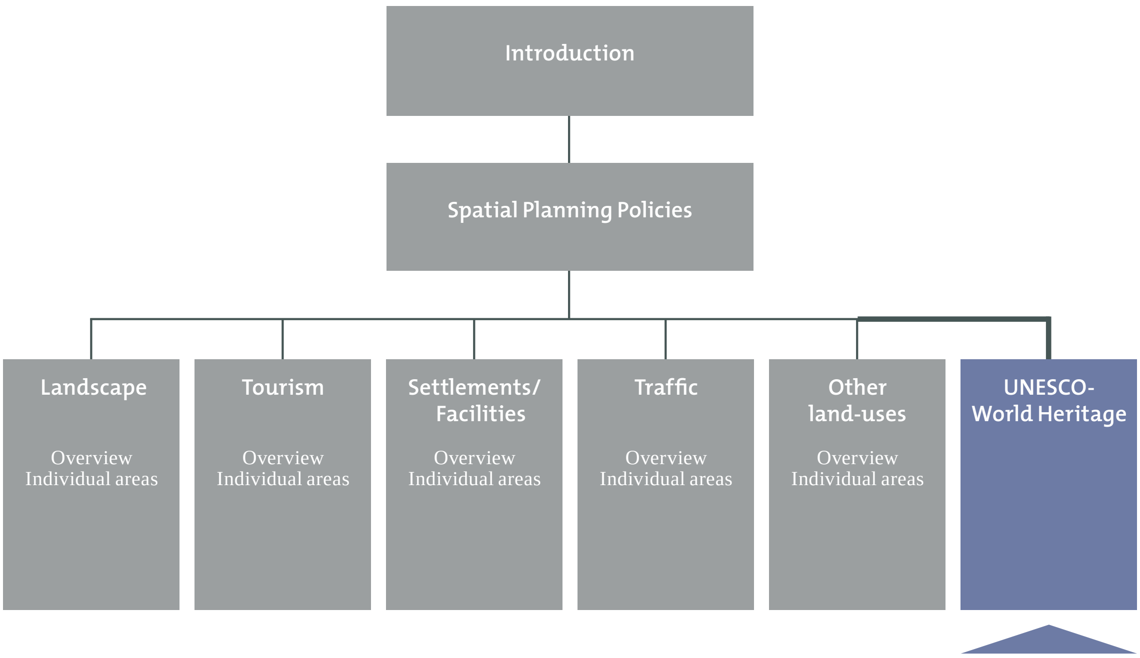
Anchoring the protection of the site (core and buffer zones) in the Cantonal Structure Plan

The Cantonal Structure Plan is the central steering instrument for spatial development; if the "Rhaetian Railway in the Albula/Bernina Cultural Landscape" is approved as a World Heritage Site, it would be integrated in this Structure Plan.

The Cantonal Structure Plan sets out how the



various activities of the federal administration, cantons and communities relating to spatial development are coordinated. This is done by drawing on federal inventories, concepts and specific plans (cf. the relevant chapter above) while taking into consideration the needs of the population and the economy, regional and community planning, concepts and programmes as well as the protection and conservation objectives concerning nature, landscape and environment. Consideration will also be given to the concerns of the neighbouring cantons and countries. With a view to sustainable spatial development, the aim is to strike a balance between



the differing demands on the site, in particular those made by the diversity of interests relating to protection and use of resources. The Cantonal Structure Plan is binding on the federal, cantonal and community authorities. The plan itself comprises a text and the relevant maps. It is continually adapted to changing circumstances and completely reviewed at least every ten years.
The Cantonal Structure Plan of Graubünden is currently divided into five subsectors: landscape – tourism – settlement – traffic – other land-uses. Each of these is introduced by a concise overview and then broken down into three to ten subchapters. Binding objectives are set and primary considerations defined for each topic that must be taken into account by the authorities in the course of their spatial development activities (planning, issuing authorisations, licences etc.).
If the nominated property is included on the UNESCO World Heritage list, a new subsection will be included in the Cantonal Structure Plan. This will define the provisions for protection and sustainable development of the World Heritage Site with legally binding effect.
The primary considerations and objectives set out in the draft for the new subsection relating to the "UNESCO World Heritage Rhaetian Railway in the Albula/Bernina Cultural Landscape" are as follows:

Objective

In compliance with the protective provisions of a World Heritage Site, the Albula/Bernina line of the Rhaetian Railway and the cultural landscape around it shall be used and further developed in such a way that its particularities and specific qualities are preserved over the long-term as stipulated by the UNESCO Convention

Principles

Railway infrastructure in the UNESCO core zone

In the event of the construction of new buildings or of conversions and renovations of the railway infrastructure (buildings, underground engineering, engineering structures) along the Albula and Bernina line, special attention will be paid to the preservation of its character and appearance as well as their integration into the local architectural tradition and the landscape. This will be assured on the basis of professional technical advice. In the case of renovation of the engineering structures, modular building techniques will be developed, in cooperation with construction experts in order to preserve the character and appearance of the line while complying with the requirements of running a modern railway system. These principles for the conservation of the character and appearance of the railway infrastructure as well as its integration in the cultural landscape will have no detrimental effect on its operation over the long-term.

Settlement areas and open cultural landscape in the primary UNESCO buffer zone

All new buildings, conversions and renovations of buildings and installations will require a heightened awareness and sensitivity to ensure their harmonious integration into the architectural heritage and landscape. The position, type and design of new buildings and installations will respect the local landscape and cultural values. They shall be executed to such a high standard that the intrinsic value of the region's cultural landscape will be enhanced, or at least not impaired. Consulting with urban development experts or similar measures is the key to ensuring compliance with these principles.

The cultural landscape in the UNESCO buffer zone in the 'near' area

All agents who intervene in the UNESCO buffer zone, in particular when zoning or upgrading zones (higher land-use densities or an increase in the number of storeys in existing building zones) are advised to consult with urban development experts. The decision on whether to implement this recommendation rests with the communities.

Keeping the horizon free of intrusive buildings and installations

The scenic horizon is an important element for the character of the mountain railway and the perception of the landscape. The skyline should therefore be kept free of new structures and installations as possible. Should they be inevitable, they should be planned meticulously to ensure that they impair the skyline as little as possible.

Forest stewardship along the Rhaetian Railway's Albula/Bernina line

In the 'near' area along the Albula/Bernina line, the forest will be managed in such a way that passengers' appreciation of the landscape and cultural values is impaired as little as possible by afforestation. This means ensuring an unobstructed view of parts of the landscape as well as specific structural elements of the cultural landscape. As part of this landscape, the forest, is managed according to the sustainability principle set out in the regional forest development plans. Where the forest has a protective function, this must not be impaired by any measures whatsoever.

Integrating special features into the tourist scene

Specific elements such as the Rhaetian Railway engineering structures, historic routes, particularly valuable architectural monuments, historic settlement nuclei, building complexes, individual buildings and installations as well as natural monuments are deemed part of the tourist scene. Access to them will be provided via the existing network of paths and roads as far as possible. It will be ensured that such paths will be kept open and safe, rest places will be provided and these will be designed to blend naturally into the cultural landscape.

Utilisation of the cultural landscape and technological change support the objective

Various utilisations (e.g. farming, harnessing hydropower, use for tourism etc.) have left their mark on the cultural landscape of the prospective World Heritage Site. The resulting added value contributes directly and indirectly to the stewardship and conservation of the cultural landscape. Activities having an effect on land use are appraised on the principle of weighing up competing interests. The use of modern technologies on the railway and in the utilisation of the cultural landscape contributes to their efficient and sensitive development and consequently to the maintenance of their value over the long-term.

UNESCO World Cultural Heritage sponsoring association and management plan

The sponsoring association for the UNESCO World Heritage promotes the preservation and sustainable utilisation of the World Heritage Site and is responsible for coordinating all monitoring activities. A management plan has been produced for the UNESCO World Heritage as in line with the UNESCO directives with the aim of creating a legally binding framework for the association's activities.

Overview

Overview of specific legislation

The legal bases and instruments for the protection and stewardship of the cultural landscape are listed below for the core zone (railway track) and the buffer zone (cultural landscape broken down into settlement area and cultural landscape area, cf. chapter 5.c) according to topic. The laws are given in extenso in the "Annex" File and can also be consulted – under the relevant abbreviations – in the systematic law compendia on the Internet.

Asset	*Classification*	*Type of classification*
CORE ZONE		
Protection of the railway line with its engineering structures, below ground engineering as a national monument	- Art. 78 BV - Paragraph 1 NHG (Arts. 1-12) - Paragraph 1 NHV (Arts. 1+ 2)	- Federal constitution - Federal law - Federal ordinance
Railway planning and building permission proceedings	- Art. 87 BV, - Art. 18 EBG	- Federal constitution - Federal law
Coordination of the authorities involved	- Art. 62a + 62b RVOG	- Federal law
Definition of perimeter + special World Heritage protection provisions	- Canton Graubünden Management Plan	- Cantonal law (management planning)
BUFFER ZONE		
Settlement area		
Settlement area general	-Art. 15 RPG, building zone -Art. 22 KRG, community regulative system (building law and plans) -Cantonal structure planning (Chapter 5.2) -Differentiated building zones in land-use planning	-Federal legislation -Cantonal legislation, Structure planning -Cantonal legislation, Structure planning -Land-use planning
Building zone - protected areas (protection of architectural heritage)	-Art. 5 NHG, architectural heritage of national, regional and local importance -Art. 43 KRG development planning consultancy Art. 73 KRG development planning -Cantonal structure planning (Chapter 5.5.1) -Land-use plan protected zones. development planning consultancy, development directives, building law provisions (BauG, zoning plan, general organisation plan)	-Federal legislation -Cantonal legislation -Structure planning -Land-use planning
Building project adjacent to rail operation area	-Art. 18m EBG, Art. 18m EBG, building projects adjacent to or on railway property, Rhaetian Railway approval required	-Federal legislation

Asset	*Classification*	*Type of classification*
Landscape area		
Landscape area (forest)	-Art. 5 forest law, ban on clearance law	-Federal legislation
Landscape area (other)	-Art. 24 RPG, special licence, zone conformity, site-bound	-Federal legislation
Moor landscapes and wetlands	-Art. 78 BV, moors and wetlands of national importance	-Federal constitution
Biotope protection	-Art. 18 NHG, raised and flat bogs, wetlands, amphibian spawning grounds, glacier aprons, dry meadows -Structure planning (Chapter 3.7) -Land-use plan protected zones	-Federal legislation -Structure planning -Land-use planning
Landscape	-Art. 5 NHG, landscapes and natural monuments of national importance -Structure planning (Chapter 3.5 and 3.6) -Land-use plan protected zones	-Federal legislation -Structure planning -Land-use planning
Fauna and habitats	-Art. 11 JSG, no-hunting zones -Structure planning (Chapter 3.8) -Land-use plan protected zones	-Federal legislation -Structure planning -Land-use planning

Protection of the Albula/Bernina buffer zone in the structure and land-use plans

Finally, the protection status of settlements and the cultural landscape along the Albula/Bernina line as specified in the structure and land-use plans (cf. chapter 5.c) is detailed below, broken down according to the sections of the line and the specific legislation. Chapter 7.b lists plans from the site area that reflect the detailed regulations of the Cantonal Structure Plan.

Abbreviations

OBSnr	Protection of village architectural heritage (national = n, regional = r)
OBSZ	Protection of architectural heritage zones
KDnr	Cultural monument (national = n, regional = r)
KDS	Protected cultural monuments (land-use planning)
EHZ	Conservation zones (protected zones) (groups of buildings of cultural-historical value)
KL	Cultural landscape with special stewardship
LSG	Protected landscape area according to structure planning
BLN	Federal inventory of landscapes and natural monuments of national importance
ML	Moor landscape of outstanding beauty and national importance
LSZ	Protected landscape area according to community land-use plan
LWZ	Agricultural zone
FFF	Crop rotation area

General	*Settlement*	*Landscape*
Domleschg/Thusis		
-KL protected in near vicinity (LSG, LWZ, forest) -Orderly settlements -Architectural heritage protected -Art monuments and environs protected	-Thusis: historic nucleus Altdorf and Neudorf (OBSr), OBSZ, development planning consultancy, protected -Sils i. D.: OBSr, OBSZ, KDS, development planning consultancy (Palazzo, Campi ruins, Baldenstein castle)	-Domleschg, KL with special stewardship and LSG/LSZ -San Cassian church and environs OBSn, KDS, LSG/LSZ -Hohenrätien and Carschennna LSG/LSZ -Campi ruins and environs OBSn, KDS -Hohenrätien ruins, KDn, KDS -Fort Ehrenfels KDS -Cave drawings Badugnas KDS -Prehistoric rock drawings Carschenna KDN, KDZ
Schin Gorge		
-Difficult access area with precipitous rocks and forest Protection from natural hazards necessary as required	-No settlements close to the core or buffer zone -Villages Zorten, Lain, Muldain; sharp delimitation of building zone (buffer zone in far distance)	-Mainly forest (ban on forest clearance and therefore protected) -LWZ -Alvaschein, KL with special stewardship LSG -Mistail church with environs (OBn, LSG)
Tiefencastel – Filisur		
-Orderly settlements Architectural heritage and cultural monuments protected -Cultural landscape with special stewardship (hedge landscape) protected -Arable land on valley floor in LWZ -Quarry areas are being re-greened	-Tiefencastel Kirchhügel KDn -Surava: Belfort ruins KDn -Surava/Alvaneu Bad: Surava regional crafts location with historical lime kiln KDS -Filisur OBSn, OBSZ, detailed organisation plan with protected buildings, development planning consultancy, protected	-Prada plain (LSG) with EWZ (electricity works) settlement -KL Albula valley (LSG) -Valley plains LWZ -Forest (ban on forest clearance and therefore protected) -Golf course -KL Albula valley (LSG) -Landwasser viaduct KDn
Filisur – Bergün/Bravuogn		
-Deep cut valley with river, rock outcrops and forest -Protection from natural hazards necessary as required	-Greifenstein ruins, KDS	-Largely forest (ban on forest clearance and therefore protected) -Landscape in the buffer zone, also extending to the far distance LSG/LSZ
Bergün/Bravuogn – Preda		
-Orderly settlements -Architectural heritage protected -Meadows on valley floor and around Bergün and Preda in LWZ -Extensive areas of forest and rocks/screes -Protection from natural hazards necessary as required	-Bergün/Bravuogn: OBSn and tower KDn protected, detailed heritage plan with protected buildings, development planning consultancy -Latsch: OBSn; environs protected, development planning consultancy -Stugls/Stuls: OBSn; KDn, detailed design plan with protected buildings, development planning consultancy -Naz: Maiensäss settlement in EHZ	-Forest (ban on forest clearance and therefore protected) -Landscape in the buffer zone, also extending to the far distance LSG/LSZ

General	*Settlement*	*Landscape*
Val Bever – Pontresina		
-Well structured, clear-cut settlements in Samedan – Celerina – St. Moritz – Pontresina area (tourism and focal points in the Engadin) -Meadows, grazing and open larch forests in LWZ, partly BLN and LSG	-Bever: OBSn, OBSZ, detailed organisation plan with protected buildings, development planning consultancy, protected -Bever: Church KDn -Samedan: OBSn, OBSZ, development planning consultancy -Celerina: OBSr; special community heritage directives -St. Moritz: OBSr -St. Moritz: Engadin Museum and Segantini Museum KDn -Pontresina: OBSn, detailed organisation plan with protected buildings -Pontresina: S. Maria chapel with tower and Grand Hotel Kronenhof KDn	-Val Bever in LSG -Bever-Samedan-Pontresina plain in LWZ and forest, BLN, LSG/LSZ -Samedan-Celerina golf course -S. Gian (KDn) with environs: BLN, LSG and LSZ -ML, BLN
Val Bernina – Bernina Pass		
-Alpine meadow and water-glacier landscape with imposing views of Bernina Group; virtually unpopulated	-no cohesive settlements	-Val Bernina extensively covered in BLN and LSG -Glacier apron, Morteratsch glacier -Albris-Morteratsch federal no-hunting reserve
Bernina Pass – Cavaglia		
-Alpine grazing and glacier landscape with imposing views of Palü glacier and into Val Poschiavo; virtually uninhabited	-no cohesive settlements	-Largely in LSG, subsectors in BLN -Palü glacier apron and Lake Palü LSG -Cavaglia plains with moulins LSG
Cavaglia – Poschiavo valley floor		
-Well tended cultural landscape (Maiensäss areas) from Cadera to valley floor -Valley floor, orderly but changed settlements and intensively farmed areas; hedge landscapes on the alluvial fans (KL with special land stewardship) -Lake Poschiavo with largely natural shores (except Le Prese-Li Geri and Miralago)	-San Carlo: OBSn, detailed organisation plan with protected buildings, east flank LSG / LSZ -San Carlo: S. Carlo Borromeo church with Casa Volt, KDn -Poschiavo Borgo: OBSn, detailed organisation plan with protected buildings -Poschiavo Borgo: historic nucleus and “Spagnoli” district KDn -Poschiavo Borgo: S. Vittore church KDn -Poschiavo Borgo: S. Maria Assunta church, KDn -Poschiavo Borgo: Old Augustinian convent -Poschiavo Borgo: Council building with tower KDn -Poschiavo Borgo: De Bassus-Mengotti house KDn -Prada: OBSn, detailed organisation plan with protected buildings, -Canton: OBSn, detailed organisation plan with protected buildings -Le Prese OBSr	-Alluvial fans with hedge landscape (LSG) -Valley plain FFF, LWZ -Lake Poschiavo surroundings LSG, forest (clearance ban, thus protected), LWZ
Lake Poschiavo – Campocologno		
-Narrow valley and valley floor that is relatively densely populated and intensively farmed	-Brusio – Campascio: orderly settlement pattern -Brusio OBSr, nucleus with development planning consultancy -Crafts locations (traditional) -San Romerio chapel KDn -“Cröt” cool house KDn	-Motta, massive rockfall area in LSG -Terrace landscape, LSG/LSZ -Chestnut forests with terraces, LSG/LSZ -Brusio reverse curve viaduct, LSG/LSZ

Legal bases according to legislative level

The following table sets out the most important legal bases, arranged according to -legislative level (appended to the candidature documentation ["Annex" File] in electronic form). All federal laws can be found in the systematic collection at www.admin.ch/ch/d/sr/sr.html available in the national languages German, French and Italian. The cantonal laws can be consulted at www.gr.ch.

Level	*Most important legal provisions*	*Bases, inventories*	*Specific plans and concepts (Federation) structure planning (canton and region), land-use plans (communities)*
Federation	-Agreement of 23 November 1972 on the protection of the world cultural and natural heritage (SR 0.451.41) -Haag Convention of 14 May 1954 for the protection of cultural assets in the event of armed conflict (SR 0.520.3) -Federal law of 1 July 1966 on the protection of nature and the environment (NHG; SR 451). -Decree of 16 January 1991 on the protection of nature and the national heritage (NHV; SR 451.1) -Decree of 10 August 1977 on the federal inventory of landscapes and natural monuments (VBLN; SR 451.11) -Decree of 9 September 1981 on the federal inventory of Swiss Heritage Sites (VISOS; SR 451.12) -Decree of 28 October 1982 on the protection of riverside wetlands of national importance (Wetlands decree; SR 451.31) -Decree of 21 January 1991 on the protection of raised and transition bog lands of national importance (Raised bogs decree; SR 451.32) -Decree of 7 September 1994 on the protection of flat bogs of national importance (Flat bogs decree; SR 451.33) -Decree of 15 June 2001 on the protection of amphibian spawning grounds of national importance (Amphibian spawning grounds decree; AlgV; SR 451.34) -Decree of 1 May 1996 on the protection of moor landscapes of outstanding beauty and national importance (Moor and wetland landscapes decree; SR 451.35) - Federal law of 22 June 1979 on spatial planning (RPG; SR 700) -Spatial planning decree of 28 June 2000 (RPV; SR 700.1)	-Federal inventory of landscapes and natural monuments of national importance (BLN) -Federal inventory of cultural assets of national and regional importance -Federal inventory of Swiss Heritage Sites (ISOS) -Federal inventory of historic routes (IVS) -Federal inventory of the riverside wetlands of national importance -Federal inventory of raised and transitional bog lands of national importance -Federal inventory of the flat bogs of national importance -Federal inventory of the amphibian spawning grounds of national importance -Federal inventory of the moor landscapes of outstanding beauty and national importance -Federal inventory of glacier aprons and alluvial plains -Inventory of the federal no-hunting zones -National forestry inventory -Production cadastre for agriculture (extended transition zone, pre-alpine hill zone, mountain zones I-IV, summer grazing area)	-Swiss agricultural concept; (LKS), issued by the federal council by decision of 19 December 1997 -Specific crop rotation area plan; (FFF), issued by the federal council by decision of 8 April 1992 -Specific plan for transmission cables (SüL), issued by the federal council by decision of 27 June 2001 and updated continuously -Specific military plan, issued by the federal council by decision of 28 February 2001 -Specific traffic plan, part programme, issued by the federal council by decision of 26 April 2006 -Specific aviation infrastructure plan (SIL), part i - IIIB, issued by the federal council by decision of 18 October 2000 with continuous updating of part IIIC, 1. – 6. Series -National sports grounds concept (NASAK), issued by the federal council by decision of 23 October 1996 -Specific plan – AlpTransit, New Alpine Rail Axis (NEAT) issued by the federal council by decision of 15 March 1999

Level	*Most important legal provisions*	*Bases, inventories*	*Specific plans and concepts (Federation) structure planning (canton and region), land-use plans (communities)*
	- Federal law of 21 June 1991 on the melioration of water courses (SR 721.100) - Railway law of 20 December 1957 (EBG; SR 742.101) - Federal law of 24 June 1902 on electrical light and heavy power installations (EleG; SR 734.0) - Decree of 8 November 1978 on licensing of cableways (Cableway licence decree, LKV; SR 743.11) - Federal law of 7 October 1983 on the protection of the environment (USG; SR 814.01) - Decree of 19 October 1988 on the environment compatibility test (UVPV; SR 814.011) - Federal law of 24 January 1991 on protection of waters (Waters protection law, GSchG; SR 814.20) - Federal law of 29 April 1998 on agriculture (LWG; 910.1) - Decree of 29 March 2000 on summer alp grazing contributions (SöBV; SR 910.13) - Decree of 4 April 2002 on the regional promotion of quality and the network of ecological compensation surfaces in agriculture (Eco-quality promotion, ÖQV; SR 910.14) - Decree of 7 December 1998 on structural improvement in agriculture (Structural improvement decree, SVV; SR 913.1) - Federal law of 4 October 1991 on forestry (WaG; SR 921.0) - Federal law on hunting and the protection of mammals and birds in the wild (Hunting law, JSG; SR 922.0)		

Level	*Most important legal provisions*	*Bases, inventories*	*Specific plans and concepts (Federation) structure planning (canton and region), land-use plans (communities)*
Canton	- Law of 24 October 1965 on the promotion of the protection of nature and national heritage in Canton Graubünden (BR 496.00) - Decree of 27 November 1946 on the protection of nature and the national heritage (BR 496.100) - Decree of 2 June 1972 on the protection of the Upper Engadin lake landscape (BR 496.150) - Spatial planning law of 6 December 2004 for Canton Graubünden (KRG, BR 801.100) - Spatial planning law of 24 May 2005 for Canton Graubünden (KRVO, BR 801.110) - Decree of 21 November 2000 on the repurposing of farmsteads and buildings and installations worthy of protection outside building zones (repurposing decree, UVO, BR 801.150) - Directives of 6 May 1997 on risk zone planning (BR 801.500) - Introductory law of 2 December 2001 in relation to the protection of the environment law (BR 820.100) - Cantonal protection of the environment decree of 13 August 2002 (BR 820.110) - Cantonal decree of 30 April 1991 on the environment compatibility test (KVUVP, BR 820.150) - Law of 25 September 1994 on the conservation and promotion of agriculture (BR 910.000) - Agricultural decree of 28 March 2000 (BR 910.050) - Canton Graubünden melioration law of 5 April 1981 (BR 915.100) - Cantonal forestry law of 25 June 1995 (KWaG, BR 920.100) - Cantonal forestry decree of 2 December 1994 (KWaV, BR 920.110) - Export provisions of 19 December 1995 pursuant to the cantonal forestry law (AbzKWaG, BR 920.120)	- Cantonal nature and landscape inventory - Cantonal inventory of monuments	- Canton Graubünden Structure Plan, issued by the government 19 November 2002, approved by the federal council 19 September 2003 (www.richtplan.gr.ch) - Forest development plans (cf. 5.d)

Level	*Most important legal provisions*	*Bases, inventories*	*Specific plans and concepts (Federation) structure planning (canton and region), land-use plans (communities)*
Region			- Regional structure plans (see list in Chapter 5.d)
Communities		- Detailed settlement inventories - Complementary inventories on biotopes and landscapes	Land-use planning comprising - Building law - Zoning plan - General urban organisation plan (or organisation directives) - General development plan (see list in Chapter 5.d)

Albula line > The Glacier Express at Bever.
A. Badrutt / Rhaetian Railway

5.c Means of implementing protective measures

Graubünden (Switzerland)

Basic procedural principles

In Switzerland the three strata of government – federation, canton and community – have graduated levels of competence for the implementation of the protective provisions. Three fundamental principles play a central role in the process of drawing up and approving protective and development measures: deposition for viewing by the public, consultation and appraisal of differing interests.

Deposition for public viewing

The spatially effective plans described in Chapter 5.b (Federal concepts and specific plans, structure plans, land-use plans) involve a public hearing and participation in accordance with article 4 RPG. This means that these plans are open to the public and that anyone may comment on them (see articles 7, 11, 13 KRVO). The basic principle of public presentation and giving members of the public the opportunity to lodge objection also applies to building projects, with the exception of construction work which either will take only a brief period of time or which does not affect public or private interests (see article 86 KRG and article 40 KRVO).

Consultation

The consultation process is based on the principle of involvement and is the same for all procedures (spatial planning, railway law). One of the first steps in this procedure involves the lead authority (as determined by law) investigating the areas that will be or might be affected by the spatial plan or building project. Here ‘areas’ refers to aspects such as nature protection, heritage protection, environmental protection, agriculture, forestry, and so forth. The responsible technical bodies are given the opportunity to comment on the submission and to forward an opinion to the lead authority. As a rule, the lead authority prepares the decision on behalf of the legally established decision-making body. During this procedure, the various interests are weighed against each other. The same principle applies in terms of the involvement from a territorial point of view (directly affected regions or local authorities). In the case of the UNESCO World Heritage Site, for example, the *Federal Office of Transport* BAV invites the *Federal Office of Culture* BAK to submit an opinion.

Harmonising interests

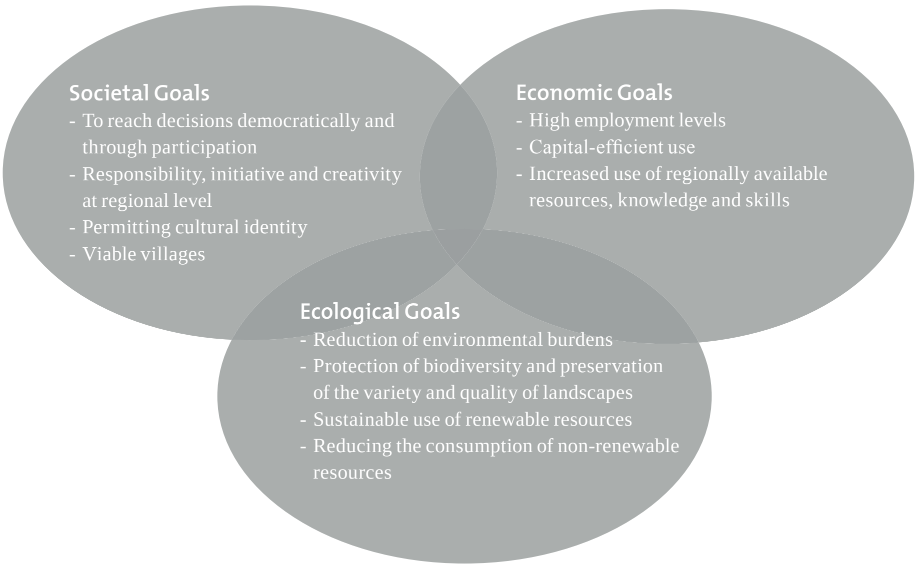
The harmonisation of interests is a core method used in spatial planning, protection of nature and the national heritage protection. The method involves assessing the interests affected and weighting them in terms of clearly understandable criteria. The planning principles defined in article 3 of Federal law on spatial planning provide a guideline for this. These principles do not of course offer a definitive system, free of contradictions, as their application and weighting is always related to the particular problem being considered. The weighting takes into consideration the importance of objects, and when considering nature protection and national heritage protection a distinction is made between national,

regional and local importance. The convention on the protection of the world's natural and cultural assets (SR. 0.451.41) is implemented by means of domestic laws (non self-executing). Switzerland has no special law relating to World Heritage sites, so in practice any such site within the country is taken to be of national importance and is therefore assigned the highest level of importance.
The harmonisation of interests is an open process that can respond to any new interests that may arise. It is also based on the concept of sustainable development, now established as part of the new Federal constitution, and is a higher-ranking guideline applicable to all policy areas. Sustainable development means satisfying the needs of the present day without putting at risk the ability of future generations to fulfil their own needs. Sustainable development aims to achieve societal, economic and ecological compatibility – three interdependent areas that must be given due consideration when harmonising the various interests.

Implementation of site protection (core zone)

Planning approval procedures in accordance with Railway law which take account of the legislation on protection of nature and the national heritage protection

The plan-approval procedure derived from railway legislation is regulated by the Railway Law, the Railway Directive and the Plan Presentation Order. When the BAV (*Federal Office of Transport*) as lead authority distributes a project to other federal bodies as part of a normal planning-approval procedure, the consultation process applied is based on the principle of involvement. These federal bodies may include the BAFU (*Federal Office of the Environment* – the federation's technical body responsible for the environment, forests, nature protection and landscape protection) and the BAK (*Federal Office of Culture* – the federation's technical body for the preservation of monuments,



archaeology and the protection of townscape images). BAK and BAFU check aspects such as the extent to which a project touches on the interests of the protection of nature and the national heritage. This work takes into account the special circumstances presented by the UNESCO World Heritage Report on the "Rhaetian Railway in the Albula / Bernina Cultural Landscape", as set out in the Cantonal Structure Plan. These authorities base their decisions in part on the national importance of the railway fundamental for a World Heritage Site. The authorities may also ask (and in some cases are required to ask) the EKD and ENHK – the advisory commissions of the federation – to submit technical reports. The EKD is the *Federal Commission for the Preservation of Monuments*, and the ENHK the *Federal Commission for the Protection of Nature and Cultural Heritage*. As part of the assessment of a project, the technical departments can submit requests for changes to the lead authority or even reject the project completely. The BAV makes its decision based on a balance of interests and is required to reach an agreement with the technical departments by means of a legally defined procedure whereby the conservation and appropriate care and maintenance of the railway is of national importance i.e. the protection of the World Heritage Site is in the highest possible public interest.

The planning approval project is also sent to the canton, which accepts responses from the local authorities and any third parties affected. Laws passed by the canton and the local authorities cannot oppose the planning approval. In practice, however, due consideration is given to the laws passed by the canton and local authorities, as well as to the railway law and to other public interests. The local authorities keep the project on public display in the form normally used locally for a period of 30 days. During this period, anyone whose rights and duties are affected by the building project and whose interest in the project is worthy of protection may express an opinion or request changes to the plan. The law on group complaints (cf. 5.b) allows all issues to be raised, including questions on alignment, environmental protection and noise protection, spatial planning aspects, and so forth.

The planning approval procedure as a rule concludes with the BAV issuing a decision; this decision may be challenged.

The planning approval is important in two ways. On the one hand it is in effect a building approval and on the other it implies that the project correctly applies the normal rules of railway know-how and is designed using state-of-the-art technology; in other words, the planning approval also confirms that the project has passed a safety review by the BAV.

Technical advice and the Rhaetian Railway

The Cantonal Structure Plan contains provisions concerning protection of the World Heritage Site (see draft for the new Structure Plan subsection "UNESCO World Heritage" in 5.b). The provisions require the Rhaetian Railway to involve qualified specialists (specialists in the cantonal tasks of preservation of monuments or other experts) during the planning, design or implementation of new railway facilities and during the conversion and rehabilitation of existing railway facilities. The task of these experts is to ensure that the specific character and dominant image of the Albula and the Bernina lines remain preserved and that new structures and facilities are properly integrated into the townscape and the landscape images.

The example of the development of modular construction methods for the rehabilitation of railway bridges shows how this type of technical advice works in practice (cf. 4.a.1).

Implementation of the protective provisions for the environs of the site (buffer zone)

As detailed in Chapter 5.b, the definition of the desired spatial development and its instrumental implementation, is largely incumbent on the cantons; the cantons delegate these obligations in part to the communities. As central steering instrument of spatial development, the Cantonal Structure Plan is compiled by the Cantonal Spatial Development Authority, the *Amt für Raumentwicklung*, in cooperation with other cantonal authorities as well as with the regions and communities on a partnership basis. The Cantonal Spatial Development Authority elaborates a draft structure plan, Presents this for public viewing for at least 30 days, and submits it to the relevant cantonal authorities for approval.

In Graubünden, the Structure Plan is approved by the government (article 14 KRG) whereupon it becomes binding on the cantonal authorities. Upon final approval by the Federal government, the structure plan then also becomes binding on the federal authorities.

As explained in Chapter 5.b, the relevant amendments will be made to the Structure Plan in the event of the site being inscribed on the UNESCO World Heritage List. This will be initiated as soon as the success of the candidature has been confirmed. Core and buffer zones together with the key considerations in the Cantonal Structure Plan have been elaborated in conjunction with the communities, regions, canton and federation. This specific amendment shall be binding on the authorities at all levels; all authorities committed to the higher interests defined in the Structure Plan with respect to the protection and sensitivity in dealing with the World Heritage.

Details of the structure plan procedure may be found under www.are.gr.ch > Richtplanung > Verfahrenabläufe (in German).

Obligation to consult on design

The cantonal structure plan makes higher demands in terms of the design of buildings and facilities and the quality of their integration into the townscape and landscape images (see draft for the new Structure Plan subsection “UNESCO World Heritage” in 5.b). The approach used to implement this principle is that of ‘consultation on design’. In concrete terms, the consultation on design occurs through the involvement of qualified technical advisers in the approval procedure (see the relevant chapter below). Where this consultation is not possible, measures of similar value are pursued, for example establishing appropriate design guidelines or articles in the building law.

During the period when the present candidacy was being drafted, the opportunity was taken to develop a number of implementation and support tools related to the area of village-level advice with respect to design. These tools are intended for use by the authorities involved in spatial development. They have been published on the Internet (www.siedlungsgestaltung.gr.ch) and provide a valuable basis for the day-to-day work and implementation.

In the *primary buffer zone* (for derivation and definition of the term cf. 1.e), consultation on design is an obligatory requirement. Where new agricultural structures within the UNESCO primary buffer zone are concerned, financial contributions from the public sector are only granted if the buildings concerned fit correctly into the townscape and landscape images.

In the *buffer zone in the ‘near’ area* (for derivation and definition cf. 1.e) the various existing building regulations and zone plans of the local authority will ensure an orderly development. Consultation on design is recommended for the buffer zone in the adjoining area and is a way of emphasising the requirement for increased sensitivity of the design. Where proposals involve intensification of use or extensions to settlements, special attention must be paid to the design and the integration into the images of townscape and landscape. Measures for directing growth in extensions of settlement areas have already been set out by the existing structure planning.

For the *buffer zone in the 'distant' area* (views which include the horizon line, cf. 1.e), the significance of the horizon line moves into the foreground. This line is to be kept free of any new structures and facilities affecting the landscape and which can be seen from the core zone. Should such buildings and facilities be unavoidable due to higher-level public interest (e.g. to ensure national supplies), then a design and layout must be selected which will minimise any adverse affect on the horizon line.

Protection of nature and the national heritage

Aspects of special interest include the preservation of monuments, archaeology, protection of the townscape image, protection of the landscape and the protection of nature. The relevant technical departments of the BAK (*Federal Office of Culture*), the BAFU (*Federal Office of the Environment*), the cantonal section for the Care of Historic Monuments (*Denkmalpflege Graubünden),* the cantonal Archaeological Service (*Archäologischer Dienst Graubünden*), and the departments for nature protection and the protection of the landscape within the cantonal *Office for Nature and the Environment* (Amt für Natur und Umwelt ANU) are responsible for the implementation of these aspects, both at federal and cantonal levels. The inclusion of the World Heritage Site in the Cantonal Structure Plan is a clear statement of the increased interest in its protection. During the harmonisation of interests, which is a normal part of the protection process (see above in this section), special consideration will be given to this feature.

It has already been described in the protection of the railway facilities (see the chapter on planning approval procedure earlier in this section) how the federal task of implementing protection of nature and the national heritage is carried out in individual cases. In a similar process, the BAK also checks all other federal tasks affecting the cultural landscape of the Albula / Bernina region, reviewing them in terms of their influence on the cultural heritage; the BAFU carries out a similar review in terms of the influence on the natural heritage. The federation is responsible for reviewing all activities with a strong spatial impact. Such activities include the construction or alteration of infrastructure facilities (a federal task commensurate with the federation's duty of approving them), transport facilities (concession under federal law), the development of waterways, the construction or conversion of structures for agricultural use or for protection against natural hazards (federal subsidies).

In making its assessment, the federation bases its work on the inventories of objects of national significance and on the preservation aims formulated with respect to them. These inventories are only legally binding on the federation, but are also taken into consideration in the canton's planning activities. A basic requirement is that the objects included must be preserved unimpaired. Deviations from this are only permitted when other, higher-level interests of national importance im-

ply that they cannot be avoided. Three federal inventories currently comply with the NHG – the ISOS, the BLN and the IVS.
The BLN, the *federal inventory of landscapes and natural monuments of national significance* includes objects, typical landscapes and natural monuments (for the entries in the inventory which concern the cultural landscape of the Albula/ Bernina region see 5.b, Overview tables). Typical landscapes are mostly cultural landscapes strongly influenced by nature that contain surface forms especially characteristic of a region, or features of cultural history and habitats important to local flora and fauna. Natural monuments are individual animate and inanimate natural features such as erratic blocks, rock outcrops or typical forms of landscape. These are elements of landscape protection for which the overall appearance of the landscape is in the foreground.
The ISOS, the *federal inventory of Swiss Heritage Sites* includes permanent settlements worthy of protection (for the entries in the inventory related to the cultural landscape of the Albula/Bernina region see 5.b, Overview tables; they are also appended to the candidature documentation ["Annex" File] in electronic form). A "townscape image" is more than a settlement and something more than the sum of individual buildings. It is not only buildings which make up a townscape image, spaces are also involved – the spaces between houses, the squares and streets, the gardens and parks. A locality is characterised by the relation between the buildings themselves and between the buildings and their surroundings, such as woods and meadows, and the landscape. The ISOS seeks to illustrate this interrelationship as seen by an overall view of the ensemble; it also establishes specific preservation goals for each townscape image. The Cantonal Structure Plan lists the townscape images of national and regional importance; the associated regulations on protection are binding on the authorities. Protection measures relate to individual plots of land and are binding on the property owners; these are implemented within the framework of land-use planning (see below in this section).
The IVS, the *inventory of historic transport routes in Switzerland*, the principles of which are presently only available in draft form, contains comprehensive information on the course of historic routes, their history, their condition and their significance. It is not only meant to serve as a means for the protection, maintenance and care of historic transport routes, it is also intended to provide a means for promoting the sustainable use of historic routes for tourism. The inventory will therefore also make an important contribution towards the creation of an attractive network of footpaths, trails and cycle routes. A network of this type for slow-moving traffic is part of the strategy set out in the Federal law of 4th October 1985 concerning footpaths and trails (FWG; SR 704).
Further to the three federal inventories which are regulated in a specific ordnance based on Art. 5 of the NHG (VISOS, VBLN und VIVS; cf. 5.b), there are other inventories on the federal side which are relevant in dealing with World Heritage issues: the *Biotope inventories*. They cover raised and flat bogs, spawning areas for amphibians, meadowland, glacier aprons and alluvial plains; an extension to cover other protected nature surfaces is in preparation. The Cantonal Structure Plan lists the biotopes of national and regional importance; the relevant regulations on protection are binding on the authorities. The protection that relates to individual plots of land and which is binding on the property owners is applied in the context of land-use planning (see below in this section). Besides planning-based protection, where exploitation of the biotopes is essential and

possible, specific utilisation of these areas can be contractually agreed with the users and the specific utilisation paid for.
A project control that is essentially independent of political influence is guaranteed by the *Verbandsbeschwerderecht,* the NGO right to file objection (cf. 5.b). This right enables organisations active across Switzerland to lodge complaints against certain cantonal orders or against orders issued by federal authorities. To be eligible for this right, an organisation must be dedicated to the protection of nature and the national heritage, the preservation of monuments, or related but purely conceptual goals and must have been in existence for at least 10 years. This right to file objection also ensures that the implementation of the legal provisions for the protection of the cultural landscape of the Albula / Bernina region is effectively monitored. It can be exercised only in clearly defined circumstances, for example in planning approval procedures involving the railway and in proposals subject to an obligatory environmental impact assessment; other examples include requests for land clearance work, applications for structures outside the building zone (see chapter on building permission below) and other federal tasks. The right to object is not a veto right; it simply helps to ensure that building proposals comply with the current laws. At the moment, 30 Swiss NGOs have a right to object.
The cantons are primarily responsible for the actual implementation of nature and national heritage protection, as explained in the federal constitution (article 78 BV). In Graubünden, the responsibility falls on the cantonal technical bodies already referred to, and to which the NHK (*Cantonal Commission for the Protection of Nature and Cultural Heritage*) is assigned. The commission provides advice to the cantonal government, the local authorities and to private individuals. The cantonal technical departments may also request that experts from the federation be consulted. EKD (*Federal Commission for the Preservation of Monuments*) and ENHK (*Federal Commission for the Protection of Nature and Cultural Heritage*), the federation's advisory bodies, can also be commissioned to prepare special technical reports. The *Denkmalpflege* (Care of Historic Monuments) and the *Archäologische Dienst* (Archaeological Service) are responsible for monitoring the cultural heritage of structures within the cantonal territory; these maintain close contact with the related cantonal technical bodies, the municipal authorities and with owners.
Project support and monitoring takes the form of continuing support and advice from the canton's technical experts throughout the entire course of the project. ANU (*Cantonal Office for Nature and the Environment*) is the department responsible for biotope and landscape protection; it exercises a similar function to that of the department for the preservation of monuments and the cantonal department for archaeology.
Another source of support for the preservation of natural and cultural objects is provided by financial contributions from the public sector for objects in the fields of protection of nature and national heritage which are worthy of protection (cf. 5.b); for example, the federation and canton provide joint subsidies for restoration work. Where building work involves structures entitled to subsidies, what are known as 'costs entitled to a contribution' are deducted from the total cost; 25 – 35 % of these are then assumed by the federation and/or canton, the size of the contribution being based on the importance of the object. Owners can submit a request for a financial contribution of this type to the cantonal department for the preservation of monuments. This department reviews all the applications submitted and then arranges

them in a time-based sequence as part of the joint financial planning between federation and canton. One direct consequence of a subsidy is that the object is placed under protection. In this case, the entry of an easement in the property register in favour of the confederation and the canton means that any constructional measure planned for the object must first be approved by the BAK and by the cantonal department for the preservation of monuments. A financial contribution confirms the public interest in the monument. This support allows building work appropriate to the monument to be carried out by qualified craftsmen.
Financial resources are also available for the protection of biotopes within the area of the cultural landscape. The corresponding legal basis is provided for under article 13 NHG. The contributions granted within the framework of the laws on agriculture are of much greater importance for the cultural landscape (see the chapter on other control mechanisms below).
The federation may acquire natural or cultural objects by amicable means; where this is not possible, it can acquire or safeguard them by compulsory purchase. If a natural object or cultural monument of national significance is in imminent danger, the federation can place such an object under its protection, using time-limited measures, and can then organise the safeguards needed to ensure its preservation.

Federal concepts and implementation plans

The federation's concepts and specific plans (cf. 5.b) are developed in close partnership between the federal bodies and the cantons. This is a requirement for the interplay between concepts and specific plans on the one hand and the cantonal structure plan on the other. The approving authority in this case is the Federal Council.

The authorities at all the various levels of government are required:

> to ensure compatibility of their spatial activities with current concepts and specific plans
> when harmonising interests, to give due consideration to the issues arising from the concepts and specific plans
> where necessary, to work together with the appropriate federal agencies
> to justify any wish they have to modify valid concepts and specific plans and in so doing to fully consider the various interests involved.

If the area is accepted into the UNESCO list of World Cultural Heritage sites, the Cantonal Structure plan will be modified accordingly (cf. 5.b), which will affect the federation's specific plans and concepts.

Regional Structure Plans and Forest Development Plan

The *regional structure plans* prepared by the regions (cf. 5.b) become binding upon the authorities in the canton (including the local authorities) once they have been approved by the cantonal government. The local authorities affected take the details of the regional structure plan into consideration in their land-use planning, which is how the structure plans are implemented. The various responsibilities are defined in article 18 KRG and the process regulated by article 18 KRVO. The various steps in the procedure are similar to those of the Cantonal Structure Plan, except that here the region has the role of the canton and the canton takes over the function of the federation. For further information, see www.are.gr.ch > Richtplanung > Verfahrensabläufe (in German).
The *Forest Development Plan* (cf. 5.b) is approved by the government and by the local authorities affected. The procedure here is similar to that followed by the regional structure plan.

The cantonal and local authority departments are bound to comply with and implement the outcome of the planning process. The provisions under article 5 of the Federal law of 5 October 1991 concerning the forests (WaG; SR 921.0) is of fundamental importance to the forest development plans as it provides fundamental protection to the existing forest coverage. Approvals for land clearance may be given in exceptional circumstances and subject to specific conditions. The Cantonal Structure Plan stipulates that the forest development plans must take the requirements of the UNESCO World Heritage Site into consideration. The structure plan defines the special views which are to be kept free of obstruction by the forest as well as the special views visible from the railway, due allowance being made for the functions of the forest ('protective forest').

In practice, the forest development plans find their implementation through the forestry stewardship plans. These are developed by the forest owner in collaboration with and through the support and assistance given by the cantonal forestry service.

Local authority land-use planning

Land-use planning (building law, zone plan, general design plan, general structure plan, cf. 5.b) is approved by the cantonal government and takes into consideration higher-level controls, particularly with respect to the cantonal structure plan. A detailed explanation of this procedure may be downloaded from www.are.gr.ch or www.bvr.ch (in German).

Building permission

In practice, the land-use plan is largely implemented through the building permission procedure as based on the spatial planning law. This permission procedure applies to new buildings and facilities and the conversion or rehabilitation of existing buildings and facilities; it involves checking to see whether the proposals comply with the legal provisions as well as with the framework established by the planning instruments. This procedure also involves checking for compliance with various requirements, such as the design and integration into the landscape and the environmental provisions for the buffer zones as set down in the Cantonal Structure Plan (cf. 5.b).

Buildings and structures with a significant impact on the environment are as a rule subject to an *environmental compatibility test* (Umweltverträglichkeitsprüfung UVP) – legislation specifies where such an assessment is required. Examples include proposals for new wider roads, parking structures with more than 300 parking spaces, railway facilities, power stations, high-voltage lines, large and special landfill sites, quarries for the extraction of large quantities of gravel, sand and stone. Also access to new regions by transport facilities for tourists, linking of ski areas, larger snow-making installations, golf courses, large sports stadia, land consolidation/land improvement measures, shopping centres, and the like. The type of approval procedure to be used depends on the type of facility proposed. For example, land-use planning includes assessing the environmental impact of proposed large scale sand and gravel quarries; for Federal tasks (cf. 5.b) such as buildings and facilities of the Rhaetian Railway (railway law), the UVP forms part of the planning permission procedure. The spatial planning authorisation procedure fundamentally distinguishes between *settlement area* and *landscape area*.

Settlement area

The settlement area comprises the actual building zone – those areas defined in the land-use plan as building zones, for which the local authority defines the type and extent of use through the zone plan and the building law. As a rule, a distinction is made between village core zones (historic village nuclei which have evolved over a long time), residential zones with different intensities of use, mixed-use zones (residential and commercial), commercial/industrial zones and zones for public structures and facilities. Special protective zones are defined for local centres worthy of protection and/or similar protective measures taken. For townscape images that are worthy of protection and which are of national and regional importance, the Cantonal Structure Plan defines the principles for the protection and high-quality further development of the area involved.

As a rule, the land-use plan specifies a duty to prepare a district plan for larger new building areas, the goal being to promote high-quality development in terms of both architecture and settlement structure.

Structures and facilities within building zones may be built, altered, demolished or subjected to a change of use exclusively subject to written building permission granted by the building departments of the local authority. The local authority also requires the cantonal department for the preservation of monuments or its own design advisors to be consulted where a proposal relates to a monument that has been listed in one or other of the inventories.

For building projects, the application submitted directly by the owner is first subjected to a formal review by the local authority department, which checks to ensure the application is complete and clarifies whether any additional authorisations are needed, in which case the building department initiates the appropriate applications for permission from the authorities concerned. At the same time as the building application is submitted, the applicant has profile markers staked out at the proposed building site showing the dimensions of the planned buildings or facilities. When the documents are complete (and additional documents are requested if this is not the case), the building application is published in the official cantonal gazette and can be viewed by the public for a period of 20 days. Should an environmental impact assessment or other special approval be necessary, the corresponding documents will also be made available to the public.

Those organisations entitled to file objection are informed of the building application by the building department. These can either express their interest in participating in the procedure or file objection. At the end of the objection period, the building department reviews all objections lodged and informs the applicant of them. The applicant then considers the objections and must state their response to them within a period of 20 days. On the basis of this statement of position and of the conditions defined by planning and building law, the building authority assesses the building submission and publishes the decision on the building approval together with the decisions on any other additional approvals that may additionally be required. As mentioned earlier, there is a provision that any building proposal in the primary buffer zone of the World Heritage Site must involve a neutral expert; it is recommended that an expert of this type be involved for any proposals within the buffer zone in the ‘near’ area, although this is not a requirement. At this stage in the procedure, the local authority either calls on an advisor qualified in the field of design and style planning (as a rule an architect or an expert from the cantonal department for the preservation of monuments) or itself reviews the building application in terms of compliance with the special design regulations which apply to the UNESCO primary buffer zone. If the

design qualities of a project are considered to be insufficient, the owner will be advised of this and given details of any specific deficiencies; the building application is returned for revision, in some cases together with specific suggestions for improvement. A revised building application is again subjected to the entire review process.
As a rule, to avoid any risk of conflict with his work as an advisor, the technical expert called in to advise may not accept any commissions within the local authority area which appointed him. Generally, the costs for this advisory service are passed on to the applicant on the basis of the expenses incurred. If the design of the proposed work for which the building application is submitted is of a high quality, then the services of the advisor will be less extensive; conversely, if the quality of the design is poor then his services (and the financial expenditure) will be correspondingly higher. This creates an incentive to prepare a design that is of a high quality.
A detailed explanation of the procedure may be downloaded from www.are.gr.ch or www.bvr.ch (in German).

Landscape area

The landscape area comprises all the territory outside the area of the settlement, and primarily concerns forest, agricultural areas, recreational areas (such as ski areas and golf courses), protected zones (such as nature, landscape and rivers and lakes protection zones, cultural objects, archaeological sites), mining and quarrying sites and landfill areas and zones exposed to natural hazards. These zones are also defined in the zone plan, and the building law contains the relevant provisions for them. In the landscape area, the local authorities also consider the binding content and area-specific considerations of the Cantonal Structure Plan and in particular the regulations concerning the buffer zones of the outlying area. Cultural objects in the landscape are identified and protected; these include ruins of forts, unique religious buildings, rock drawings, and so forth.
Buildings and facilities outside the building zone require not only building permission from the local authority but also an approval from the canton (BAB approval). Essentially, only those buildings and facilities are approved that are located outside the building zone. A distinction is made between buildings and structures that conform to the zone (such as a new agricultural building in an agricultural-use zone), location-related buildings and facilities (such as power stations and overhead lines) and ‘exceptions’ such as the partial conversion of buildings no longer used for agricultural purposes. The main legal basis is provided under the Federal law on spatial planning (articles 24 – 24d RPG). The building approval procedure for structures outside the building zones is similar to that for structures within these zones. However, the local authority’s building department is required to forward the building application together with a preliminary assessment to the cantonal *Office of Spatial Development*. This leads to additional consultation based on the principle of involvement with other cantonal technical departments. The results of this additional consultation provide the basis for the Office of Spatial Development to inform the local authority’s building department with respect to the canton’s decision. If the canton and local authorities cannot come to the same conclusion as to whether a building application should be approved or not, then the law requires a relevant settlement to be made.
A detailed explanation of the procedure may be downloaded from www.are.gr.ch or www.bvr.ch (in German).
Where applications concern buildings or facilities to be constructed in a forest area, the site-

specific requirement must be demonstrated just as for similar developments in a landscape area. Furthermore, the spatial planning requirements must be met and the site clearance must not lead to any serious risk to the environment. If more than 5,000 m^2 of forest are affected, the approval procedure for land clearance applications must also take the views of the federation into consideration. If the area to be cleared is less than 5,000 m^2 then the canton can issue permission autonomously. However, every case must provide for replacement of the cleared area of forest (reforestation or nature protection measures). Should clearance work or similar additional approvals be required, then as a rule these are coordinated in terms of land-use planning by the Office of Spatial Dvelopment and collected from the responsible technical body.

Other control mechanisms

The agricultural zones defined in the land-use plan ensure that the cultural landscape is preserved to its full extent. However, this requires that it should continue to be used and cultivated, as cultural landscapes not put to agricultural or forest use tend to run wild. Mountain areas are especially at risk of decline, due to their unfavourable location and population drift. A system of financial incentives has been set up to avoid this risk: area-based financial contributions to farmers and livestock owners (‘direct payments’) support their preservation of the cultural landscape. Additional, ecology-based compensation payments – founded on the concept of ecological networks – offer farmers financial support and compensation for their services in the protection of nature.
The provision of supporting information and advice is yet another way of implementing the protection of the World Heritage Site. Here, a large variety of guidelines and advisory documents on the design of buildings and facilities are available (such as on the planning and design of power supply lines, land improvement measures, the design of quarry areas, landfill areas, roads and ski slopes).
Another starting point for implementing the protection of an area is to exert influence on a project during the early stage of its development. One example would be during the construction of new agricultural businesses (‘relocation’ cf. 4.a,2); a cantonal procedure used during the early design stages of such a scheme reviews possible locations for the project and its impact on the townscape and landscape images. This ensures that the planned building is integrated into the landscape; the subsequent design work then concentrates on the form of the proposed building.
The various guidelines, leaflets, and so forth are drawn up by the appropriate technical departments. Many of these are available on the Internet (www.are.gr.ch, www.anu.gr.ch, or www.alsv.gr.ch [in German]).

Tirano (Italy)

Both the *Piano regolatore generale del Comune di Tirano* PRG and the *Piano territoriale di Coordinamento della Provincia di Sondrio* PTCP (cf. 5.b) are approved, in the last instance, by the Region of Lombardy. Structures have been created at regional level which are responsible for handling all World Heritage issues: these are the *Ministry of Cultural Heritage* and the *Ministry of the Environment*. Environmental and cultural heritage conservation matters are not dependent on municipal jurisdiction. The Ministry of Cultural Heritage is responsible for the cultural and monumental heritage and is located in the Regione Lombardia or Lombardy. On the other hand, the Ministry of the Environment is responsible for natural heritage and is also located in the Regione Lombardia. Any structural interventions on the site, require environmental planning permission from the municipal authorities with a view to conservation of the land. The authorisation process is conducted by two environmental experts, nominated by the municipal authorities, who appraise the project and issue a binding opinion. Planning permission is granted by the municipality. The superior authority has the power to revoke the measure within 60 days. In the Municipality of Tirano, the person delegated by the mayor to grant environmental planning permission is the engineer Paolo Clementi, who is responsible for technical issues in the Municipality of Tirano. The environmental experts are the architect Simone Cola from Sondrio and the engineer Virgilio Scalco from Villa di Tirano. They both attended a specific environmental further training course to prepare them for the position as environmental experts for the municipality.

The *Directorate general for Lombardia's cultural and land heritage* is a regional expression of general managerial level of the Ministry of Cultural Heritage and Activities, attached to the cultural and natural heritage department and is located in Milan, the capital of the region. The regional director coordinates and controls the activities of the outlying offices ('Superintendences') of the territory, whose priority task is to protect the (architectural, landscape, historical-artistic, anthropological-ethnic and archaeological) cultural heritage and to handle relations with the Ministry of Cultural Heritage and Activities with Regione Lombardia, the local governments and other institutions on the territory. Moreover, the regional director proposes to the head of the department, the measures to be introduced in the one-year and multi-year programmes and the budget plans, defining priorities on the basis of the indications submitted by the 'superintendences' of each sector. One activity which has been developed by the directorate general of Lombardia over the past two years represents enforcement of an initial value added Code to "exercise functions and activities with a view to promoting awareness of the cultural heritage and guaranteeing the best conditions for public utilisation and sustainable conservation of this heritage". The directorate general ensures the conservation of cultural assets in museums, archaeological sites and parks, monument-character objects in public ownership; it is convinced that the effectiveness of the measures implemented by the Ministry of Cultural Heritage and Activities on the site today, is to be measured in terms of (adequate and consistent) accessibility and usability of the cultural assets. Beyond the adhesion to and signing of many other important Programme Agreements, the Frame Programme Agreement between the Ministry of Cultural Heritage and Activities and the Regione Lombardia (signed in 1999 and renewed in 2003) concerns the cultural heritage and promotes the cooperation with other qualified institutions and individuals. The directorate general has implemented specific agreements and conventions governing individual sites and monument-character estates, in order to assess various modes of associate management of public services, respecting the particular characteristics of each reality. Within the directorate general there are many technical and scientific specialists. Among them, for example, architects, art historians and archaeologists, backed up by administrative and information personnel (some 30 people). Within the directorate general there is also an UNESCO work group, both for the sites that already figure on the World Heritage List, and for those which are nominated or candidates. These groups each comprise an architect, an art historian, two archaeologists and an administrative officer.

Charter of the support group

A supporting group founded in the legal form of an association was founded, 13 June 2007, to realise the objectives defined in the Management Plan in the context of the UNESCO World Heritage: the "UNESCO World Heritage Rhaetian Railway in the Albula/Bernina Cultural Landscape Association" (cf. 5.e). Members of the Association are the Federal Office of Culture BAK, the Canton Graubünden, the Rhaetian Railway, the communities within the World Heritage perimeter as well as persons or organisations linked to the World Heritage. The Association is responsible for promoting the preservation and sustainable use of the World Heritage Site in general, for the coordination of monitoring and controlling activities concerning the railway and the cultural landscape, and in particular for information on and use of the UNESCO label.
To anchor increased sensitivity in dealing with the World Heritage more firmly, the Association members are also bound by a charter, that is incorporated in the Articles of Association in the form of an introduction. By signing the charter, all participants undertake to implement the principle considerations formulated in the Management Plan.

Albula line > The Glacier Express in Val Bever.
A. Badrutt / Rhaetian Railway

5.d Existing plans related to municipality and region in which the proposed property is located

Graubünden (Switzerland)

Regional level

Regional structure planning

At present, the following regional structure plans covering the area of the property (core and buffer zones) are in force (cf. 5.b and 5.c), position 1 October 2006:

Heinzenberg-Domleschg

- > The Feldis, Sarn, Tschappina and Mutten ski areas, landscape protection and wildlife protection areas, regional public transport, hiking trails, cycle tracks, mountain bike routes, bridle-paths, and private motorised traffic routes were approved by the government 13 June 1995 by decision N°. 1469 and duly noted.
- > The Viamala motorway service area, approved by the government 30 March 2004 by decision N°. 444.
- > Change in the extraction and exploitation of material, Campi quarry; approved by the government 6th October 2005 by decision N°. 1209.

Mittelbünden

- > Ski areas, snow-making, concept for a golf course, landscape protection areas, landfills/deposits of material 1 part: Lenzerheide, regional public transport, concept for shooting range for civilian use, regional priorities extending the road network; approved by the government 16 March 1993 by decision N°. 557 and duly noted.
- > Lenzerheide snow-making facility, change approved by the government on the 13 June 1995 by decision N°. 1472.
- > Savognin and Sur Carungas ski areas, change approved by the government 4 October 1999 by decision N°. 1782.
- > Extraction of gravel, sand and stone, approved by the government 2 October 1995 by decision N°. 2531.
- > "Kessi" material extraction in Filisur, minor change approved by the department of economics and the interior, approved 14 May 1996.
- > Marmorera quarry, minor change approved by the department of economics and the interior, approved 30 August 1996.
- > Landfills/material deposits 2 part: Albula valley/Surses, approved by the government 2 October 1995 by decision N°. 2531.
- > "Schinterbödeli" in Schmitten, minor change approved by the department of economics and the interior 27 November 2000.
- > Gneida/Dartgaz, minor change approved by the department of economics and the interior 16 June 1997.
- > Proposal for landfills and material deposit, change approved by the government 23 April 2002 by decision N°. 563.
- > Proposal for the extraction of gravel, sand and stone, change approved by the government approved 23 April 2002 by decision N°. 563.
- > Recreation areas, approved by the government 17 June 2002 by decision N°. 843.

Upper Engadin

> Snow-making facilities, approved by the government 11 July 1988 by decision N°. 2025.
> Snow-making facilities in the St. Moritz area, approved by the government 12 August 1997 by decision N°. 1702.
> Loipen (cross country skiing tracks), approved by the government 13 May 1997 by decision N°. 1052.
> Ski areas and transport facilities for tourists, extraction of material, landfills for inert materials, paths (cycle ways and others), approved by the government 13 May 1997 by decision N°. 1052.
> Golf facilities, approved by the government 29 August 2000 by decision N°. 1367.
> Landscape protection, approved by the government 19 December 2000 by decision N°. 2094.
> Snow-making facilities, approved by the government 1 October 2002 by decision N°. 1418.
> Transport, approved by the government 19 August 2003 by decision N°. 1180.

Val Poschiavo

> Winter tourism: ski areas, cross-country skiing, sledging, mountain huts/accommodation; summer tourism: walking trails, cycle ways, mountain huts/accommodation and mountain-bike routes; camping; landscape protection; quarrying for stone, gravel and sand; landfills; raw materials deposits; collection and sorting points, regional public transport, and private motorised traffic; approved by the government 2nd November 1999 by decision N°. 1936 and duly noted.
> Regional snow-making facilities, approved by the government 27 October 1992 by decision N°. 2650.
> Quarrying for stone, gravel and sand; landfills; deposits of material; modification of 2005, approved by the government 6 June 2006 by decision N°. 642.

Forest Development Plans

The current Forest Development Plans (cf. 5.b and 5.c) are:

> Heinzenberg-Domleschg: in preparation, position summer 2006; the structure and details of demands have been prepared
> Mittelbünden: approved by the government 5 March 2002 by decision N°. 294.
> Upper Engadin: work is expected to start during 2006
> Val Poschiavo approved by the government 11 March 2003 by decision N°. 317.

Local authority level

Local authority land-use plans (district plans)

The following table shows the current status of the local authority plans (cf. 5.b and 5.c). The following district plans are updated continuously.

Thusis: District plan approved by the government 15 January 1990 by decision N°. 82; with numerous subsequent partial revisions (the last approved by the government 20th September 2005 by decision N°. 1153).

Sils i.D.: District plan approved by the government 20 February 1989 by decision N°. 437; with numerous subsequent partial revisions (the last approved by the government 23rd December 1997 by decision N°. 2552).

Zilllis-Reischen: District plan approved by the government 13 July 1993 by decision N°. 1760; with numerous subsequent partial revisions (the last approved by the government 7th March 2006 by decision N°. 248).

Scharans: District plan approved by the government 11 April 1983 by decision N°. 863; with numerous subsequent partial revisions (the last approved by the government 14 September 2004 by decision N°. 1305).
Mutten: District plan approved by the government 28 April 1975 by decision N°. 843; with numerous subsequent partial revisions (the last approved by the government 31 August 1999 by decision N°. 1548).
Vaz / Obervaz: District plan approved by the government 17 July 2001 by decision N°. 1179; with numerous subsequent partial revisions (the last approved by the government 28 February 2006 by decision N°. 219).
Alvaschein: District plan approved by the government 3 September 1991 by decision N°. 1578; with numerous subsequent partial revisions (the last approved by the government 7 September 1999 by decision N°. 1578).
Stierva: District plan approved by the government 14 November 1988 by decision N°. 2844; with numerous subsequent partial revisions (the last approved by the government 19 September 2000 by decision N°. 1526).
Tiefencastel: District plan approved by the government 12 October 1997 by decision N°. 2578; with numerous subsequent partial revisions (the last approved by the government 17 August 1999 by decision N°. 1465).
Brienz / Brinzauls: District plan approved by the government 15 July 1985 by decision N°. 1948 and 15 December 1985 by N°. 3342; with numerous subsequent partial revisions (the last approved by the government 23 August 2004 by decision N°. 1191).
Surava: District plan approved by the government 12 July 1982 by decision N°. 1801.
Alvaneu: District plan approved by the government 16 July 1991 by decision N°. 2196; with numerous subsequent partial revisions (the last approved by the government 3 June 2003 by decision N°. 829).
Schmitten: District plan approved by the government 19th March 1984 by decision N°. 674; with numerous subsequent partial revisions (the last approved by the government 26 October 1999 by decision N°. 1875).
Filisur: District plan approved by the government 6 April 1993 by decision N°. 817; with numerous subsequent partial revisions (the last approved by the government 4 July 2000 by decision N°. 1104).
Bergün / Bravougn: District plan approved by the government 16th December 1985 by decision N°. 3030, 1 December 1986 by decision N°. 3183 and 4 October 1994 by decision N°. 2511; with numerous subsequent partial revisions (approved by the government 20 September 2005 by decision N°. 1154).
Bever: District plan approved by the government 28 February 2006 by decision N°. 220.
Samedan: District plan approved by the government 21 October 1997 by decision N°. 2157; with numerous subsequent partial revisions (the last approved by the government 23 May 2006 by decision N°. 569).
Celerina: District plan approved by the government 13 April 1987 by decision N°. 889 and 7 December 1999 by decision N°. 2136; with numerous subsequent partial revisions (the last approved by the government 7 February 2006 by decision N°. 140).
St. Moritz: District plan approved by the government 29 February 2000 by decision N°. 326, 17 October 2000 by decision N°. 1638 and 15 January 2002 by decision N°. 37; with numerous subsequent partial revisions (approved by the government 26 September 2006 by decision N°. 1083).

Pontresina: District plan approved by the government 5 December 1988 by decision N°. 3017 and 19 June 2004 by decision N°. 943; with numerous subsequent partial revisions (the last approved by the government 27 June 2006 by decision N°. 790).
Poschiavo: District plan approved by the government 19 March 1984 by decision N°. 627; comprehensive revision of the settlement section 29 April 2004 by decision N°.625.
Brusio: District plan approved by the government 13 April 1999 by decision N°. 657; with one subsequent partial revision (approved by the government 24 February 2004 by decision N°. 242).

Tirano (Italy)

Municipality of Tirano and the Province of Sondrio

> *Piano regolatore generale del Comune di Tirano* PRG; approved by the Region of Lombardy 13 March 1990.

> *Piano territoriale di Coordinamento della Provincia di Sondrio* PTCP, adopted by the mayors of the Province of Sondrio 9 September 2006 with a view to approval at regional level.

Albula line > Larch forests line the railtrack in Val Bever.
A. Badrutt / Rhaetian Railway

5.e Property management plan or other management system

The Management Plan establishes a binding framework for the efficient protection and long-term management of the "Rhaetian Railway in the Albula / Bernina Cultural Landscape" World Heritage site.

The Management Plan (annexed to the candidature material as a separate document) outlines the objectives for the World Heritage site and additional measures required to achieve these objectives. It also sets out the institutional framework needed to implement measures, as well as the means for monitoring, maintaining and further developing the World Heritage site in the spirit of the UNESCO Directives.
Fundamental for all phases of the Management Plan is the definition of a guiding principle expressing the understanding for and appreciation of the World Heritage concept.

Management guiding principle

The award of UNESCO World Heritage status will ensure that this stretch of the unique Rhaetian Railway will be durably preserved and enhanced in the Albula/Bernina cultural landscape. This will be achieved by qualitative development taking into account the various influential factors in order to achieve an optimum balance between traditional and modern. Appropriate landscape stewardship and continuity in spatial development policy, will ensure that the historical character of the Albula/Bernina cultural landscape, that has been formed by traditional use, can be maintained in the long-term.
Awareness of the cultural heritage of the region and the need to maintain it must be raised. This contributes to the generation of regional offers, promoting the regional added value and ensuring continuity of settlement; it keeps jobs. Specific communications measures will be used with a view to raising cultural awareness beyond the region and, above all, to enhancing its appeal for tourism.

Sponsors

The "UNESCO World Heritage Rhaetian Railway in the Albula/Bernina Cultural Landscape Association" was founded 13 June 2007 (cf. Articles of Association in Management Plan). The purpose of the Association is to ensure the conservation and promotion of the World Heritage Rhaetian Railway in the Albula/Bernina cultural landscape according to the Management Plan. Accordingly, it is incumbent on the Association to coordinate the monitoring of the World Heritage site and to oversee the measures foreseen under the Management Plan. The Association relies on the existing structures, both for monitoring protection of the site and also in marketing and developing the offer. Its task is to establish and promote coordination between the existing institutions and administrative offices which are concerned with the protection and promotion of the World Heritage sites, within the legislative framework.
The Association's strategy is based on the concept of sustainable development. The Association sets binding objectives for its work which

consist in compiling standards for general organisational work, determining means for protecting the cultural asset and cultural landscape and ensuring sustainable development. An appropriate system will be set up to assess the efficacy of the defined objectives and resulting measures as well as guidance of these measures; here the Association can have recourse to existing instruments both within the Rhaetian Railway company and in the national and cantonal spatial development observation system. The Association complies with all legal requirements in the implementation of its objectives which allows the communities, the regions, the cantons and the Rhaetian Railway company relative autonomy in their operations.

Fields of Action

Five fields of action are defined on the basis of the guiding principle:

1. Railway, technology and architectural heritage
2. Cultural landscape
3. Economy and tourism
4. Organisation and communication
5. National and International cooperation

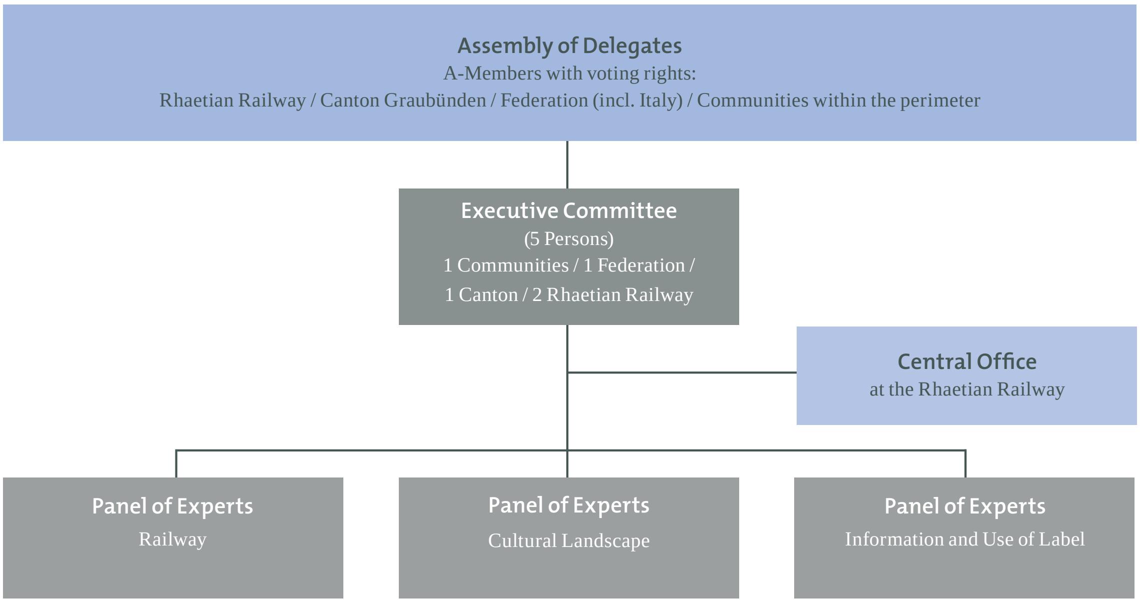
Objectives, fields of intervention and measures

The objectives, the relevant fields of intervention and the measures are based on the five fields of action. This operational process is set out, including concrete measures, in detail in the Management Plan. The Management Plan is designed so that new experience is incorporated and measures on the basis of the new findings can be further developed.

Transnational management

In addition to the 22 communities on Swiss territory, the perimeter of the property also takes in the municipality of Tirano, in Italy. This calls for transnational management of the World Heritage site. Like all the Swiss communities involved, Tirano is a full member of the Association, where it can promote its interests. At national level, the Swiss Federal Office of Culture will represent the concerns of Italy in the Association. The basis is the “Memorandum of Understanding” drawn up and signed by both states (the relevant document is an integral element of the Management Plan). The exchange of interests will be realised on the basis of interstate cooperation. Individual activities, calling for interstate cooperation will be dealt with on a case by case basis.

Sponsoring



Fields of action, objectives, fields of intervention and measures

	Sustainable development (activity maxims)				
	Activity domains				
	1 Railway	2 Cultural landscape	3 Economy/Tourism	4 Organisation	5 Cooperation
Objectives O	Railway O1	Cultural landscape O2	Economy/Tourism O3	Organisation O4	Cooperation O5
Sectors S	Railway S1	Cultural landscape S2	Economy/Tourism S3	Organisation S4	Cooperation S5
	S 1.1 Protection, maintenance and further development S 1.2 Documentation S 1.3 Safety S 1.4 Public transport S 1.5 Railway museum/ information center	S 2.1 Protection and care, biodiversity, landscape aesthetics S 2.2 Forestry S 2.3 Agriculture S 2.4 Settlement and building consulting	S 3.1 Railway programmes S 3.2 Natural and cultural landscape programmes S 3.3 Agricultural and forestry programmes S 3.4 Tourist programmes S 3.5 Regional development S 3.6 Networking S 3.7 Logo use and brands	S 4.1 Quality management association S 4.2 Coordination with administrations S 4.3 Monitoring and controlling S 4.4 Finances S 4.5 Communications	S 5.1 Cooperation with Italy S 5.2 National and international cooperation projects
Measures M	Railway M1	Cultural landscape M2	Economy/Tourism M3	Organisation M4	Cooperation M5

Albula line > The Glacier Express in Val Bever. The Beverin stream flows alongside the embankment.
A. Badrutt / Rhaetian Railway

5.f Sources and levels of finance

The owners of the objects which make up the nominated world heritage are basically responsible for financing the measures necessary for the preservation and sustainable development of the railway and the cultural landscape; their efforts are supported by government grants. Accordingly, the Rhaetian Railway receives a substantial amount of public funds to help offset the cost of transport services and the maintenance and repair of the rail infrastructure. "UNESCO World Heritage Rhaetian Railway in the Albula/Bernina Cultural Landscape" is an association financed by members' contributions. A regional promotion plan, the "Regio Plus+", will be implemented for the starting phase.

The association was created to promote the preservation and sustainable development of the World Heritage (cf. 5.e). It coordinates the activities of all the institutions involved in this work, and its two panels of experts – the Railway Committee and the Cultural Landscape Committee – ensure proper monitoring and controlling in the different areas of operation. The association is financed primarily by contributions from its members, the Swiss Federal Office of Culture, the Canton Graubünden, the Rhaetian Railway, the municipalities in the World Heritage perimeter and organisations or people connected with the World Heritage.

The association office is attached to the Rhaetian Railway. The implementation of the starting phase of the association (development of work processes and structures, realisation and further development of various part-projects such as staging/information, monitoring/protection, financing, regional cooperation etc.) is supported within the framework of a national promotional programme "Regio Plus". Contributions by the federation, the Canton Graubünden and the Rhaetian Railway for the sustainable implementation of the association in the context of this project amount to 1.7 million Swiss francs.

The effective financing of the Albula and Bernina lines, including all fixed rail installations and the entire rolling stock, is handled by the Rhaetian Railway. Together with receipts from passenger traffic and freight transport, the most important sources of financing are contributions from the public purse, as provided for in the Railway Law (cf. 5.b): under "Compensation Payments for Regional Transport", the federal and cantonal authorities reimburse transport companies for the cost of services ordered in the traffic and infrastructure sectors which are not covered by the budget. By means of special "infrastructure payments", the authorities meet the cost of infrastructure investments which are not financed by the above compensation payments. These contributions take the form of interest-free, conditionally repayable loans. Compensation payments for traffic and infrastructure totalled CHF 116.2 million in 2005, with CHF 103.5 million provided by the Confederation and CHF 12.7 million by Canton Graubünden). In the same year, total public sector investment contributions for Rhaetian Railway replacement and extension projects amounted to CHF 78.4 million (Confederation CHF 66.4 million, Canton Graubünden

CHF 12.0 million). Furthermore, uninsured damage caused by natural disasters which exceeds the Company's financial capacity may be taken over by the federal authorities. The Confederation also provides subsidies to promote combined rail / road carriage of goods, and transport of accompanied motor vehicles by train. Apart from the Railway Act, there are other legal bases for public sector financing. Investment contributions, for example, can be granted under the Equal Opportunities for the Disabled Act or noise control regulations. The various financial flows in the public transport sector are basically an integral part of financial planning at the federal and cantonal levels of government – which means that they are subject to political influence. A reorganisation of railway infrastructure financing is currently under way.

The framework conditions necessary to secure the authenticity and integrity of the cultural landscape on a long-term basis are provided by regional planning. In the final analysis, the owners themselves are responsible for the maintenance and sustainable development of the objects making up the cultural landscape. Existing funding and support schemes are available to ensure the requisite finance. For instance in Switzerland, farms receive direct payments according to surface area farmed and tied to ecological conditions. Direct payments to farms in the Albula / Bernina region currently amount to approximately CHF 16 million a year. In addition, other annual contributions totalling CHF 4 million are made to the agricultural sector (investments and summer pasturing). Financial assistance is also provided for forestry. Regional policy instruments are available to encourage sustainable development projects in mountainous areas, the countryside and border regions. Planning consultancy fees for buildings and installations (cf. 5.b and 5.c) are normally passed on by the municipalities (the building authority) to the builder. Financial aid for projects to preserve monuments is granted in accordance with the relevant legal provisions.
Information is disseminated via the sponsoring institutions, the Rhaetian Railway and interested organisations, and paid for separately by those concerned. The costs of other specific projects, such as visitor management or the development of tourist services, are borne by the parties involved.

Albula line > Before the south portal of the Albula tunnel at Spinas (Val Bever).
A. Badrutt / Rhaetian Railway

5.g Sources of expertise and training in conservation and management techniques

The technical expertise essential to ensure professional conservation and development of heritage sites is assured for all disciplines. The authorities responsible have access to accredited specialists who are already engaged in the management of the sites or can be called on to do so. The institutionalised cooperation between the individual departments, as well as with other institutions, guarantees the transfer of knowledge when specific problems arise; where academic questions and research projects are involved, the personnel also have access to numerous public and private institutions. Government legal and logistics services and sponsoring bodies assist the specialists in their work. Further education and training services are assumed by a number of public and private institutions. They offer qualified study and further training opportunities at all levels and for all specialised fields.

Graubünden (Switzerland)

Knowledge base of the authorities involved

At national level (www.admin.ch, www.ch.ch) the *Federal Office of Culture* (BAK, the authority responsible for the conservation of monuments, archaeology and protection of local heritage) and the *Federal Office of the Environment* (BAFU, the federal authority responsible for the conservation of nature and landscapes) and the *Federal Office of Spatial Development* (ARE, federal authority responsible for spatial planning, overall transport and sustainable development) have qualified personnel in all the specialised fields concerned (architecture, history of art and architecture, spatial planning, agronomy, geography, geology, biology, environmental sciences, forestry and cultural engineering sciences). The *Federal Office of Transport* (BAV, federal authority for land-based public transport) has the specialists for all technical questions (engineering sciences).

The *Federal Commission for the Preservation of Monuments* (EKD) as well as the *Federal Commission for the Protection of Nature and Cultural Heritage* (ENKH) are the technical commissions providing advice in the sectors conservation of monuments, archaeology and protection of local heritage and the protection of nature and landscapes. The commissions comprise reputed, highly qualified specialists in the fields of teaching , research and practice (architecture, art and the history of architecture, archaeology, natural sciences). BAK and BAFU and the cantons, can entrust the compiling of expert opinions in the context of cultural and national heritage to the commissions.

On application by the cantons, the federal government may appoint additional specialists from the private sector as federal experts and entrust them with specific mandates as the need arises. The BAK assigns some 150 expert mandates a year throughout Switzerland; currently some 300 are ongoing. In this way the sites always have experts to hand for highly specialised questions.

The *Federal Archive for the Conservation of*

Monuments (EAD) is a documentary office run by the Federal Office of Culture. The EAD collects, archives, looks after and provides access to documents on archaeology, care of monuments, visual aspects of urban patterns and the landscape, history of architecture and art as well as folk culture. The extensive archives include restoration reports, plans, photographs and negatives, administrative files and publications; they provide information on archaeological excavations, restoration measures carried out on listed objects and on the development of the visual impact of local areas; it also answers questions on changes to the landscape, culture and society over the past 110 years.

At cantonal level (www.gr.ch) the *Denkmalpflege* (Care of Historic Monuments) and the *Archäologische Dienst* (Archaeological Service) are departments of the *Office of Culture*; they have their own qualified specialists in architecture, history of art and architecture, archaeology and conservation. The *Office for Nature and the Environment* covers a large number of technical services including the Nature and Landscape service (geography, geology, environmental sciences, spatial planning, forestry and cultural engineering etc.). The staff of the Canton Graubünden *Office of Spatial Development* (architecture, geography, spatial planning, cultural and forestry engineering) are engaged in the fields of cantonal structure planning, regional master planning, outline planning, municipal land-use planning, building permission procedures, geographic information systems, electronic data processing, administration and archiving. The Cantonal *Office for Agriculture and Geo-information* (agronomy, geography, biology, other natural sciences) deals with questions involving geo-information and surveying, sustainable development and structural improvements in agriculture.

The Graubünden *Forestry Office* is the cantonal centre of competence for woodlands and forests and implementing the relevant legal prescriptions; it also has specialists in forestry engineering and associated fields. The *Office for Hunting, Game and Fishing* is responsible for the maintenance of healthy game and fish populations appropriate to their habitats; the game and fish wardens and the other personnel are qualified experts. The Office for Economy and Tourism has qualified personnel for questions dealing with the economy, living space and tourism sectors.

The Cantonal *Commission for the Protection of Nature and Cultural Heritage* advises the Canton Graubünden authorities on issues involving care of historic monuments, archaeology and landscape preservation. The members are also highly qualified specialists in the history of art, architecture and natural sciences.

All historic documents and documents produced by the cantonal administration are in the safekeeping of the *State Archives* of Canton Graubünden. The archives preserve and classify the relevant archives and make them available to research in their registers, inventories and publications. The State Archives have a central function for research on the history of Graubünden and the regional cultures and also has its qualified staff.

Knowledge base of the private and public institutions involved

The *Rhaetian Railway* (www.rhb.ch) has its own qualified personnel in the technical fields of engineering and transport sciences. The material accessible in its archives, which go back to the earliest days, and the knowledge transfer (oral history) of employees – a large proportion

employed by the Rhaetian Railway for many years – is used in the management of the sites. The planned *Railway Museum* in Bergün/Bravuogn (cf. 5.h) will be able to serve, on the one hand as information point for the UNESCO World Heritage, and on the other as competence centre for the history of railway construction.
The Protection of Monuments *Expert-Center* (www.expert-center.ch) is an interdisciplinary counselling and research unit for natural science and technological questions in connection with the conservation of construction monuments and their furnishings. It makes its services available to public and private owners of architectural and art monuments, construction specialists, persons responsible for the care of monuments at federal, cantonal community level, university and polytechnic research and specialists in Switzerland and abroad. The Expert-Center with its two laboratories in Zurich and Lausanne is integrated in both Federal Institutes of Technology: The laboratory in Zurich collaborates with the Forschungsstelle für Technologie und Konservierung des Instituts für Denkmalpflege of the Federal Institute of Technology in Zurich and the Lausanne laboratory continues the work of the former Laboratoire de Conservation de la Pierre of the Federal Institute of Technology in Lausanne.
The *Federal Materials Testing Institute* (EMPA, www.empa.ch) is a research institute engaged in the field of material sciences and technology It is part of the Federal Institute of Technology area and thus the Swiss science and technology and educational complex. The primary tasks of the institute focus on applications-oriented research and development and provides highest standard services in the field of sustainable material sciences and technologies. Innovative cooperation with industry and public institutions assuring the safety of the individual and the environment, dissemination of knowledge and teaching at university level are all central elements.
The *Swiss Institute for Art Research* (SIK, www2.unil.ch/isea/) founded 1951 is an art history and art technology research and documentation centre focusing on art in Switzerland. The institute enjoys federal recognition and is largely supported by public funds. The Swiss Institute for Art Research realises art science and art technology research projects, namely studies and material analyses. Works of art are conserved and restored in its own workrooms. These works may be paintings by old masters, classic wooden sculptures or contemporary works of art. The institute compiles technological expertises on cases of damages and offers counselling on and support in the care and preparation of collections and exhibitions.
The *Swiss national group* of the *International Council on Monuments and Sites* (ICOMOS, www.icomos.ch) is an association of specialists involved in the care of historic monuments. The group works in the fields of architecture, landscaping, conservation of monuments, archaeology, inventorisation, restoration, accessibility, natural sciences and in specialised crafts. The front line activities of ICOMOS Switzerland are the promotion of the national and international exchange of ideas on tasks and problems related to the maintenance of historic structures. To this purpose the Swiss group participates in the planning and realisation of congresses and seminars that are mostly jointly funded by professional associations, federal commissions or cultural institutions.
The *Society for the History of Art in Switzerland* (GSK; www.gsk.ch) is an influential participant in the research of location-specific art in Swit-

zerland and issues publications on its findings. It facilitates involvement in teaching and research and promotes young scientific talent in the field of Swiss art history research. To fulfil these tasks, the GSK collaborates regularly with institutions pursuing similar objectives.

The *National Information Centre for the Conservation of Cultural Assets* (NIKE, www.nike-kultur.ch) is the centre of information in Switzerland on the conservation of cultural assets. The centre is supported by 30 specialised associations and public organisations. Its objective is the interdisciplinary exchange of specialist knowledge and to provide information for the general public.

The objective of the *Plantahof Agricultural Training and Advisory Centre* (www.plantahof.ch) is to strengthen the economic and social situation of farming families and the rural communities in Graubünden. Thanks to its traditional roots in the rural region and specialist support by experts the information service can provide comprehensive counselling in all sectors of agriculture and rural economy (economics, production technology and ecological farming taking into account the cultural and social structures; it also provides appraisals, expert opinions and further training).

Training and further education of the persons responsible for heritage sites

Most of the specialists involved in the authorities and institutions working in the field of the cultural and natural heritage have a relevant university or college degree. In Switzerland this implies the two *Federal Institutes of Technology* in Zurich (www.ethz.ch) and Lausanne (www.epfl.ch), the *Universities* of Zurich (www.unizh.ch), Basel (www.unibas.ch), Bern (www.unibe.ch), Fribourg (www.unifr.ch), Neuchâtel (www.unine.ch), Lausanne (www.unil.ch), Geneva (www.unige.ch) and Mendrisio (www.arch.unisi.ch). All Swiss federal institutes and universities offer university degree and post-graduate courses (Bachelors and Masters degrees, doctorates, post-doctorate and lecturing qualifications, post graduate courses) in the scientific fields concerning the conservation of nature and protection of the national heritage. The *Institute for the Conservation of Monuments and Building* Research of the Zurich Federal Institute of Technology (www.idb.arch.ethz.ch) is devoted to the specific issues of the care and protection of monuments.

Numerous *Universities of Applied Sciences* (the Eastern Switzerland, North West Switzerland, Zurich and Bern Universities of Applies Science, the Hautes écoles spécialisée de Suisse occidentale in western Switzerland, the Italian-speaking Scuola universitaria professionale della Svizzera italiana, www.bbt.admin.ch/fachhoch/e/index.htm) also offer courses, post graduate and further education courses in most of the fields concerning cultural and natural heritage.

The *Abbegg-Stiftung Riggisberg* (www.abegg-stiftung.ch), the *Hochschule der Künste Bern* HKB (www.hkb.bfh.ch), the *Haute école d'arts appliqués* HEAA-Arc in La Chaux-de-Fonds and the *Scuola universitaria professionale della svizzera italiana* SUPSI in Lugano provide training as restorers and conservers (Master/Bachelor of Arts AUS in Conservation-Restoration) in the various specialist fields (textiles, architecture and interior design, painting and sculpture, graphic design, written material and photography, modern materials and media, archaeology, ethnography, scientific objects, architectonic surfaces). Further, the Federal Office of Culture grants annual scholarships for

further training at the *Centro Europeo di Venezia per i mestieri della conservazione del patrimonio architettonico* in San Servolo.
The dual system for on-the-job occupational training customary in Switzerland offers numerous opportunities for learning the crafts and craftsmanship demanded in the conservation of cultural heritage.
Thanks to the recognised high standard of education and training, Swiss professionals have access to many further training opportunities abroad (for example the ICCROM courses) www.iccrom.org.

Tirano (Italy)

Several authorities, at various political levels are responsible for the Italian part of the property: The administration of the *Provincia di Sondrio* (www.provincia.so.it), the *Municipality of Tirano* (www.comune.tirano.so.it) and, specifically for the architectural and cultural heritage, the *Direzione regionale per i beni culturali e paesaggistici della lombardia* (www.lombardia.beniculturali.it). All these authorities have the necessary experts available, in various scientific fields, for the conservation of the site. The *Ufficio Lista patrimonio mondiale UNESCO* in the *Ministero per i beni e le attività culturali* (www.benicultuali.it) deals with all questions concerning the Italian World Heritage Sites at national level, and oversees the management of the sites.
The association founded for the management of the sites, the "UNESCO World Heritage Rhaetian Railway in the Albula/Bernina Cultural Landscape Association" (cf. 5.e), in which all the parties involved will be represented, assures the transnational transfer of know-how and, further to the existing protection mechanisms of both states, also guarantees the appropriate preservation of the cultural property.
As in Switzerland, training and continuous training in the field of natural and cultural heritage is assured by numerous university and other institution courses at the highest level.

Albula line > Rhaetian Railway train on the Albula Viaduct I.
A. Badrutt / Rhaetian Railway

5.h Visitor facilities and statistics

The Rhaetian Railway's Albula and Bernina lines carry almost 2 million passengers per year. The buffer zone of the property contains facilities offering the equivalent of 2.5 million overnight stays per year, provided by 150 hotels with around 11,850 beds and about the same number in the self-catering sector. Several documentation outlets in the area provide visitors to the heritage site with information on the Rhaetian Railway and the surrounding cultural landscape, and additional information centres are currently being planned. One example is the railway museum in Bergün / Bravuogn, that is still at the planning stage.

Railway infrastructure and statistics

The railway infrastructure immediately related to the World Heritage site focuses on the Albula /Bernina line peak seating capacity. According to the current timetable some 13,000 seats per day are available on the Albula section, whilst the Bernina section offers some 5,000 seats per day in winter and 8,000 in summer. The figures quoted apply to services operating at full capacity, although in practice the actual levels of utilisation vary with the time of day and are also subject to strong seasonal fluctuations. The passenger-carrying capacity is also dependent on the amount of freight transported by the trains providing the passenger services. In 2005, the Rhaetian Railway carried the following numbers of passengers on the Albula and Bernina sections:

Chur – St. Moritz section

Departing from Chur	680,000 passengers
Arriving at St. Moritz	430,000 passengers
Departing from St. Moritz	355,000 passengers
Arriving at Chur	640,000 passengers

St. Moritz – Tirano section

Departing from St. Moritz	320,000 passengers
Arriving at Tirano	190,000 passengers
Departing from Tirano	205,000 passengers
Arriving at St. Moritz	320,000 passengers

In the same year, some 17,000 passenger trains ran on the Albula section and some 11,000 on the Bernina section. All new wagons purchased under the Rhaetian Railway's current rolling stock acquisition programme will comply with the requirements of the Equal Opportunities for the Disabled law and will be equipped with modern passenger information systems.

At present the railway stations within the nominated property at Thusis, Tiefencastel, Filisur, Bergün/Bravuogn, Samedan, St. Moritz, Pontresina, Poschiavo, Campocologno and Tirano are fully staffed, either by the Rhaetian Railway or by subcontractors. The personnel at these stations are able to provide visitors with information on the Albula and Bernina railway lines and on the cultural landscape. The stations also have a range of informative material on the lines. Should the Albula/Bernina Lines be accepted for inclusion in the list of World Heritage Sites, the

Rhaetian Railway plans, in cooperation with the local authorities, to make additional information available to the general public at a number of the stations; this material would cover the Albula/Bernina lines, the cultural landscape surrounding them and the UNESCO World Heritage Site. There are also plans to set up a UNESCO information centre in the planned railway museum in Bergün/Bravuogn, directly next to the Rhaetian Railway's main station building.

The Rhaetian Railway runs through the cultural landscape of the Albula/Bernina area, a popular destination for day trips. Should the property be included in the list of World Heritage Sites the popularity of the area will probably be accentuated, with starting points at the medium and larger-sized centres such as Davos, Scuol, Lenzerheide, Savognin, Chur, Flims, Laax and Tirano. Public transport services and the extensive networks of hiking and biking trails have opened up the area, providing ideal conditions for encouraging visitors to dispense with the use of cars. Combined tickets offered by the Swiss Federal Railways the Rhaetian Railway and the Italian Railways could also meet with interest. Even if there is a wider range of opportunities and attractions for discovering the cultural landscape in summer, should the nomination for listing as a World Heritage Site be successful, the demand for railway trips through the area during the winter season is also likely to grow.

Tourist infrastructure and key figures

The Canton Graubünden is one of the major holiday regions in Switzerland. The region has a total of 830 hotels with 48,000 beds plus a further 125,000 offered by the self-catering sector. Together these generate a total of 11 million potential overnight stays, of which 4.5 million are during the summer season. With the exception of the Upper Engadin, the main tourist activity in the canton takes place largely outside the perimeter of the World Heritage Site. While tourism in the Albula valley and in the Val Poschiavo does indeed play an important part for both areas, in terms of numbers, it does not make a major contribution at cantonal level. The largest localities in these valleys – Bergün/Bravuogn and Poschiavo – typically record annual visitor figures of a mere 30,000 and 52,000 hotel overnight stays respectively (by comparison, the number of overnight stays per year in hotels in Davos is greater than 800,000). Altogether the number of overnight stays in hotels in the potential heritage site is around 1.5 million per year with a similar number of overnight stays recorded for the self-catering sector.

The hotel capacity in the Albula and the Poschiavo Valleys amounts to 1,547 beds, provided by 55 different businesses. In addition, about the same number of beds are available in self-catering apartments. There are almost 60 restaurants in the same area, with seating for some 4,900 guests. The localities in the Upper Engadin affected by the nomination as a World Heritage Site contain 100 hotels with some 10,000 beds together with 145 restaurants with seating for around 14,000 guests. Five camping sites are also located within the primary buffer zone.

Tourism in the province of Sondrio focuses on Livignio, Bromio, Aprica, Val Malenco, Madesimo and Teglio, but plays only a minor role in Tirano. The town has 292 hotel beds and recorded 29,000 overnight stays in 2005. Its 27 restaurants can accommodate 2,400 guests.

Museums and other sources of information

A number of informative and educational attractions and services are located within the perimeter (core and buffer zones) of the proposed World

Heritage Site. Extensive parts of the Mittelbünden (central Graubünden) region, including the Albula valley, are situated within a regional nature park (the Parc Ela). The park offers interconnected tourist services and features, each related to specific themes. The various themes include the Railway History Education Trail between Preda and Bergün/Bravuogn, which passes very close to the engineering structures of the Rhaetian Railway. The trail is almost 8 km long and involves a change in altitude of 400 m. Illustrated info boards erected at special points of interest provide details of the construction and alignment of the railway line, whilst timetables tell visitors the time when the next train will be passing. As part of the 'Albula Railway Experience' project – the heart of which is the planned Railway Museum in Bergün / Bravuogn – there are plans to extend the railway education trail as a railway adventure trail as far as Tiefencastel; the new trail section will cover the historic railway corridor between Stugl/Stuls and Bergün/Bravuogn, the former Bellaluna mining centre (today a cultural centre), and Filisur. The Filisur Nature Education Trail – a high altitude trail between Filisur and Wiesen – has illustrated info boards which provide information on the local flora, fauna and geology. Another resource within the perimeter of the World Heritage site which is connected with the Parc Ela is the "ansaina" waterway.

The international prize-winning 'On the track of climatic change' educational adventure trail runs between Muottas Muragl and Alp Languard (in the Upper Engadin). The trail aims to accentuate awareness of the global-warming induced natural phenomena in the Alps. Besides addressing the question of the rapid warming of the climate, the adventure trail also provides information on the causes and global consequences of the greenhouse effect. The info boards show examples of different approaches to solving the problems and possible ways of dealing with them. The climate trail project was developed by WWF Switzerland in cooperation with the Engadin Nature Research Society. The valley station of the Lagalb cableway is the starting point for a mining history education trail whose eight stopping points lead the visitor over the Bernina Pass to the Camino mine tunnels, the only tunnels which are still accessible. The trail also leads over the Fuorcla Minor, crossing the two mining areas and passing the Fuorn d'Plattas ore smelting plant, which dates back to 1458. The trail provides information on the history of mining activities in the area from the 13th to the 16th centuries, on the history of the mine tunnels and on the type of rock in this area (pyrite – arsenopyrite). The 'Protecting People and the Forest' education trail runs between Alp Grüm and Poschiavo. The trail illustrates the links between the protective engineering measures and the important protective function that mountain forests provide with respect to settlements, railways and people. The 'Environmentally-friendly Electricity' education trail from Lago Bianco (Ospizio Bernina) to Cavaglia illustrates the history of the electrification of the Rhaetian Railway and Val Poschiavo, the requirements needed for the ecologically-friendly generation of electricity and also the geology and biology of the high Alpine valley. Seven moulins can be viewed in the Cavaglia area, at a height of 1700 m above sea level.

The AlpenAcademie (alpine academy) in the Engadin was established quite recently; it is supported by the Academia Engiadina in Samedan. As part of its GeoParc and Cultur Engadin educational courses, in lectures and guided tours the Academy introduces visitors to the attractions that the Engadin has to offer in the fields of cul-

ture and natural sciences.
There are numerous museums in the property. Thusis, the starting point of the Albula line, is also the starting point of the Viamala EcoMuseum, run by the Association for the Cultural Area of the Viamala; the purpose of this museum is to preserve the valuable cultural area around the impressive natural monument of the Viamala Gorge and to use it for tourism at a sustainable level. The district museum (Fundaziun Museum) in Bergün/Bravuogn offers an insight into daily life in an Engadin house – a type of farmhouse which is unique in the Alps (cf. 2.a.6); the former working part of the house contains a 1:87-scale model railway showing the line between Bergün/Bravuogn and Preda on the Albula line. In Bergün/Bravuogn, work is presently in hand on the development and construction of the Albula railway museum. Here, the former arsenal next to the Rhaetian Railway main station building is being converted for this purpose.
In Samedan, the Chesa Planta museum of daily life offers the opportunity to visit one of the most important stately homes in the region. The museum provides an insight into the way of life of nobility in Graubünden during the 17th and 18th centuries (cf. 2.a.6). The Chesa Planta houses the offices of the cultural archives of the Upper Engadin and also what is probably the most important library of Rhaeto Romansh literature in the world. The Bob Museum in Celerina illustrates the history of the sport of bobsledding since 1900 and provides an understanding of an important aspect of the history of tourism in the Upper Engadin. There are several museums in St. Moritz including the Museum Engiadinais that dates from 1906. This museum provides an important record of the national heritage protection movement which grew up across Europe around 1900 (cf. 2.a.4) and is also a forerunner of the many local customs and crafts museums which were set up after the Second World War. The Museum Engiadinais has exquisite interiors, high quality furniture spanning six centuries and a large number of other exhibits; it is one of the most representative museums in terms of local customs and traditions. The building itself, designed by the architect Niklaus Hartmann the Younger, was one of the first in the canton to be built in the 'Heimat' style (cf. 2.a.5). The Segantini Museum, which was designed by the same architect, was opened in 1908. The museum building, constructed in the form of a rotunda, was based on a preliminary draft by the renowned artist Giovanni Segantini (1858–1899) for an Engadin Panorama planned for the Paris World Fair of 1900 (cf. 2.b.9). Amongst other exhibits, the museum houses the artist's famous Alpine Triptych. Segantini spent the last five years of his life in the Engadin. The hundred year old Villa Arona in the centre of St. Moritz houses the Berry Museum, dedicated to the spa physician and painter Peter Robert Berry (1864–1942), who based his artistic work strongly on Segantini's style of painting. The Mili Weber House is the home of the Mili Weber Foundation. The house was built in 1917 for the artist of the same name (1891–1978), who also designed and decorated interior. The location of the house, on the wooded mountainside, above the eastern end of the lake is idyllic. The Museum Alpin in Pontresina, located in an Engadin house dating from 1716, hosts a permanent exhibition which covers many themes; these include the traditional Engadin house, the development of summer and winter tourism, mining in the Upper Engadin, minerals to be found in the region, hunting, game and the environment. The Palazzo de Bassus-Mengotti in Poschiavo, the most significant stately home in the Poschiavo Valley, contains a regional mu-

seum (Museo Poschiavino) which focuses on the lifestyle and way of life in the Val Poschiavo over the past 300 years. There are plans to move the museum's collection of 'farming tradition' items in the near future to the Casa Tomé, one of the last, largely unchanged farmhouses in the village. The Casa Console Museum of Romantic Art in Poschiavo displays the paintings collected by the former publisher Ernesto Conrad. The collection includes works from the 19th century (mainly of the Munich school), with works by Wilhlem Kaulbach, Franz von Lenbach, Carl Spitzweg, Franz von Stuck and also by renowned Swiss painters such as Ferdinand Hodler, Louis-Auguste Veillon and Heinrich Füssli. The Museo Casa Besta in Brusio is located in an aristocratic house dating from the 17th century. The museum provides information on tobacco-growing, smuggling, milk production and shoe-making in the valley. In Tirano, the Museo Ethnographico Tiranese, on the Piazza della Bailica documents the history of the town. The museum houses a wealth of artefacts from the region.
Besides the education trails and museums the nominated heritage site also includes a large number of valuable sacred and secular buildings. These and several other places of interest which are open to the public can be reached by the Rhaetian Railway. Guided tours are frequently available.

Albula line > The Glacier Express on the Landwasser Viaduct.
A. Badrutt / Rhaetian Railway

5.i Policies and programmes related to the presentation and promotion of the property

There is already a range of information offers on the nominated property. Further presentation and promotional offers are in preparation. A comprehensive documentation system is at the planning stage.

Visitors to the property can already read various information pamphlets on the Rhaetian Railway and the surrounding cultural landscape (cf. 5.h).

Numerous measures and publications within the scope of the candidature have drawn the attention of the general public and visitors to the values of the UNESCO World Heritage in general as well as to the cultural-historic importance of the railway. They are being further developed on a continuous basis. If the site is entered on the World Heritage List, the information activities could be oriented in a more direct way to the UNESCO World Heritage. Thus a major information and implementation concept is currently being prepared as part of a promotional programme ("Regio Plus" Project) financed by the Swiss federation, the Canton Graubünden and the Rhaetian Railway. This project aims to communicate the values of the UNESCO World Heritage and the Rhaetian Railway in the Albula/Bernina Cultural Landscape to various target groups (population, rail passengers, holiday visitors, school classes) effectively and sustainably. The awareness for cultural and landscape values will be backed up by specific local information measures and the objectives of the UNESCO World Heritage will be made accessible to a broader public. Aspects such as culture, nature and daily use should be addressed in addition to the UNESCO World Heritage and the Albula and Bernina line.

> Schools and universities – The complete candidature dossier was submitted to UNESCO in Paris by two classes of school children from the Puschlav. The topics of the World Heritage and UNESCO had previously been covered in class. The aim of this Swiss initiative was to launch a pilot project on covering this subject in schools as well as to underline the key part played by young people in safeguarding our cultural heritage. The initiative was a resounding success and met with wide interest throughout the region. The Paris trip was accompanied by a blog brought it to the attention of a large part of the population.

> Several diploma assignments dealing with the World Heritage candidature are currently being prepared at the HTW University of Applied Sciences in Chur as a direct outcome of this widespread interest. Members of the Association are assisting the students with information and explanations.

> Informing the public – The public are informed regularly via newsletters printed in five languages (German, English, French, Italian and Romansh). These comment on the current progress of the candidature and present certain topics within its context.

> The candidature web site (www.rhb-unesco.ch) includes an interactive flash map: a pop-up

description of major engineering structures, monuments and features of the landscape can be obtained by clicking the object on a map. It allows numerous visitors to the website to appreciate the high density of valuable cultural and historic features. The web site is available in five languages.

> The general public is kept up-to-date on the candidature and background aspects via media reports and press conferences. Numerous articles in all the major print media and on television ensure a broad flow of information about the UNESCO World Heritage and maintain its topicality. The PR Department of the Rhaetian Railway informs numerous national and international journalists by means of media trips and other initiatives on the progress of the candidature as well as on the objectives of the UNESCO World Heritage.

> During a trip on the Bernina Express, brief informative texts on the cultural-historic features are relayed over the public address system in several languages. Passengers are thus informed direct about the cultural value of the site and about UNESCO.

> A locomotive and a railcar of the Rhaetian Railway have been decorated with the "UNESCO World Heritage Candidature" logo. The passing trains continuously remind rail passengers and people living along the railway of UNESCO. Banners at all the railway stations in the core zone draw attention to the current candidature.

> Numerous information brochures and special offers run by the Rhaetian Railway (such as special historic trips or the opportunity to book a ride in the driver's cab on the Albula/Bernina line) enhance the awareness of visitors and passengers for the UNESCO World Heritage.

> The *Bündner Monatsblatt*, a magazine with a cultural-historical focus, will publish a special issue on the Albula/Bernina line in 2008. Several guides are also planned by the GSK, Society for the History of Art in Switzerland, on objects of cultural and historic value in the region.

Further initiatives to present and promote the World Heritage Site are planned. If the Rhaetian Railway in the Albula/Bernina Cultural Landscape is accepted for the UNESCO World Heritage list it will become a central theme permanent exhibition at the planned railway museum in Bergün/Bravuogn (cf. 5.h). Moreover, the existing documentation on the various topics will be coordinated and streamlined to heighten its PR impact. Public awareness of the cultural and landscape value of the nominated asset should be reinforced to heighten popular responsiveness to the need for its maintenance and promotion. In general, cooperation between representatives of the tourist industry, cultural bodies, spatial planers and the Rhaetian Railway will be intensified by placing the railway on the UNESCO World Heritage List. The development of such concepts and the promotion of inter-institutional cooperation is another element of the "Regio Plus" promotional programme currently in preparation by the Association for the UNESCO World Heritage Rhaetian Railway in the Albula/Bernina Cultural Landscape .
This Association (cf. 5 e) will also create a documentation system in conjunction with the Rhaetian Railway and the communities in the nominated area with the objective of identifying and, where possible, providing access to the available material. Existing databases will be interlinked to allow information on the World Heritage Site to be disseminated as efficiently as possible.

5.j Staffing levels (specialist, technology and maintenance staff)

Various organisations, with a large number of highly qualified specialists, ensure that the Albula/Bernina line and its environs maintains its World Heritage quality standard long-term.

The Rhaetian Railway alone, which as owner is responsible for the infrastructure and operation of the Albula/Bernina stretch, has a staff of some 1,500 including, among other professions: agricultural machinery mechanic, architect, automation technician, car mechanic, carpenter, carriage cleaner, catenary wire fitter, civil engineer, civil engineering draughtsman/woman, clerical workers, construction engineering draughtsman/woman, computer specialist, construction engineer, depot assistant, development engineer, economist, electrician, electrical assistant, electrical draughtsman/woman, electrical engineer, electronics technician, electromechanical engineer, engine driver, engine fitter, engineering draughtsman/woman, engine shed foreman, general mechanic, lawyer, locksmith, logistics assistant, machine fitter, machine mechanic, machinery fitter, mechanic, operating assistant, painter, plumber, precision mechanic, railway traffic controller, saddler, smith, secretary, track engineer, technical draughtsman/woman, ticket collector, turner, upholsterer, warehouseman/woman, workshop assistant.
In the cultural landscape sector as well, the project can draw on the expertise of Canton Graubünden and the Province Sondrio departments and administrative offices engaged in the sustainable management of the cultural landscape (cf. 5.g). The staff of these offices include the following specialists: architect, agronomist, biologist, chemist, forestry engineer, geographer, geologist, lawyer, cultural engineer, art historian, economist and physicist.
Besides the Rhaetian Railway and the public administration, the personnel of the 23 communities involved will contribute to ensuring that the authenticity and integrity of the nominated property is sustained. There are several local and regional tourist offices in the nominated area, all run by qualified professionals, to provide information to tourists and to raise awareness.

6. Monitoring

Bernina line > Clearing snow on the Bernina Pass.
P. Donatsch / Rhaetian Railway

6.a Key indicators for measuring state of conservation

The condition of the railway and the cultural landscape (cf. 4.a), together with the various influencing factors (cf. 4.b), form the basis for selecting the key indicators to assess the condition of the nominated asset. The influencing factors are particularly important for the cultural landscape.

Indicators for assessing the condition of the railway

The key indicators for appraising the condition of the railway infrastructure are based on the inventories and appraisals, completed or in progress, and their findings (cf. 4.a). The measures are determined according to the findings and set out in a several-year plan; the Business and Investment Plans are adapted appropriately. The condition analyses are regularly updated. Beyond this, developments on the Albula and Bernina lines are followed up as an integral element of the monitoring process; the development log is based on surveys of passenger transport frequency and records of the freight volumes transported.

Table of indicators

Theme / Target Value	Indicator	Source	Periodicity
Protection and conservation of engineering structures	Up-to-date rehabilitation of the - Bridges - Tunnels - Protective structures - Revetment walls	Rhaetian Railway condition reports	Every 10 years
Protection and conservation of buildings	Up-to-date rehabilitation of the - Stations	Rhaetian Railway condition reports	Every 10 years
Protection and conservation of railtrack infrastructure	Up-to-date rehabilitation of the - Track - Electro-technical installations - Catenaries	Rhaetian Railway condition reports	Every 10 years
Passenger frequencies	Number of passengers transported on the Albula and Bernina lines	Rhaetian Railway frequency surveys	Annually
Freight carried	Freight transported on the Albula and Bernina lines in tonnes	Rhaetian Railway freight statistics	Annually

Indicators for assessing the condition of the cultural landscape

Natural features and topographic criteria, rather than territorial aspects, are decisive for the demarcation of the World Heritage perimeter. Most of the cultural landscape indicators listed below cannot therefore be unequivocally restricted to the nominated asset, as the assessment is conducted at community and, in Switzerland, sometimes at cantonal level. This is best illustrated by a few examples: the farmed area of a single agricultural unit may cover both part of the World Heritage area and land beyond it. Ecological networking concepts are determined by the community and consequently apply to the community land as a whole, which may comprise areas that are not part of the World Heritage area. Further, it is to be expected that certain communities will merge in the next few years; the size of the areas covered by community-level surveys may therefore change as such mergers also abolish the old territorial borders. In these cases, the indicators for the entire community territory are adopted and qualitative considerations on their concrete significance for the effective World Heritage property added.

Table of indicators

Theme / Target Value	Indicator	Source	Periodicity
Spatial development			
Population in the World Heritage area	Number of inhabitants per community (core and buffer zones)	- Federal Office of Statistics, Population Census ESPOP - Centro per l'impiego di Tirano	Annually
Number employed in the 2nd and 3rd sectors within the World Heritage area	Number employed per community	- Federal Office of Statistics, Business Census - Centro per l'impiego di Tirano	Every 4 years
Commuter situation	Incoming commuter communities Outgoing commuter communities Number of incoming/outgoing commuters as a % of the workforce	- Population Census - Centro per l'impiego di Tirano	Every 10 years
Ratio of residents, jobs and tourism per community	Inhabitant reference value (inhabitants + employed + ½ hotel beds + ²/₃ beds in self-catering)	- Federal Office of Statistics, Business Census - Ufficio informazioni turistiche di Tirano	Every 4 years
Settlements			
Size of building zone	Changes in size of building zones according to categories and communities	- Office for Spatial Development - Comune di Tirano	As required
Number of homes	New builds/homes	- Federal Office of Statistics, Building statistics - Comune di Tirano	Annually
Ratio 1st homes / 2nd homes	Proportion of second homes by community	- Federal Office of Statistics, Homes statistics - Comune di Tirano	Every 10 years
Building activity			
Investments in building	Investments in buildings and public works by community	-Federal Office of Statistics, Building statistics - Comune di Tirano	Annually
Building inside the building zone	Number of building permits issued by community	- Federal Office of Statistics, Communities - Comune di Tirano	Annually
Building outside the building zone	Number of building permits issued by community	- Office for Spatial Development - Comune di Tirano	As required

Theme / Target Value	Indicator	Source	Periodicity
Tourism			
Beds and overnight stays	Number of beds and overnight stays in hotels and self-catering units by communities	- Federal Office for Statistics, Office for Economy and Tourism - Ufficio informazioni turistiche di Tirano	Annually
Employed in tourism	Percentage proportion of those in tourism to total number employed (2nd and 3rd sectors)	- Federal Office of Statistics, Business Census - Ufficio informazioni turistiche di Tirano	Every 4 years
Agriculture			
Area under agriculture	Agricultural area as a % of total area (without Alpine meadows)	- Federal Office of Statistics, Area Statistics - Provincia di Sondrio	Every 12 years
Management of cultural landscape	Number of farm units Number employed in agriculture	- Federal Office of Statistics, Agricultural unit Census - Provincia di Sondrio	Every 4 years
Melioration projects, structural improvement measures	Total expenditure	- Office for Agriculture and Geo-information - Provincia di Sondrio	As required
Creating favourable conditions	Number of relocations Sum of contributions to building animal sheds	- Office for Agriculture and Geo-information - Provincia di Sondrio	As required
Ecological aspects of the cultural landscape	Communities with ecological networking concepts	- Office for Nature and the Environment/ Office for Agriculture and Geo-information - Provincia di Sondrio	As required
Forestry			
Forested area	Forested area as a % of total area	- Federal Office of Statistics, Area Statistics - Provincia di Sondrio	Every 12 years
Timber utilisation	Volume of timber felled	- Federal Office of Statistics, Forestry Statistics - Provincia di Sondrio	Annually
Protective measures			
Area in the protected landscape zone, in core and buffer zones in the Structure and Land-Use Plans	Protected landscape area as a % of the core and buffer zones	- Office for Spatial Development - Provincia di Sondrio	As required
Number and area of nature reserves in the core and buffer zones in the Structure and Land-Use Plans	Nature reserves as a % of the core and buffer zones	- Office for Spatial Development - Provincia di Sondrio	As required
Protection of cultural assets	Number of protected cultural assets in the community planning	- Office for Spatial Development - Provincia di Sondrio	As required
Protection of local character	Type and cost of protective measure	- Office for Culture , Conservation of Monuments Section - Provincia di Sondrio	As required
Natural risks			
Natural risks, frequency	Number and type of occurrences in the core and buffer zone	- Office for Forestry, Damage Cadastre - Provincia di Sondrio	As required
Natural risks, costs for safety measures	Type and costs of protective measures to ensure safety of the World Heritage	- Office for Forestry /Rhaetian Railway - Provincia di Sondrio	As required
Natural risks, damages caused	Cost of damages within the perimeter of the core and buffer zones	- Property Insurance Institute/ Rhaetian Railway - Provincia di Sondrio	As required

Bernina line > On the Bernina Pass.
T. Keller / Rhaetian Railway

6.b Administrative arrangements for monitoring property

The sponsor association is responsible for the coordination of monitoring, which is carried out by specialised institutions and authorities. The association's panels of experts "Railway" and "Cultural Landscape" provide professional backup.

The purpose of the sponsor association "UNESCO World Heritage Rhaetian Railway in the Albula / Bernina Cultural Landscape" (cf. 5.e) is the conservation and sustainable utilisation of the site. Responsibility for the coordination of monitoring lies with the association, which has two panels of experts – one for the railway and the other for the cultural landscape – to ensure that monitoring is performed on a continuous basis. The members of the panels are drawn from the relevant professional fields. Monitoring will probably be carried out by specialised institutions and authorities such as the Canton Graubünden Office of Culture's Care of Historic Monuments Section or the Canton Graubünden Office of Spatial Development.

The association's address is:
UNESCO World Heritage
Rhaetian Railway in the Albula/Bernina
Cultural Landscape Association
c/o Rhaetian Railway
Bahnhofstrasse 25
CH-7002 Chur
Tel: +41 (0)81 288 63 66
E-mail: unesco@rhb.ch

Albula line > Before reaching Celerina.
T. Keller

6.c Results of previous reporting exercises

There are no independent international expert opinions on the condition of the railway and the cultural landscape; however, there have been a few studies focusing on specific aspects.

Expert opinions on the condition of the railway

To date there have been no independent international expert opinions on the condition of the railway. Between 2003 and 2004, the Rhaetian Railway conducted the first-ever systematic review and evaluation of bridges and viaducts within the World Heritage perimeter (Rhätische Bahn: *Zustand Kunstbauten [Brücken]; Albulaline [Thusis – St. Moritz], Berninaline [St. Moritz – Campocologno], Oberengadin [Samedan – Pontresina]*, Chur 17th January 2006). For the tunnels as well, the work started in 2005 was completed recently (Rhätische Bahn: *Zustand Kunstbauten [Tunnels]*, Chur 6th October 2006). Both reports are appended to the candidature documentation (“Annex” File) in electronic form. It is currently drawing up an inventory and assessing the condition of galleries, revetment walls and track for the entire rail network. The surveys are expected to be completed by the beginning of 2007 (cf. 4.a.1).

Expert opinions on the condition of the cultural landscape

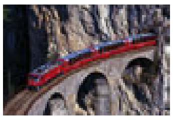
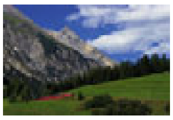
Similarly, there have been no international-focus studies on the condition of the Albula/Bernina cultural landscape. In 1999, however, a landscape typology assessment was carried out for the central and upper Albula valley (Tiefencastel to Bergün/Bravuogn) as part of a degree assignment for the University College of Rapperswil. The study also defined objectives for the overall appearance of the landscape, as well as for types and biotopes. A detailed landscape development concept was compiled for the community of Alvaneu, covering landscape appearance, types and biotopes, farming, forestry and tourism (Marie-Louise Kieffer, Alain Brugger, Matthias Merki, *Landschaftsentwicklungskonzept Alvaneu*, Diplomarbeit im Fach Landschaftsplanung, Hochschule Rapperswil October – December 1999).

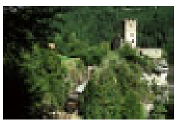
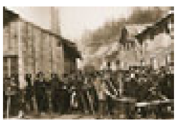
7. Documentation

Albula line > The Classic Alpine Pullman Express below Schmitten.
P. Donatsch / Rhaetian Railway

7.a Photographs, slides, image inventory and authorization table and other audiovisual materials

The images listed below are included with the candidature documentation: they are appended to the "Annex" File both in electronic form and as slides and may be re-used by UNESCO. The Rhaetian Railway holds the rights to all images made available (Rhätische Bahn, Bahnhofstr. 25, CH-7002 Chur, Tel. +41 (0)81 288 63 66, E-mail: unesco@rhb.ch). The exclusive cession of rights for all the images on the list is accepted. However, the holder of the rights should be informed of any utilisation of the images.

	No.	Format	Title	Date	Photographer	Copyright & Contact	Non-exclusive cession of rights
	1-3-34	Slide: 24 x 36 mm Digital, JPG: 1800 x 2700 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape The Landwasser Viaduct	2005	P. Donatsch	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-3-39	Slide: 24 x 36 mm Digital, JPG: 2800 x 1900 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape The «Bernina Express» at Alp Grüm	2005	P. Donatsch	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-3-46	Slide: 24 x 36 mm Digital, JPG: 2500 x 1900 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape «Montebello Curve», in the background the Morteratsch glacier and Piz Bernina	2005	P. Donatsch	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-3-67	Slide: 24 x 36 mm Digital, JPG: 3000 x 2000 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape Train above Bergün/Bravuogn in the Albula Valley	2005	P. Donatsch	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-3-61	Slide: 24 x 36 mm Digital, JPG: 2700 x 1800 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape On the Bernina Pass	2005	P. Donatsch	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-3-70	Slide: 24 x 36 mm Digital, JPG: 5400 x 3600 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape The "Bernina Express" crossing the square in front of the Madonna di Tirano pilgrim church	2005	P. Donatsch	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-3-73	Slide: 24 x 36 mm Digital, JPG: 3800 x 2500 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape The Circular Viaduct at Brusio	2005	P. Donatsch	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-3-75	Slide: 24 x 36 mm Digital, JPG: 5300 x 3500 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape The Circular Viaduct at Brusio	2005	P. Donatsch	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-3-81	Slide: 24 x 36 mm Digital, JPG: 2600 x 2800 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape On the Bernina Pass	2005	P. Donatsch	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes

	No.	Format	Title	Date	Photographer	Copyright & Contact	Non-exclusive cession of rights
	1-3-82	Slide: 24 x 36 mm Digital, JPG: 2500 x 1600 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape The Solis Viaduct	1997	T. Keller	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-3-90	Slide: 24 x 36 mm Digital, JPG: 3700 x 2500 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape On the Lago Bianco (Bernina Pass)	1997	T. Keller	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-3-91	Slide: 24 x 36 mm Digital, JPG: 3070 x 3070 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape Transporting timber from the Engadin to Italy	2005	A. Hänkel	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-5-79	Slide: 24 x 36 mm Digital, JPG: 4900 x 3300 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape The Landwasser Viaduct	2006	A. Badrutt	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-5-80	Slide: 24 x 36 mm Digital, JPG: 3500 x 2300 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape The Landwasser Viaduct	2006	A. Badrutt	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-5-82	Slide: 24 x 36 mm Digital, JPG: 3500 x 2300 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape «Glacier Express» at Preda	2006	A. Badrutt	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	1-5-90	Slide: 24 x 36 mm Digital, JPG: 3200 x 3300 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape Between Bergün/Bravuogn and Preda in the Albula Valley	1997	Foto Geiger	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	3-4-14	Slide: 24 x 36 mm Digital, JPG: 2000 x 3100 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape Train drawn by a "Crocodile" locomotive below the Campi fort at Sils i.D.	2005	B. Studer	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	6-4-8	Slide: 24 x 36 mm Digital, JPG: 1500 x 1100 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape Construction team in front of the north portal of the Albula Tunnel	1902	Unknown	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	6-4-12	Slide: 24 x 36 mm Digital, JPG: 1600 x 2200 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape Construction of the Solis Viaduct	1901	Unknown	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes
	6-4-13	Slide: 24 x 36 mm Digital, JPG: 1600 x 1300 ppi	Rhaetian Railway in the Albula/Bernina Cultural Landscape Construction of the Landwasser Viaduct	1902	Unknown	Rhätische Bahn Bahnhofstrasse 25 CH-7002 Chur Tel: +41 (0)81 288 63 66 E-mail: unesco@rhb.ch	Yes

7.b Texts relating to protective designation, copies of property management plans or documented management systems and extracts of other plans relevant to the property

List of protective legislation

Graubünden (Switzerland)

Protective legislation at federal level

All the protective provisions listed below are included with the candidature documentation: they are appended, in the languages German, French and Italian to the "Annex" File in electronic form.

> Agreement of 23 November 1972 on the protection of the world cultural and natural heritage (SR 0.451.41).

> Haag Convention of 14 May 1954 for the protection of cultural assets in the event of armed conflict (SR 0.520.3).

> Federal law of 1 July 1966 on the protection of nature and the environment (NHG; SR 451).

> Decree of 16 January 1991 on the protection of nature and the national heritage (NHV; SR 451.1).

> Decree of 10 August 1977 on the federal inventory of landscapes and natural monuments (VBLN; SR 451.11).

> Decree of 9 September 1981 on the federal inventory of architectural heritage in Switzerland worthy of protection (VISOS; SR 451.12).

> Decree of 28 October 1982 on the protection of riverside wetlands of national importance (Wetlands decree; SR 451.31).

> Decree of 21 January 1991 on the protection of raised and transition bog lands of national importance (Raised bogs decree; SR 451.32).

> Decree of 7 September 1994 on the protection of flat bogs of national importance (Flat bogs decree; SR 451.33).

> Decree of 15 June 2001 on the protection of amphibian spawning grounds of national importance (Amphibian spawning grounds decree; AlgV, SR 451.34).

> Decree of 1 May 1996 on the protection of moor landscapes of outstanding beauty and national importance (Moor and wetland landscapes decree; SR 451.35).

> Federal law of 22 June 1979 on spatial planning (RPG; SR 700).

> Spatial planning decree of 28 June 2000 (RPV; SR 700.1).

> Federal law of 21 June 1991 on the melioration of water courses (SR 721.100).

> Railway law of 20 December 1957 (EBG; SR 742.101).

> Federal law of 24 June 1902 on electrical light and heavy power installations (EleG; SR 734.0).

> Decree of 8 November 1978 on licensing of cableways (Cableway licence decree, LKV; SR 743.11).

> Federal law of 7 October 1983 on the protection of the environment (USG; SR 814.01).

> Decree of 19 October 1988 on the environment compatibility test (UVPV; SR 814.011).

> Federal law of 24 January 1991 on protection of waters (Waters protection law, GSchG; SR 814.20).

> Federal law of 29 April 1998 on agriculture (LWG; 910.1).

> Decree of 29 March 2000 on summer alp grazing contributions (SöBV; SR 910.13).

> Decree of 4 April 2001 on the regional promotion of quality and the network of ecological compensation surfaces in agriculture (Eco-quality promotion, ÖQV; SR 910.14).

> Decree of 7 December 1998 on structural improvement in agriculture (Structural improvement decree, SVV; SR 913.1).

> Federal law of 4 October 1991 on forestry (WaG; SR 921.0).

> Federal law on hunting and the protection of mammals and birds in the wild (Hunting law, JSG; SR 922.0).

List of protective legislation at cantonal level

All the cantonal protective provisions listed below are included with the candidature documentation: they are appended, in the languages German and Italian, to the “Annex” File in electronic form.

> Law of 24 October 1965 on the promotion of the protection of nature and national heritage in Canton Graubünden (BR 496.00).

> Decree of 27 November 1946 on the protection of nature and the national heritage (BR 496.100).

> Decree of 2 June 1972 on the protection of the Upper Engadin lake landscape (BR 496.150).

> Spatial planning law of 6 December 2004 for Canton Graubünden (KRG, BR 801.100).

> Spatial planning law of 24 May 2005 for Canton Graubünden (KRVO, BR 801.110).

> Decree of 21 November 2000 on the repurposing of farmsteads and buildings and installations worthy of protection outside building zones (repurposing decree, UVO, BR 801.150).

> Directives of 6 May 1997 on risk zone planning (BR 801.500).

> Introductory law of 2 December 2001 in relation to the protection of the environment law (BR 820.100).

> Cantonal protection of the environment decree of 13 August 2002 (BR 820.110).

> Cantonal decree of 30 April 1991 on the environment compatibility test (KVUVP, BR 820.150).

> Law of 25 September 1994 on the conservation and promotion of agriculture (BR 910.000).

> Agricultural decree of 28 March 2000 (BR 910.050).

> Canton Graubünden melioration law of 5 April 1981 (BR 915.100).

> Cantonal forestry law of 25 June 1995 (KWaG, BR 920.100).

> Cantonal forestry decree of 2 December 1994 (KWaV, BR 920.110).

> Export provisions of 19 December 1995 pursuant to the cantonal forestry law (AbzKWaG, BR 920.120).

Tirano (Italy)

> Decreto legislativo 22 gennaio 2004 n°42.
Code of cultural heritage and environment, article n° 10 of law n° 137 of the 6th of July 2002.

> Legge Regionale 9 giugno 1997 n°18.
Arrangement of competences and simplification of procedures concerning environment heritage conservation and landscape plans.

> Legge Regionale 5 gennaio 2000 n°1, e Delibera della G.R. 7 aprile 2000 n°6/49509.
Promulgation of general lines concerning Lombard territory structure, article n° 3, paragraph 39 of the Regional Law of January, 2000.

> Delibera Giunta Regionale 29 dicembre 1999 n°6/47670.
Criteria concerning contents of landscape and the natural environment of the Territory Plan of Provincial Coordination, Regional law n° 18 of the 9th of June, 1997.

> Piano Territoriale Paesistico Regionale – approvato con delibera del Consiglio Regionale n° VII/197 del 6/3/2001, pubblicato sul B.U.R.L. n°32 del 6 agosto 2001.

> Documento approvato con delibera della G.R. 21 dicembre 2001 n°7/7582.
Integrative document of the general lines on the Lombard territory structure, article n° 3 of the Regional Law n° 1 of the 5th of January 2000.

> Aree assoggettate ai vincoli di cui all'art 1 ter delle L. n. 431/1985 ai sensi della delibera G.R. 4/3859/1985 e dell'art. 17 del Piano del paesaggio lombardo.

> Legge Regionale 12/2005 art. 16.

> Legge Regionale 9 giugno 1997 n°18.
Regulation of competences and simplification of procedures concerning environment heritage conservation and landscape plans.

> Delibera Giunta Regionale 29 dicembre 1999 n°6/47670.
Criteria concerning contents of landscape and the natural environment of the Territory Plan Coordination.

> Legge Regionale 12/2005 comma 4.
Conservation of areas characterized by the presence of vineyard or non-vineyard terracing, as economic, cultural and territorial heritage of extraordinary uniqueness and significance.

> Legge Regionale 27 luglio 1977 n. 33.
Conservation of places of particular local natural interest, certain animal species and their landscape, certain spontaneous species of vegetation, included mushrooms. The law also regulates public and private intervention on those connected goods, in order to guarantee the environment structure, article n° 3 of the Regional Statute.

> D.P.R. 6/06/2001 art. 3 n° 380.
Conservation of the morphological, typological, technological, material and visual aspects concerning buildings of historical and landscape interest.

> Legge Regionale 29 aprile 1980 n. 44.
This law regulates the use of mineral and thermal water, its research and cultivation within the frame of the development regional plan, in order to safeguard regional hydro-mineral goods and emphasize its use.

> Legge Regionale 11 marzo 2005 n°12 e Legge regionale n°41 dell' 24 novembre 1997.
Regulates any transformation or building interventions subordinated to a specific study of geologic and hydro-geologic nature to demonstrate their compatibility.

> Legge 18 maggio 1989 n°183.
The purpose of this law is to ensure the ground conservation, the water renewal, the water heritage conservation and management for any use of rational social and economic development and all the associated environmental aspects.

> Legge 26 Ottobre 1995 n°447.
This law establishes the fundamental principles concerning the safeguard of the external and housing environments from noise pollution, article n°117 of the Constitution.

> Delibera Giunta Regionale 19 ottobre 2001 n°7/6501.
Regulates provincial territory zoning in order to obtain the air quality objectives and to prevent noise pollution.

> Legge regionale n°17/2000 e modifica Legge regionale n°38/2004.
The purpose of this law, as the article n° 3, paragraph n° 3, topics n° 7, 8 and 9 of the Lombardy Statute establishes, is to reduce light pollution and the resulting consumption of energy over the regional territory. The law also regulates the safeguard of the scientific and popular research activity carried out by professional astronomical observers of regional or provincial relevance or by other scientific observers, and the conservation of the ecological balance inside and outside the protected natural areas.

> Legge regionale n°12/1997.
Promotes the localization of hotel accommodation structures as soon as the criteria concerning the placement in a good landscape are respected.

> Decreto Legislativo 4 agosto 1999 n°372.
This decree-law regulates the integrated prevention and reduction of pollution originated by activities; it provides measures meant to avoid or, if not possible, reduce the activities emissions into the air, water and ground, included measures concerning rubbish and measure intended to achieve a high level of environment conservation as a whole.

> Decreto del Presidente della Repubblica 24 maggio 1988 n°203.
This decree-law dictates regulations for the air quality conservation in order to protect health and environment throughout the national territory.

> Decreto Legislativo 1995 n°43.
Conversion into law, with modifications, of the decree-law n° 312 of the 27th of June, 1985, which brings urgent dispositions for the conservation of all the areas of particular environmental interest. Integration of the article n° 82 of the Decree of the President of the Republic n° 616 of the 24th of July, 1977.

> Decreto Legislativo 4 agosto 2002 n°35.
Implementation of the Directive 96/62/EC on the evaluation and management of the environmental air quality.

> Legge del 1939 n°149.
Conservation of natural beauty.

> Legge dell’8 agosto 1985 n°43.
Conversion into law, with modifications, of the Legislative Decree n° 312 of 27th of July, 1985, whith urgent dispositions for the conservation of all the areas of particular environmental interest.

> Legge 6 dicembre 1991 n°34.
Frame law on protected areas.

> D.P.R. dell’8 settembre 1997 n°35
Regulation which brings the implementation of the Directive 92/43/EC concerning the conservation of natural and semi-natural habitat and of wild plants and animals.

Management

The Management Plan is included with the candidature documentation as a separate document ("Management Plan" File).

Planning bases in the nominated area

Switzerland

All the documents listed below are included with the candidature documentation: they are appended to the "Annex" File in electronic form.

> *Cantonal Structure Plan* (RIP 2000) of 19th December 2003 with structure plan map on the scale 1:100,000.

> Structure Plan text for the new subsector "UNESCO World Heritage" (draft).

> Synthesis maps, scale 1:25,000 with detailed protection provisions (3 maps: "North East: Filisur – Lago Bianco", "North West: Thusis – Bergün" and "South: Morteratsch – Tirano").

> District Plan Bever (example of community planning).

Italy

> *Piano regolatore generale del Comune di Tirano* PRG; approved by the Region of Lombardy 13th march 1990.

> *Piano territoriale di Coordinamento della Provincia di Sondrio* PTCP, adopted by the mayors of the Province of Sondrio 9th September 2006 with a view to approval at regional level.

The PTCP and the PRG protection provisions relevant for the property are appended to the "Annex" File in electronic form (Italian).

7.c Form and date of the most recent records or inventory of property

Inventorising the Albula/Bernina line

All the documents listed below are included with the candidature documentation: they are appended to the “Annex” File in electronic form (German).

> CAPREZ, GION: *Berninabahn: St. Moritz – Tirano, 1906 – 1910, Streckenbeschreibung und technikgeschichtliche Wertung*, Chur 2005.

> CAPREZ GION: *Albulabahn: Thusis – St. Moritz, 1899 – 1904, Beschreibung der Linie und Stationen*, Trin 2000.

Other railway registers/reports

All the documents listed below are included with the candidature documentation; they are appended to the “Annex” File in electronic form (German).

> Rhätische Bahn: *Brückenverzeichnis: Linien 13, 14 und 15*, Chur 2003-2004.

> Rhätische Bahn: *Zustand Kunstbauten (Brücken): Albulalinie (Thusis – St Moritz), Berninalinie (St. Moritz – Campocologno), Oberengadin (Samedan – Pontresina),* Chur 17th January 2006.

> Rhätische Bahn: *Zustand Kunstbauten (Tunnels)*, Chur 6th October 2006.

Inventory of Swiss Heritage Sites

The extracts concerning the property, from the inventories listed below, are included with the candidature documentation: they are appended to the “Annex” File in electronic form (German).

> *Inventory of Swiss Heritage Sites* (ISOS).

List of the immovable structural and art monuments

> POESCHEL ERWIN: *Die Kunstdenkmäler des Kantons Graubünden* (Die Kunstdenkmäler der Schweiz), issued by the Gesellschaft für Schweizerische Kunstgeschichte, 7 vols., Basel 1937 – 1948.

> *Kunstführer durch die Schweiz*, vol. 2, issued by the Gesellschaft für Schweizerische Kunstgeschichte, Bern 2005, pp. 39 – 328 (Canton Graubünden).

The extract from the art guide (Kunstführer) is included with the candidature documentation: it is appended, in electronic form, to the “Annex” File (German).

Other documents

> Plans for the renovation and extension of power stations in the upper Poschiavo valley by Rätia Energie AG, Poschiavo 1995.

The plans listed above are included with the candidature documentation: they are appended to the “Annex” File in electronic form.

7.d Address where inventory, records and archives are held

Switzerland

> Staatsarchiv Graubünden
Karlihofplatz
7001 Chur
Tel: +41 (0)81 257 28 03
E-mail: info@sag.gr.ch

> Rhätische Bahn (Company Archives)
Bahnhofstrasse 25
7002 Chur
Tel:+41 (0)81 288 63 66
E-mail: contact@rhb.ch

> Amt für Raumentwicklung Graubünden
Grabenstrasse 1
7001 Chur
Tel: +41 (0)81 257 23 23
E-mail: info@are.gr.ch

> Denkmalpflege Graubünden
Loëstrasse 14
7000 Chur
Tel: +41 (0)81 257 27 92
E-mail: info@dpg.gr.ch

Italy

> Ministreo per i beni e la attività culturali
Corso Magneta, 24
I - 20123 Milano
Tel: +39 02 802941
E-mail: info@lombardia.beniculturali.it

7.e Bibliography

2.a.3 Descriptions of sections

BELLONCLE PATRICK [et al.]: *Das grosse Buch der Rhätischen Bahn 1889-2001,* Kerzers 2002.

BOSSHARD E.: *Die Berninabahn*, Zurich 1912 (*Schweizerische Bauzeitung*, offprint).

BRÜNGGER GIAN, KELLER TIBERT, MENGOTTI RENATO: *Abenteuer Albulabahn*, Chur 2003.

DOSCH LUZI [LEZA]: *Die Bauten der Rhätischen Bahn. Geschichte einer Architektur von 1889 bis 1949*, Chur 1984.

Enzyklopädie des Eisenbahnwesens, published by [Victor] v. Röll, 10 vols., Berlin und Vienna, 1912-1923 (2nd, fully revised ed.).

HENNINGS FRIEDRICH [C.S.]: *Projekt und Bau der Albulabahn. Denkschrift (im Auftrag der Rhätischen Bahn),* Chur 1908.

JEANMAIRE CLAUDE: *Die Gleichstromlinien der Rhätischen Bahn* […] (Die elektrischen und Diesel-Triebfahrzeuge Schweizerischer Eisenbahnen), Villigen 1975 (2nd ed.).

JEANMAIRE CLAUDE: *Die Berninabahn. Auf schmaler Spur über die Alpen. Ergänzungen zur Geschichte der Rhätischen Bahn* (Die elektrischen und Diesel-Triebfahrzeuge Schweizerischer Eisenbahnen), Villigen 1987.

KOLLER TH.: *Die Berninabahn,* Munich [etc.] 1911 (periodical *Elektrische Kraftbetriebe und Bahnen*, offprint).

2.a.4 Engineering structures

BEHRMANN HERMANN: *Die Rhätische Bahn. Praktischer Reiseführer durch das Schweizerische Hochland Graubünden*, Chur 1908.

BOSSHARD E.: *Die Berninabahn*, Zurich 1912 (*Schweizerische Bauzeitung*, offprint).

COULIN JULES: ‚Die Rhätische Bahn', in: *Heimatschutz*, 1913/1, pp. 1-14.

HENNINGS FRIEDRICH [C.S.]: *Projekt und Bau der Albulabahn. Denkschrift (im Auftrag der Rhätischen Bahn),* Chur 1908.

SÉJOURNÉ PAUL: *Grandes Voutes*, 6 vols., Bourges 1913-16.

STUDER HANS: ‚Steinerne Brücken der Rhätischen Bahnen', in: *Schweizerische Ingenieurbauten in Theorie und Praxis. Internationaler Kongress für Brückenbau und Hochbau,* Zurich 1926.

BIRKNER OTHMAR: ‚Der Aufbruch. Die nationale Romantik der Schweiz', in: *Das Werk. Architektur und Kunst,* 1967 (Werk-Chronik, 5).

2.a.5 Structures

CONZETT JÜRG: *Die Albulabahn* (Schweizerische Kunstführer, 461/462), Bern 1989.

DOSCH LUZI [LEZA]: *Die Bauten der Rhätischen Bahn. Geschichte einer Architektur von 1889 bis 1949*, Chur 1984.

DOSCH LUZI [LEZA]: ‚Eine Bergbahn als Gesamtkunstwerk', in: *Werk, Bauen + Wohnen*, Jg. 80/47, 1993/1-2, pp. 6–13.

DOSCH LEZA: *Kunst und Landschaft in Graubünden. Bilder und Bauten seit 1780*, Zurich 2001.

HENNINGS FRIEDRICH [C.S.]: *Projekt und Bau der Albulabahn. Denkschrift (im Auftrag der Rhätischen Bahn),* Chur 1908.

Kunstführer durch die Schweiz, vol. 2, issued by Gesellschaft für Schweizerische Kunstgeschichte, Bern 2005, pp. 39-328 (Canton Graubünden).

STUTZ WERNER: *Bahnhöfe der Schweiz. Von den Anfängen bis zum Ersten Weltkrieg*, Zurich und Schwäbisch Hall, 1983 (2nd ed.).

2.a.6 Sacred and secular buildings

Beckerath Astrid von, Nay Marc Antoni, Rutishauser Hans (publishers): *Spätgotische Flügelaltäre in Graubünden und im Fürstentum Liechtenstein*, Chur 1998.

Bormetti Francesca, Casciaro Raffaele: *Il Santuario della Madonna di Tirano nella Valtellina del Cinquecento,* Cinisello Balsamo 1996.

Clavadetscher Otto P., Meyer Werner: *Das Burgenbuch von Graubünden*, Zurich and Schwäbisch Hall 1984.

Credaro Bruno: *Tirano*, Lecco 1958.

Dosch Leza: ‚Architektur und bildende Kunst', in: *Handbuch der Bündner Geschichte,* vol. 3 (19. und 20. Jahrhundert), published by the Verein für Bündner Kulturforschung, Chur 2000, pp. 175-192.

Dosch Leza: *Kunst und Landschaft in Graubünden. Bilder und Bauten seit 1780*, Zurich 2001.

Garbellini Gianluigi: *Nel segno del Rinascimento. Il Santuario della Madonna di Tirano,* Villa di Tirano 1996.

Gianasso Mario: *Guida turistica della Provincia di Sondrio,* Sondrio 2001.

Giussanti Antonio, Varischetti Lino: *La Madonna di Tirano e il suo Santuario,* Sondrio 1964.

Il Museo Etnografico Tiranese. Guida, a cura di Bruno Ciapponi [Landi], Antonio Santini, Delia Garbellini, Sondrio 1981.

Kunstführer durch die Schweiz, vol. 2, issued by Gesellschaft für Schweizerische Kunstgeschichte, Bern 2005, pp. 39-328 (Canton Graubünden).

Meyer Werner: ‚Das Hochmittelalter (10. bis Mitte 14. Jahrhundert)', in: *Handbuch der Bündner Geschichte,* vol. 1 (Frühzeit und Mittelalter), published by the Verein für Bündner Kulturforschung, Chur 2000, pp. 138-193.

Nay Marc Antoni: ‚Architektur, Plastik und Malerei von der Gotik bis zum Rokoko', in: *Handbuch der Bündner Geschichte,* vol. 2 (Frühe Neuzeit), published by the Verein für Bündner Kulturforschung, Chur 2000, pp. 237-260.

Pedrotti Egidio: *Castelli e torri valtellinesi,* Milan 1957.

Pedrotti Egidio: *Le fortificazioni di Tirano*, Milan 1960.

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Tel: +41 (0)81 844 00 40
Fax: +41 (0)91 844 34 45
conradstiftung@bluewin.ch

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Palazzo De Bassus-Mengotti
CH-7742 Poschiavo
Tel: +41 (0)81 844 05 71
gustavo.lardi@bluewin.ch

Museo Casa Besta
Brusio Borgo
CH-7743 Brusio
Tel: +41 (0)81 846 55 18
dmonigatti@bluewin.ch

Museo Etnografico Tiranese
Piazza Basilica,30
I-23030 Madonna di Tirano (SO)
Tel. (+39) 0342 701181
Fax: (+39) 0342 701181
museo.tirano@provincia.so.it
www.museotirano.provincia.so.it

Tourism offices

Graubünden Ferien
Alexanderstrasse 24
CH-7000 Chur
Tel: +41 (0)81 254 24 24
contact@graubuenden.ch
www.ferien.graubuenden.ch

Verkehrsverein Thusis
Neudorfstrasse 49
CH-7430 Thusis
Tel: +41 (0)81 651 11 34
Fax: +41 (0)81 651 25 63
vvthusis@spin.ch
www.thusis-viamala.ch

Zillis-Schamserberg Tourismus
CH-7432 Zillis
Tel: +41 (0)81 661 21 73
Fax: +41 (0)81 661 21 73
zillis@viamalaferien.ch
www.viamalaferien.ch

Mutten Tourismus
Postfach 176
CH-7402 Bonaduz
Tel: +41 (0)81 681 17 84
Fax: +41 (0)81 641 26 64
rfrauenfelder-mutten@spin.ch
www.mutten.ch

Lenzerheide Tourismus
Voa Principala 68
CH-7078 Lenzerheide/Lai
Tel: +41 (0)81 385 11 20
Fax: +41 (0)81 385 11 21
info@lenzerheide.com

Verkehrsverein Stierva
CH-7459 Stierva
Tel: +41 (0)81 637 00 33
Fax: +41 (0)81 637 00 34
stierva@bluewin.ch
www.stierva.ch

Verkehrsverein Tiefencastel
CH-7450 Tiefencastel
Tel: +41 (0)81 681 18 71
verkehrsverein@tiefencastel.ch
www.tiefencastel.ch

Savognin Tourismus im Surses
CH-7460 Savognin
Tel: +41 (0)81 659 16 16
Fax: +41 (0)81 659 16 17
ferien@savognin.ch
www.savognin.ch

Touristikverein Albula
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CH-7473 Alvaneu Bad
Tel: +41 (0)81 404 11 16
Fax: +41 (0)81 404 18 73

Schmitten Tourismus
CH-7493 Schmitten (Albula)
Tel: +41 (0)81 404 24 84
brazerolouk@bluewin.ch

Filisur Tourismus
CH-7477 Filisur
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Fax: +41 (0)81 407 14 04
info@filisur.ch
www.filisur.ch

Bergün Tourismus
Hauptstrasse 83
CH-7482 Bergün/Bravuogn
Tel: +41 (0)81 407 11 52
Fax: +41 (0)81 407 14 04
info@berguen.ch
www.berguen.ch

Tourismusverein Bever
CH-7502 Bever
Tel: +41 (0)81 852 49 45
Fax: +41 (0)81 852 49 17
info@bevertourismus.ch
www.bevertourismus.ch

Samedan Tourismus
CH-7503 Samedan
Tel: +41 (0)81 851 00 60
Fax: +41 (0)81 851 00 66
info@samedan.ch
www.samedan-tourismus.ch

Celerina Tourismus
CH-7505 Celerina/Schlarigna
Tel: +41 (0)81 830 00 11
Fax: +41 (0)81 830 00 19
info@celerina.ch
www.celerina.ch

Kur- und Verkehrsverein St. Moritz
Via Maistra 12
CH-7500 St. Moritz
Tel: +41 (0)81 837 33 33
Fax: +41 (0)81 837 33 77
information@stmoritz.ch
www.stmoritz.ch

Kur- und Verkehrsverein Pontresina
CH-7504 Pontresina
Tel: +41 (0)81 838 83 00
Fax: +41 (0)81 838 83 10
info@pontresina.com
www.pontresina.com

Ente turistico Valposchiavo
CH-7742 Poschiavo
Tel: +41 (0)81 844 05 71
Fax: +41 (0)81 844 10 27
info@valposchiavo.ch
www.valposchiavo.ch

Ufficio informazioni turistiche di Tirano
Piazza Stazione
I- 23037 Tirano (SO)
Tel.: (+39) 0342. 706066
Fax: (+39) 0342. 706066
infotirano@provincia.so.it

Consorzio Turistico Media Valtellina di Tirano
Via Maurizio Quadrio, 11
I - 23037 Tirano (SO)
Tel.: 347.0173303
Fax: 0342.701236
info@valtellinaturismo.com
www.valtellinaturismo.com

Pro Loco di Tirano
Via Giustizia, 2
I - 23037 Tirano (SO)
Tel. and Fax: (+39) 0342.704630
info@prolocotirano.it
www.prolocotirano.it

Communities

Thusis:
Gemeindeverwaltung Thusis
Rathaus
CH-7430 Thusis

Sils i.D.:
Gemeindeverwaltung Sils i.D.
Palazzo
CH-7411 Sils i.D.

Zillis-Reischen:
Gemeinde Zillis-Reischen
CH-7432 Zillis

Scharans:
Gemeindeverwaltung
Dorfplatz
CH-7412 Scharans

Mutten:
Gemeindekanzlei Mutten
Rosenkehr
CH-7431 Mutten

Vaz/Obervaz:
Gemeindeverwaltung Vaz/Obervaz
Voa Principala
CH-7082 Lenzerheide

Alvaschein:
Gemeindekanzlei Alvaschein
Hauptstrasse
CH-7451 Alvaschein

Stierva:
Gemeindekanzlei Stierva
CH-7459 Stierva

Tiefencastel:
Gemeindeverwaltung Tiefencastel
Suloms
CH-7450 Tiefencastel

Brienz/Brienzauls:
Gemeindekanzlei Brienz
CH-7084 Brienz

Surava:
Gemeindekanzlei Surava
Schulhaus
CH-7472 Surava

Alvaneu:
Gemeindekanzlei
CH-7492 Alvaneu

Schmitten:
Gemeindekanzlei Schmitten
Hauptstrasse 65
CH-7493 Schmitten

Filisur:
Gemeindekanzlei Filisur
Hauptstrasse
CH-7477 Filisur

Bergün/Bravuogn:
Gemeindekanzlei Bergün
CH-7482 Bergün

Bever:
Gemeindeverwaltung Bever
Chesa cumünela
CH-7502 Bever

Samedan:
Gemeindeverwaltung Samedan
Plazzet 4
CH-7503 Samedan

Celerina/Schlarigna:
Gemeindeverwaltung Celerina
Chesa cumünela
CH-7505 Celerina

St. Moritz:
Gemeindeverwaltung St. Moritz
Via Maistra 12
CH-7500 St. Moritz

Pontresina:
Gemeindeverwaltung Pontresina
Chesa cumünela
CH-7504 Pontresina

Poschiavo:
Cancelleria comunale Poschiavo
Casella Postale
CH-7742 Poschiavo

Brusio:
Cancelleria comunale Brusio
CH-7743 Brusio

Tirano:
Città di Tirano
Piazza Cavour, 18
I-23037 Tirano (SO)

Regions

Regio Viamala
Rathaus
Postfach 88
CH-7430 Thusis

Regionalverband Mittelbünden
Hauptstrasse 17
CH-7493 Schmitten

Regionalplanungskommission Oberengadin
Kreisamt Oberengadin
Chesa Ruppaner
CH-7503 Samedan

Regione Valle di Poschiavo
Ufficio
CH-7742 Poschiavo

Provincia di Sondrio
Via XXV Aprile, 22
I-23100 Sondrio

8.d Official Web Address

The official Internet address for the candidature is:
http://www.rhb-unesco.ch

9. Signature on behalf of the State Parties

Signature on behalf of the Swiss State Party

Ernst Iten
Ambassador
Permanent Delegate of Switzerland to UNESCO

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Signature on behalf of the Italian State Party

Giuseppe Moscato
Ambassador
Permanent Delegate of Italy to UNESCO

Imprint

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> Erwin Rutishauser, Director Rhaetian Railway AG
> Johann Mürner, Swiss Federal Office of Culture, Head of the Protection of Monuments and National Heritage Section

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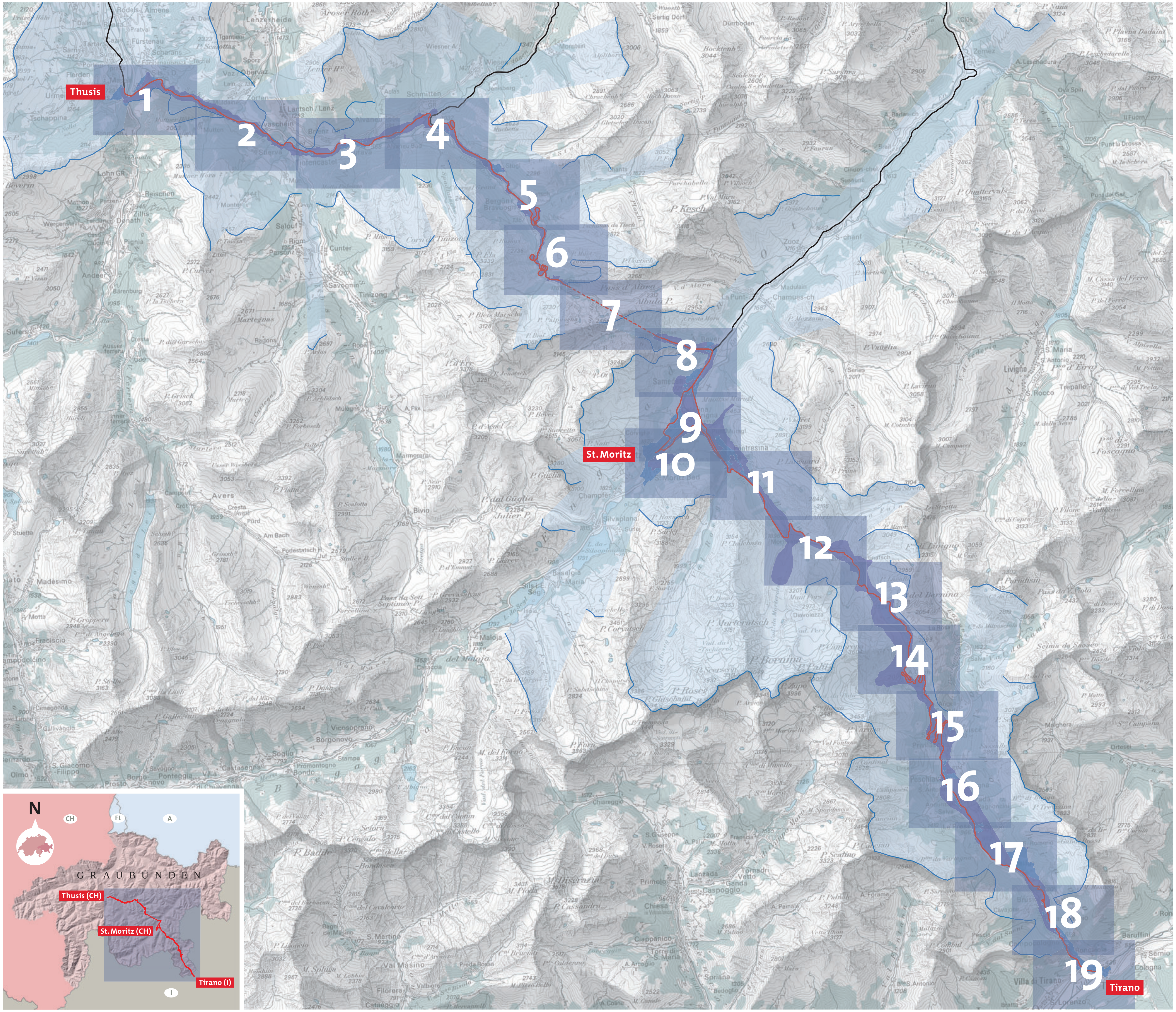
> Süsskind SGD, Graphic Design und Kommunikation AG, Chur
Erik Süsskind
Maria Schlumpf

Chur, Switzerland
December 2006

19 detailed plans of the property with the core and buffer zones, scale 1 : 15,000

Overview detailed plans, scale 1 : 15,000



Overview detailed plans scale 1 : 15,000

1 Section

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

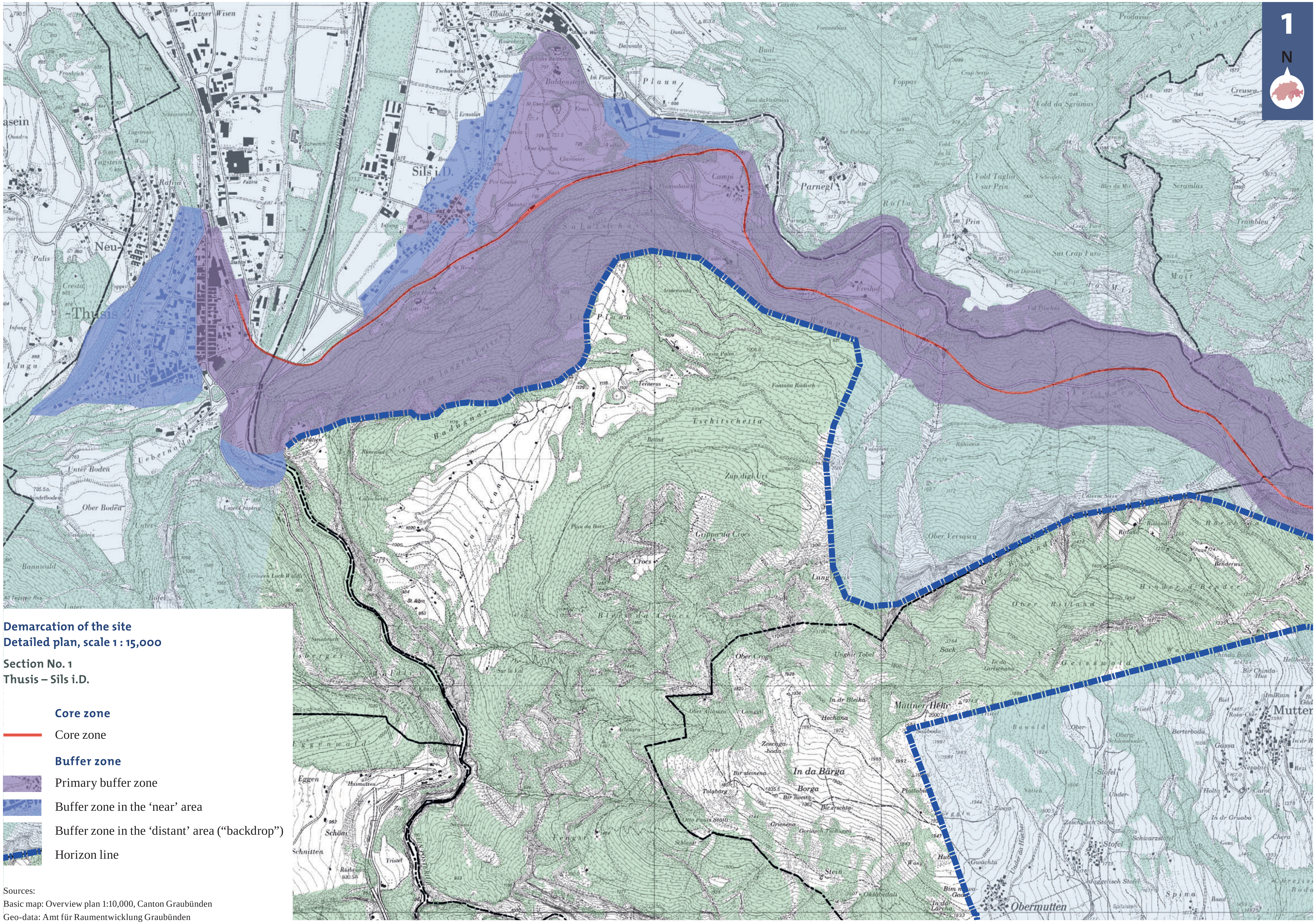
Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: PK 200,000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Design: Süsskind, SGD, Chur
Reproduced by permission of swisstopo (BM062220)

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 1
Thusis – Sils i.D.



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 1
Thusis – Sils i.D.

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

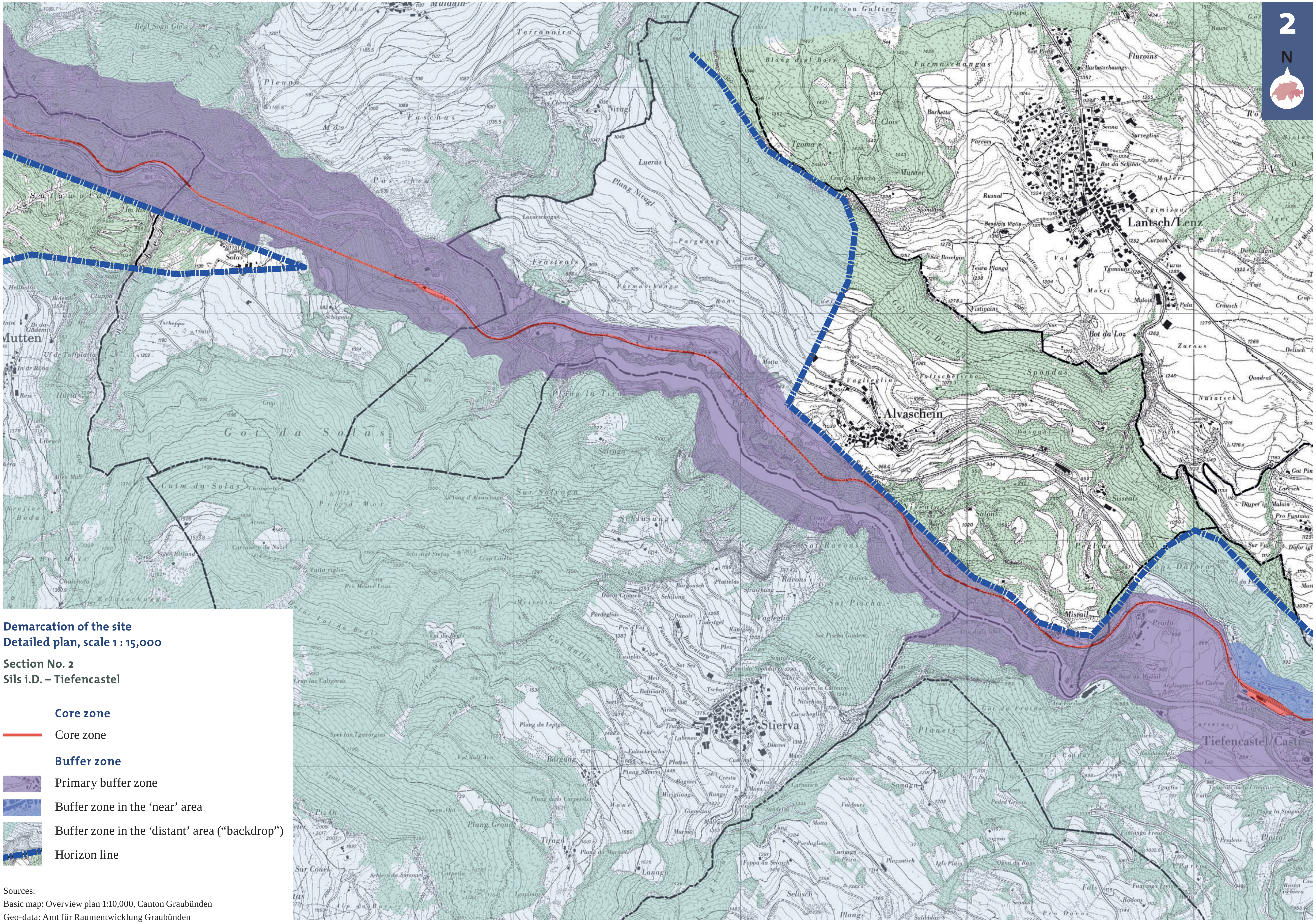
Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 2
Sils i.D. – Tiefencastel



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 2
Sils i.D. – Tiefencastel

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

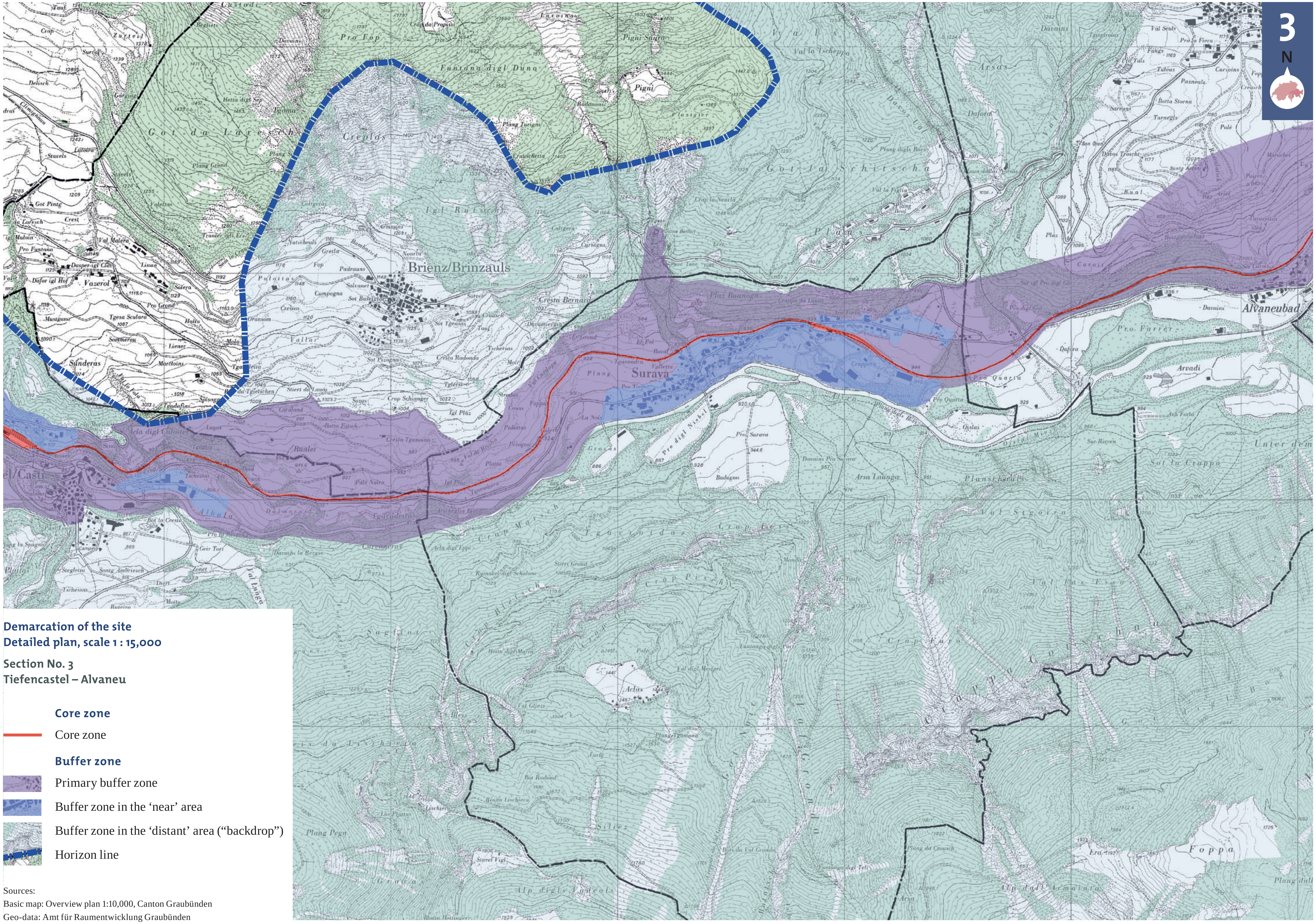
Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 3
Tiefencastel – Alvaneu



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 3
Tiefencastel – Alvaneu

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

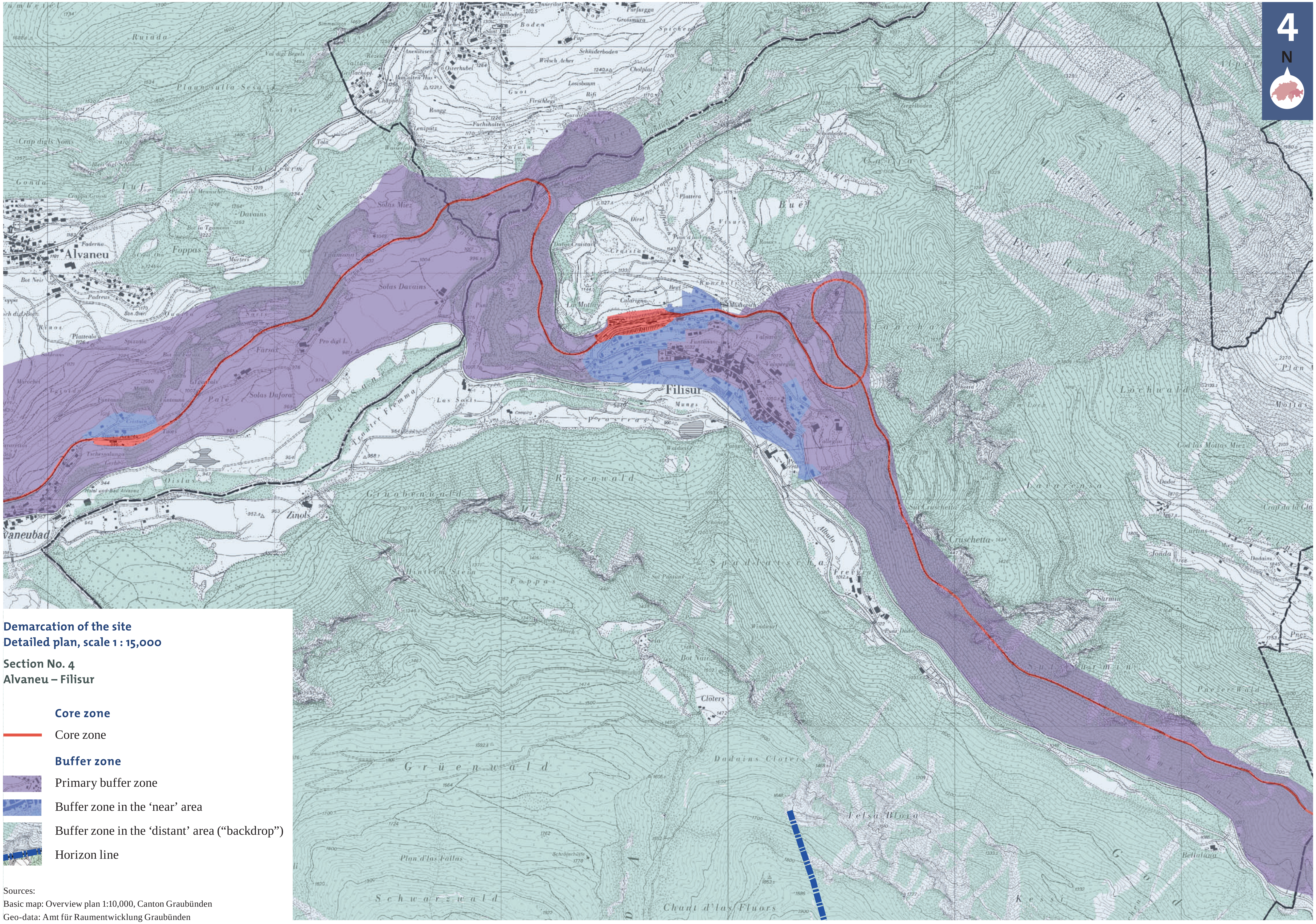
Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

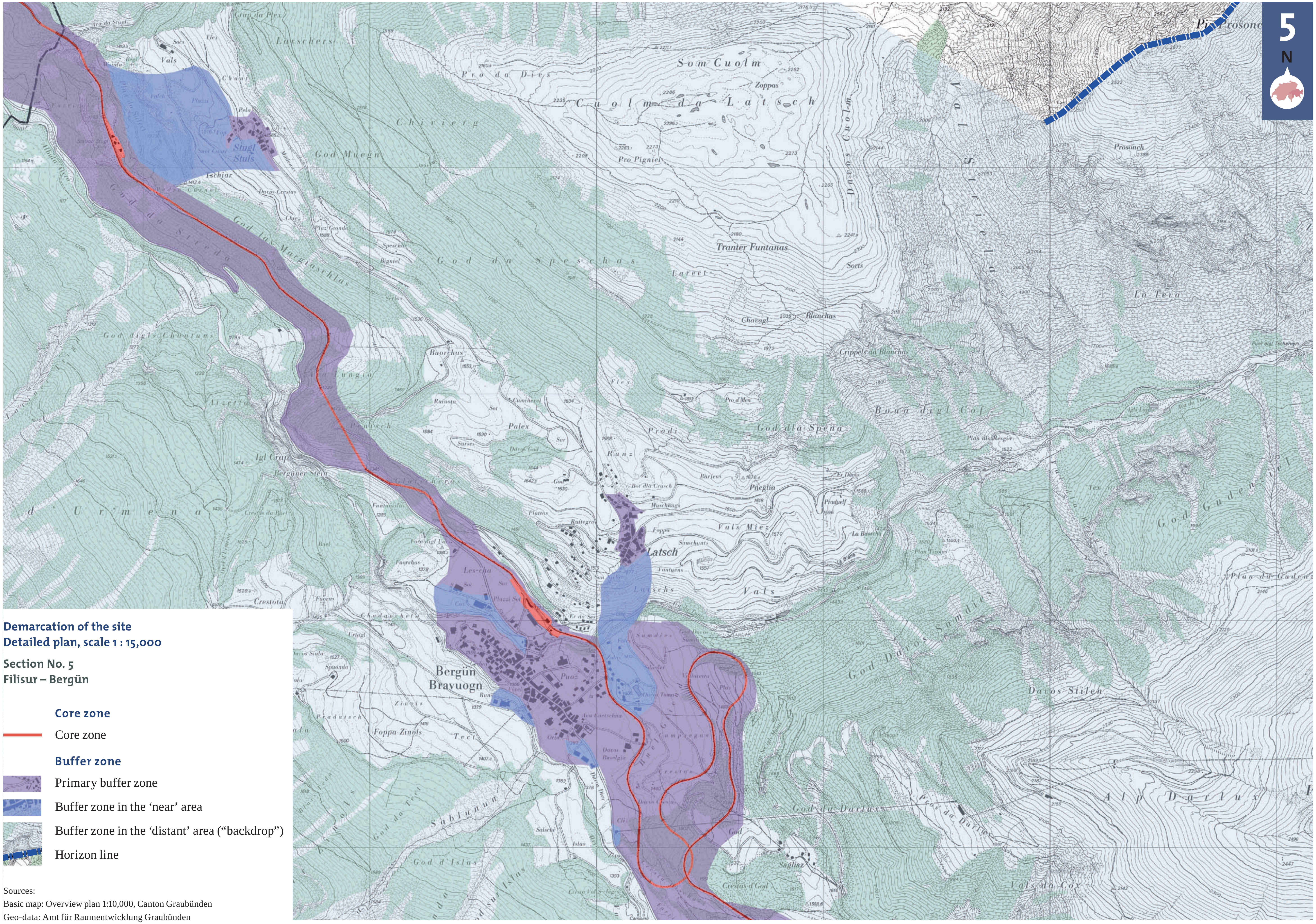
Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 4
Alvaneu – Filisur


4
N
Alvaneu
Filisur
Zinols
Grüenwald
Clôters
Demarcation of the site
Detailed plan, scale 1 : 15,000
Section No. 4
Alvaneu – Filisur
Core zone
Core zone
Buffer zone
Primary buffer zone
Buffer zone in the 'near' area
Buffer zone in the 'distant' area ("backdrop")
Horizon line
Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 5
Filisur – Bergün



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 5
Filisur – Bergün

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the ‘near’ area

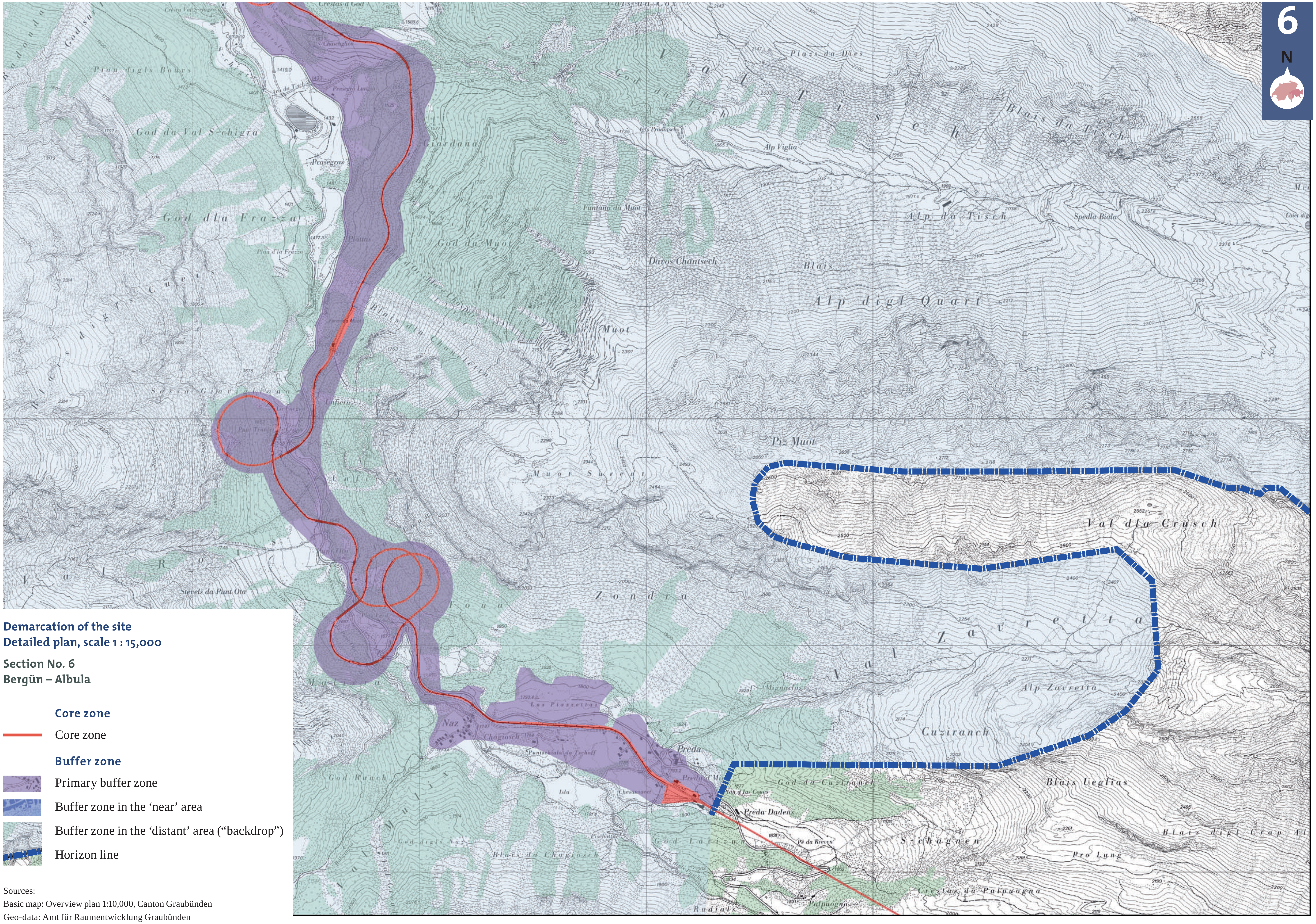
Buffer zone in the ‘distant’ area (“backdrop”)

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 6
Bergün – Albula



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 6
Bergün – Albula

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

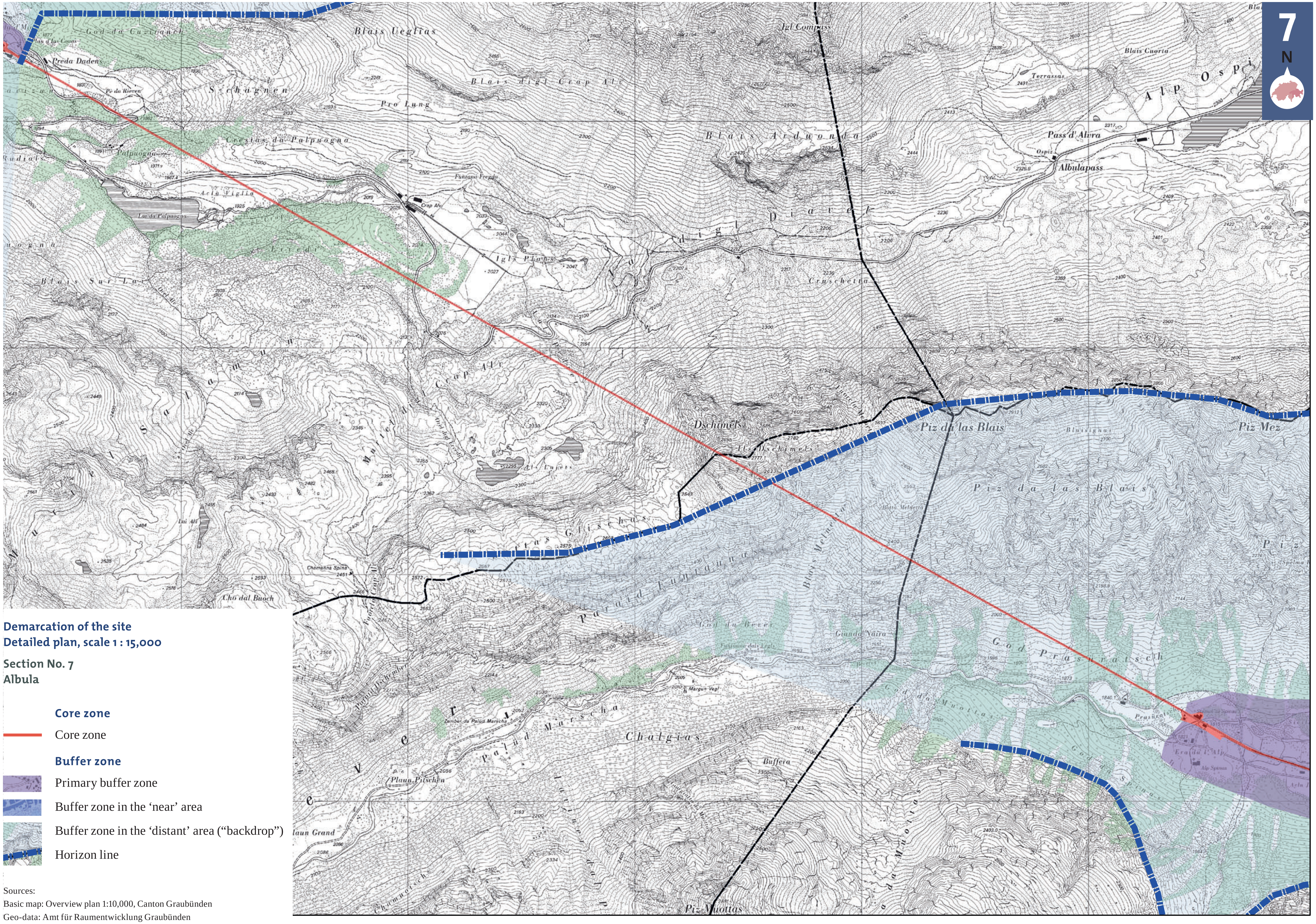
Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section No. 7 Albula



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 7
Albula

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

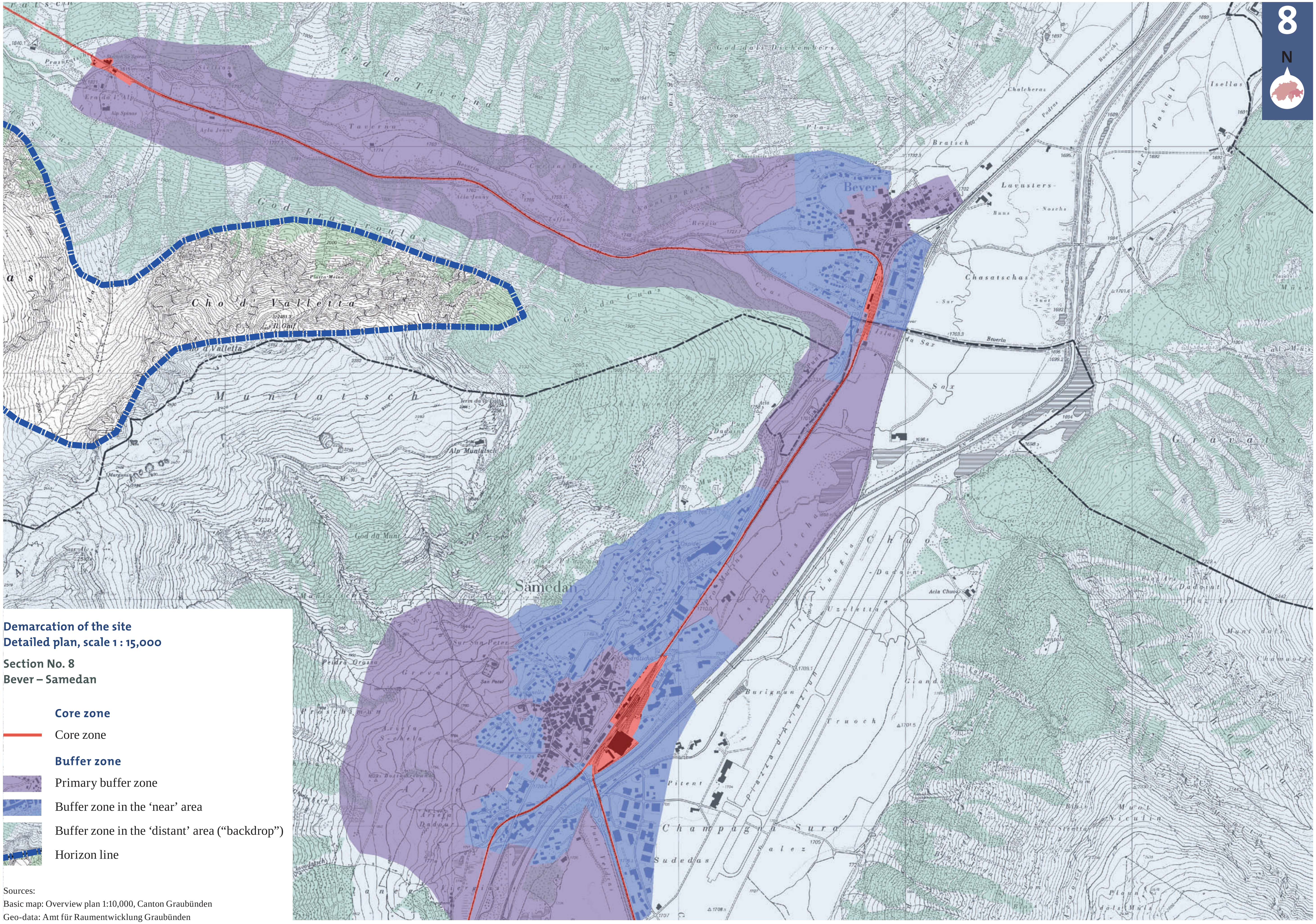
Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 8
Bever – Samedan



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 8
Bever – Samedan

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 9
Samedan – St. Moritz – Pontresina

Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 9
Samedan – St. Moritz – Pontresina

Core zone

Core zone

Buffer zone

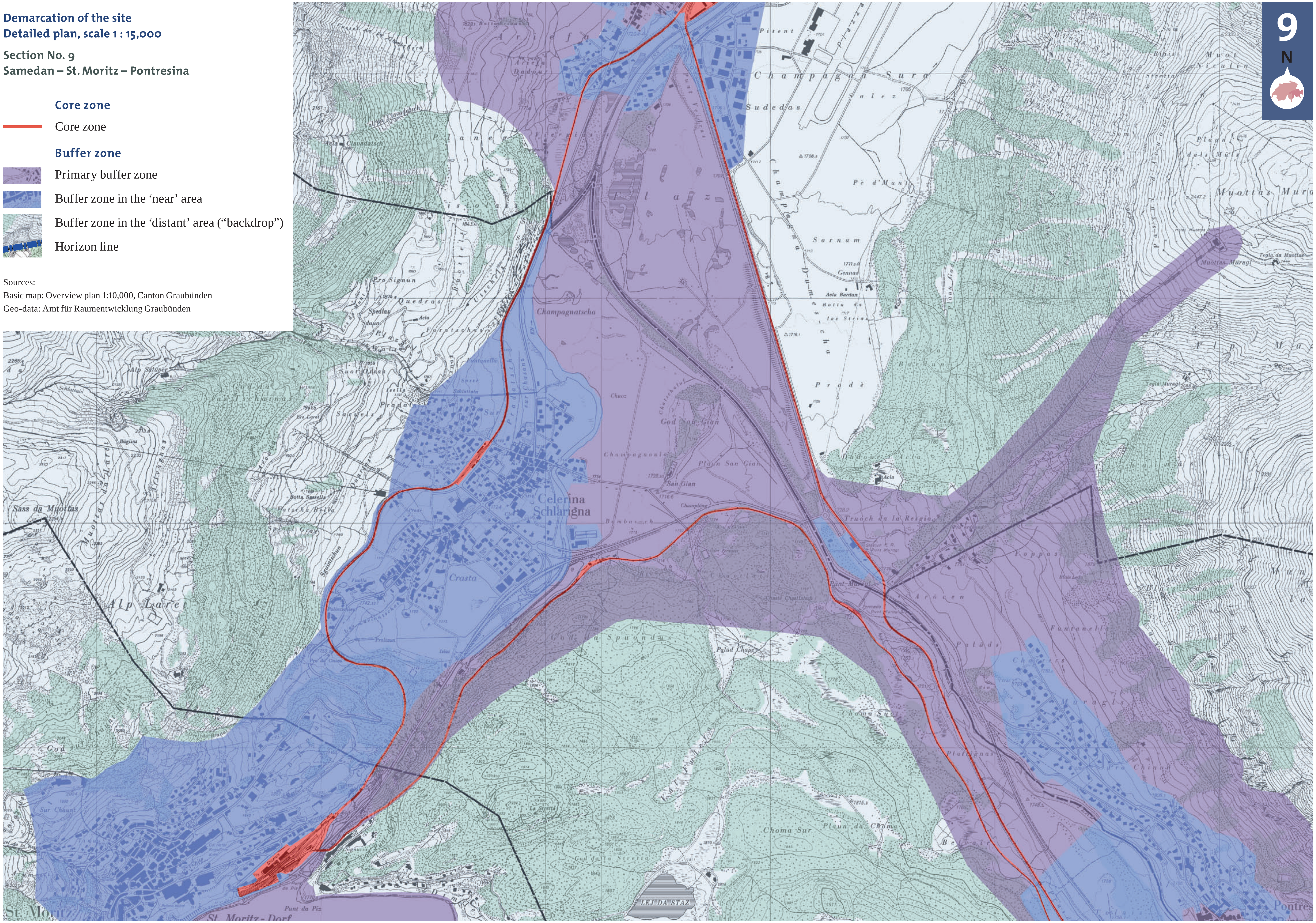
Primary buffer zone

Buffer zone in the ‘near’ area

Buffer zone in the ‘distant’ area (“backdrop”)

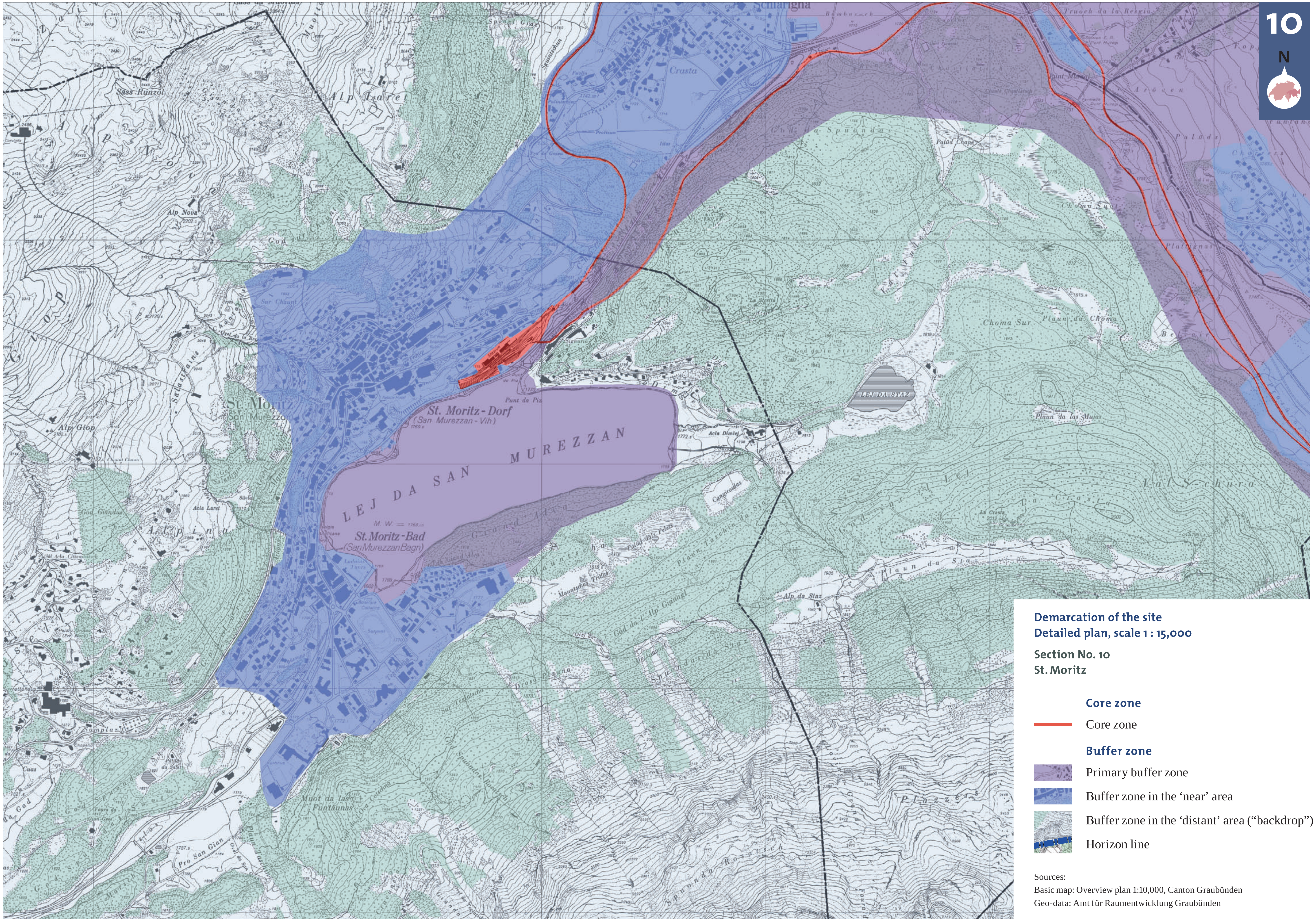
Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden



Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 10
St. Moritz



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 10
St. Moritz

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

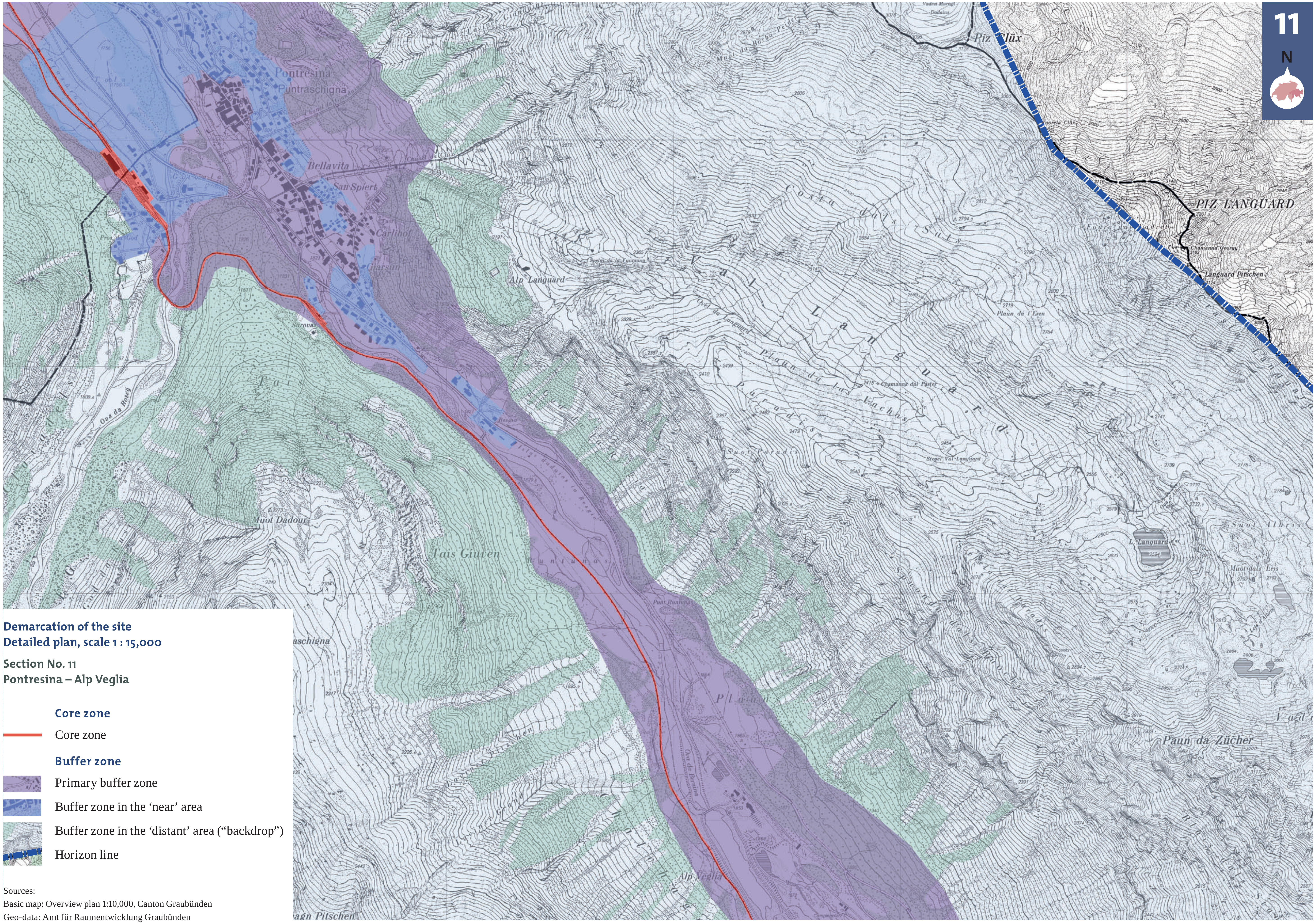
Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section

No. 11

Pontresina – Alp Veglia



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 11
Pontresina – Alp Veglia

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 12
Alp Veglia – Curtinatsch

Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 12
Alp Veglia – Curtinatsch

Core zone

Core zone

Buffer zone

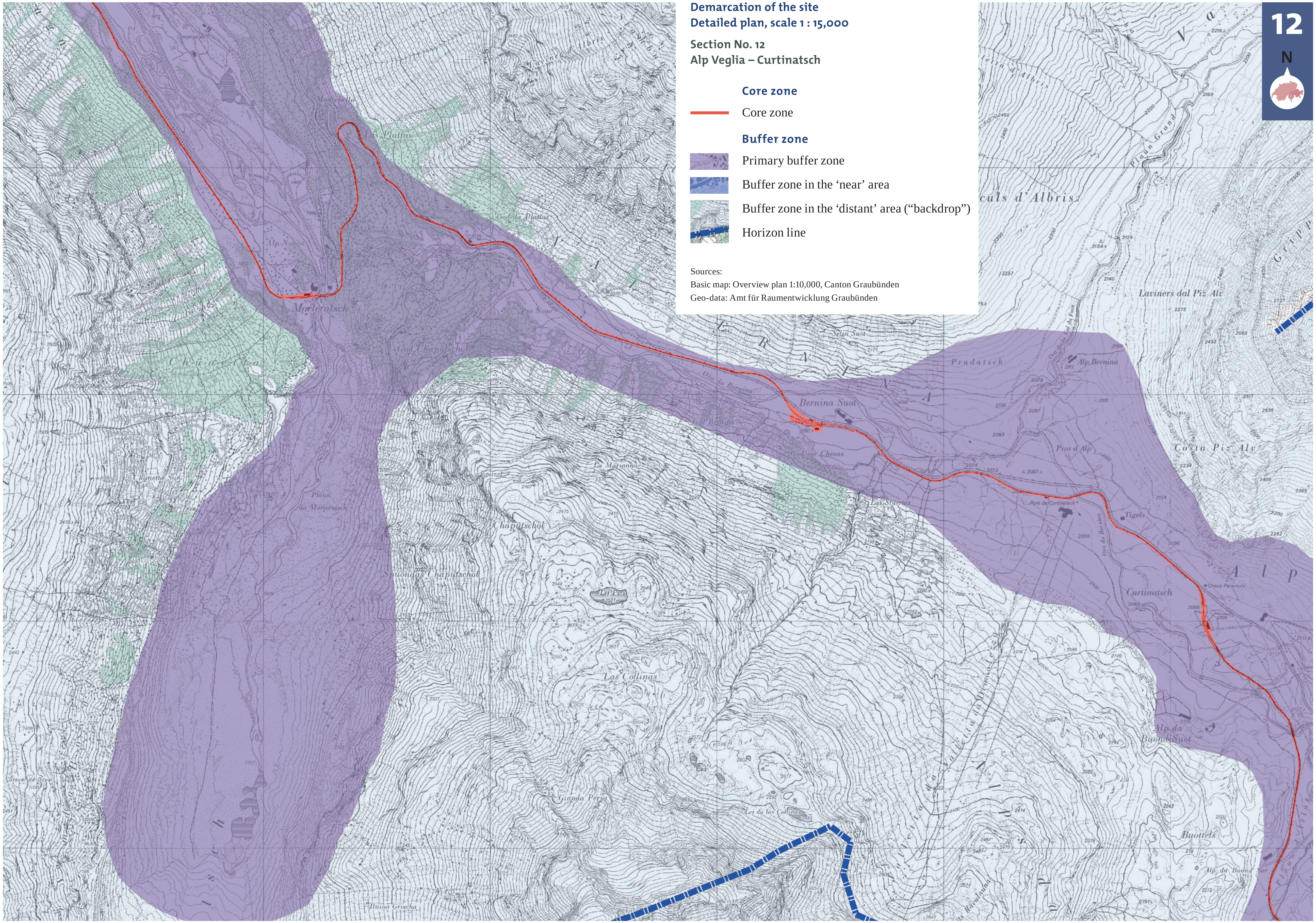
Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

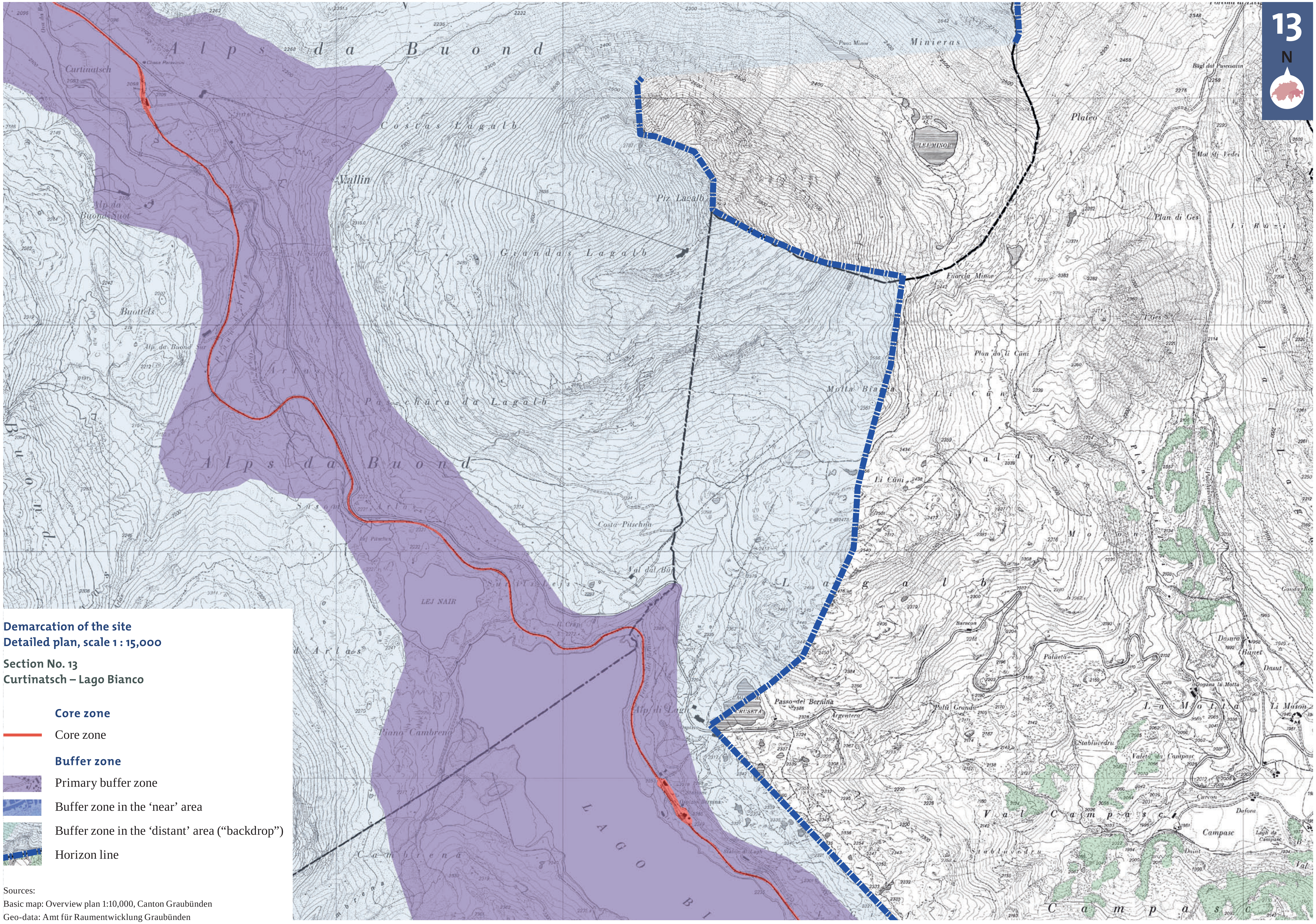
Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden



Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 13
Curtinatsch – Lago Bianco



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 13
Curtinatsch – Lago Bianco

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

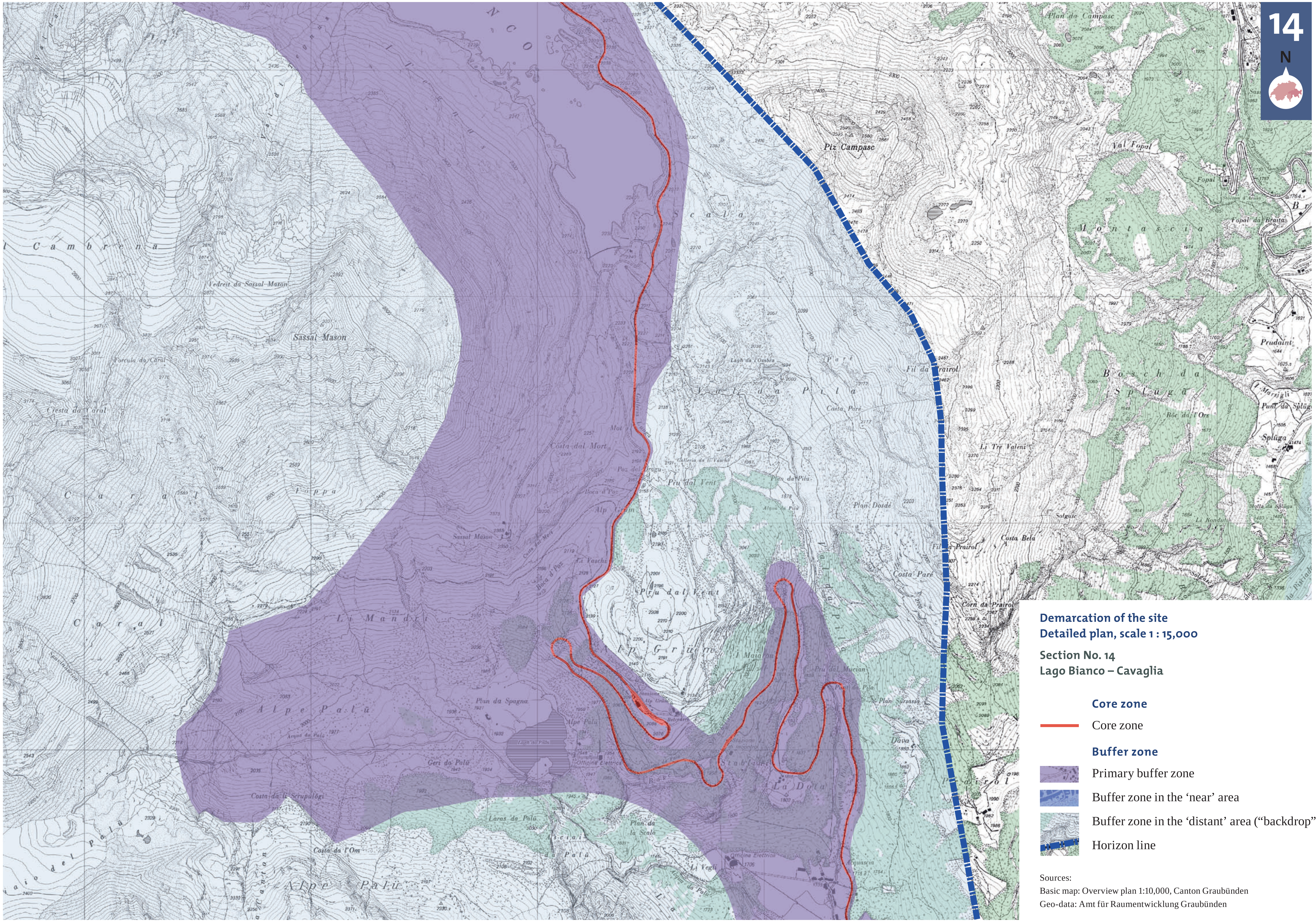
Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 14
Lago Bianco – Cavaglia



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 14
Lago Bianco – Cavaglia

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

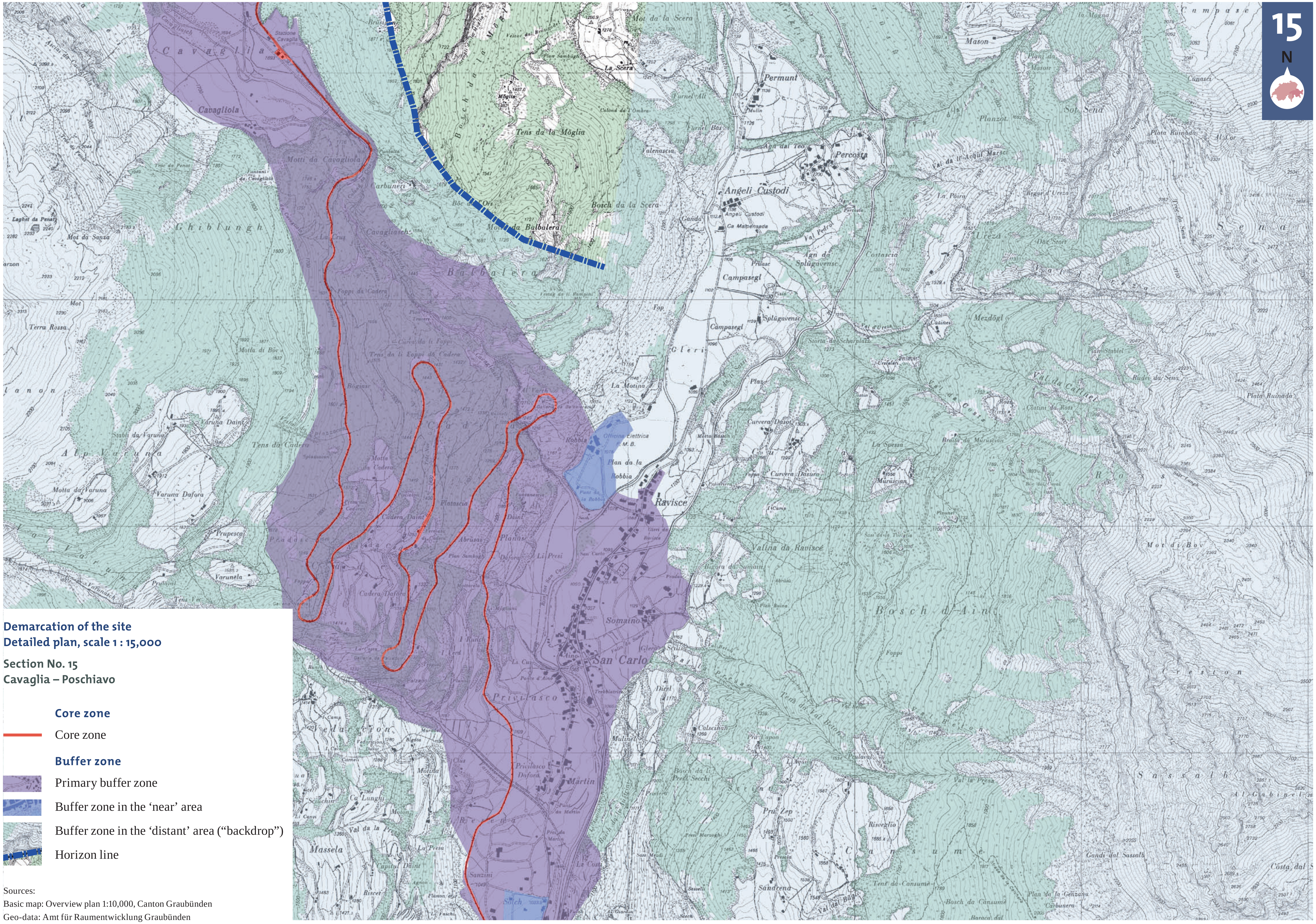
Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 15
Cavaglia – Poschiavo



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 15
Cavaglia – Poschiavo

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

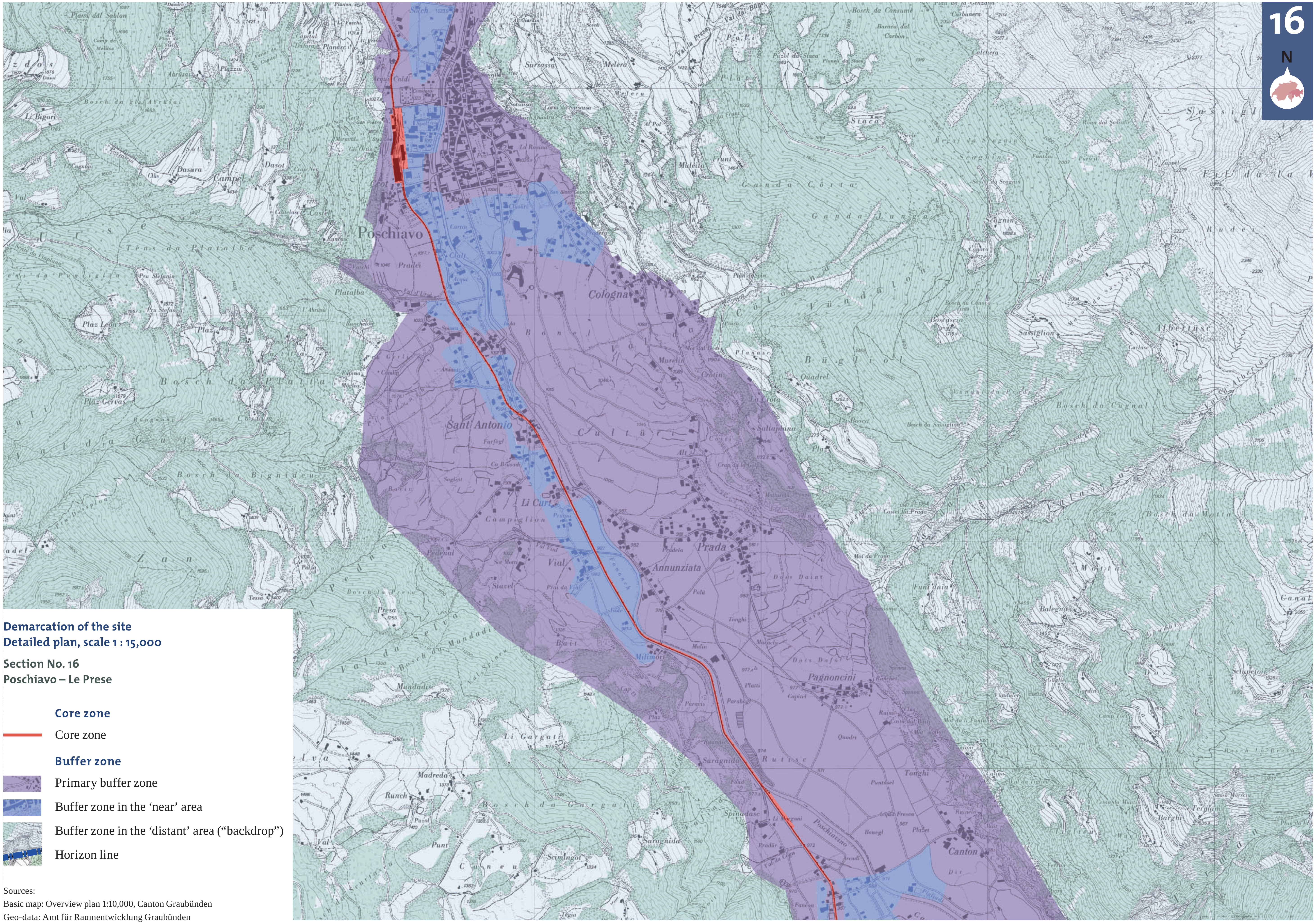
Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 16
Poschiavo – Le Prese



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 16
Poschiavo – Le Prese

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

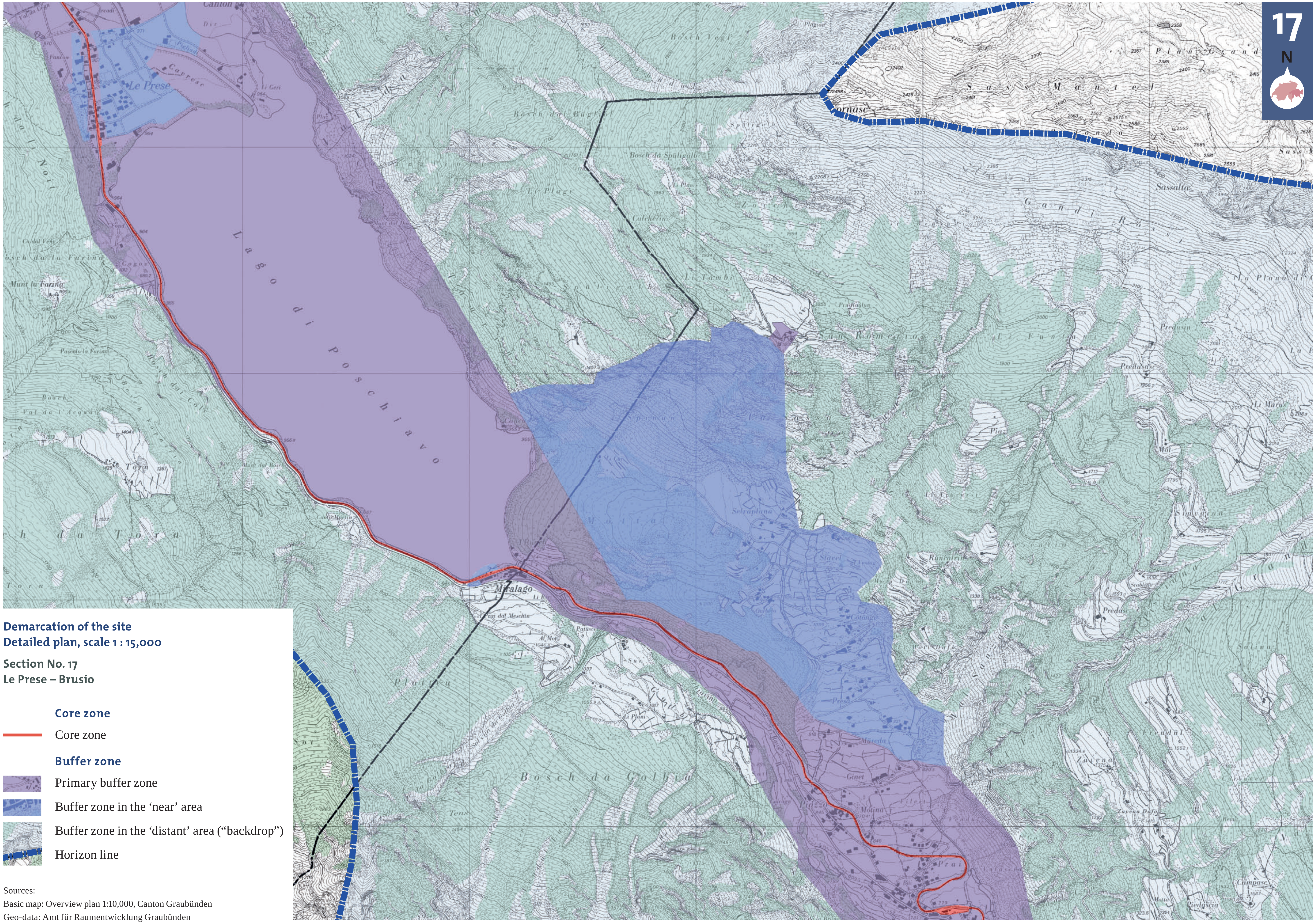
Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 17
Le Prese – Brusio

17



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 17
Le Prese – Brusio

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the ‘near’ area

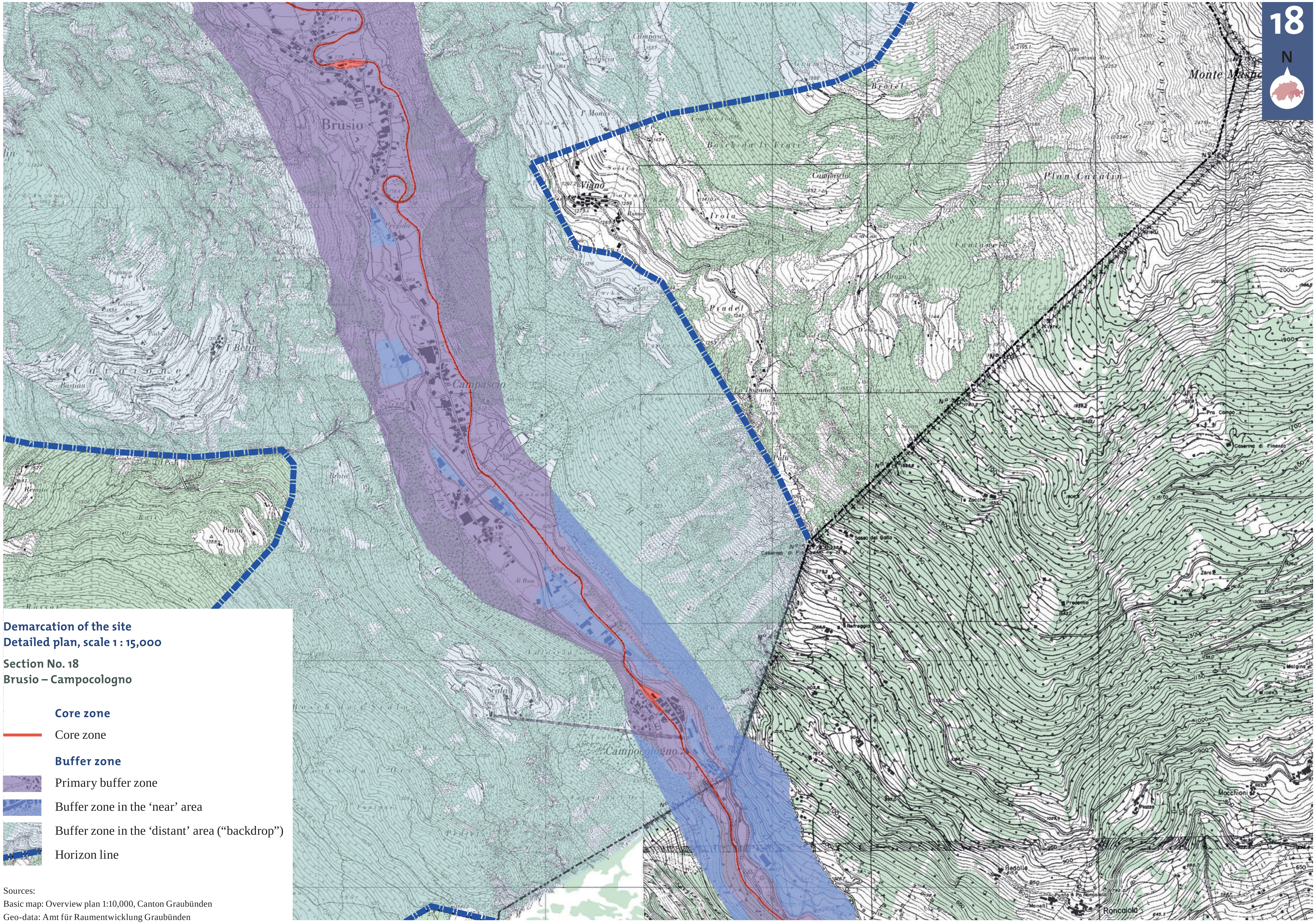
Buffer zone in the ‘distant’ area (“backdrop”)

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section
No. 18
Brusio – Campocologno



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 18
Brusio – Campocologno

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

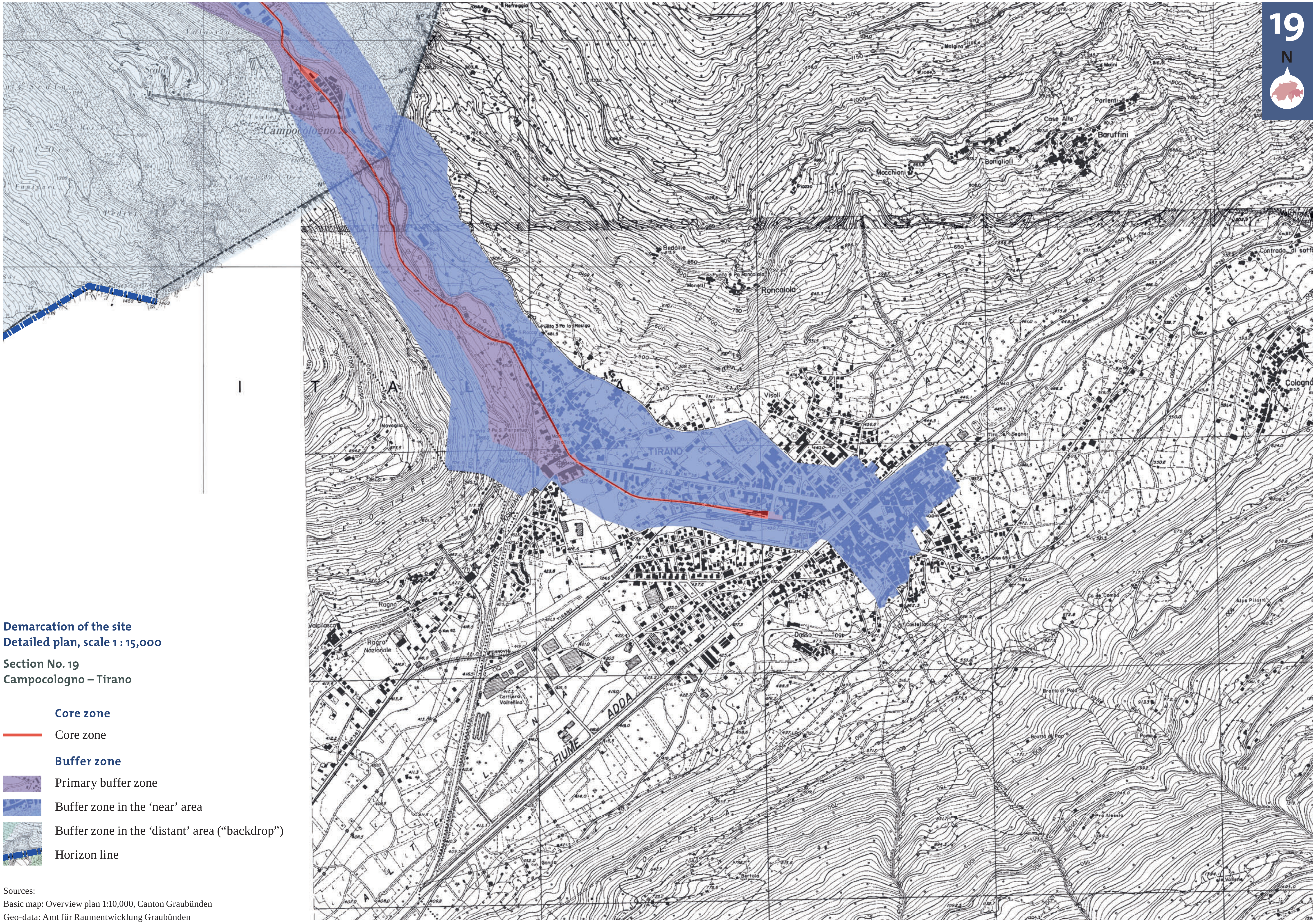
Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Detailed plans of the property with the core and buffer zones, scale 1:15,000

Section

No. 19

Campocologno – Tirano



Demarcation of the site
Detailed plan, scale 1 : 15,000

Section No. 19
Campocologno – Tirano

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

5 selected plans of the property with the core and buffer zones, scale 1 : 2,000

Selected sections, scale 1:2,000

Section No. 1
Filisur

Demarcation of the site
Detailed plan, scale 1 : 2,000

Section No. 1
Filisur

Core zone

Core zone

Buffer zone

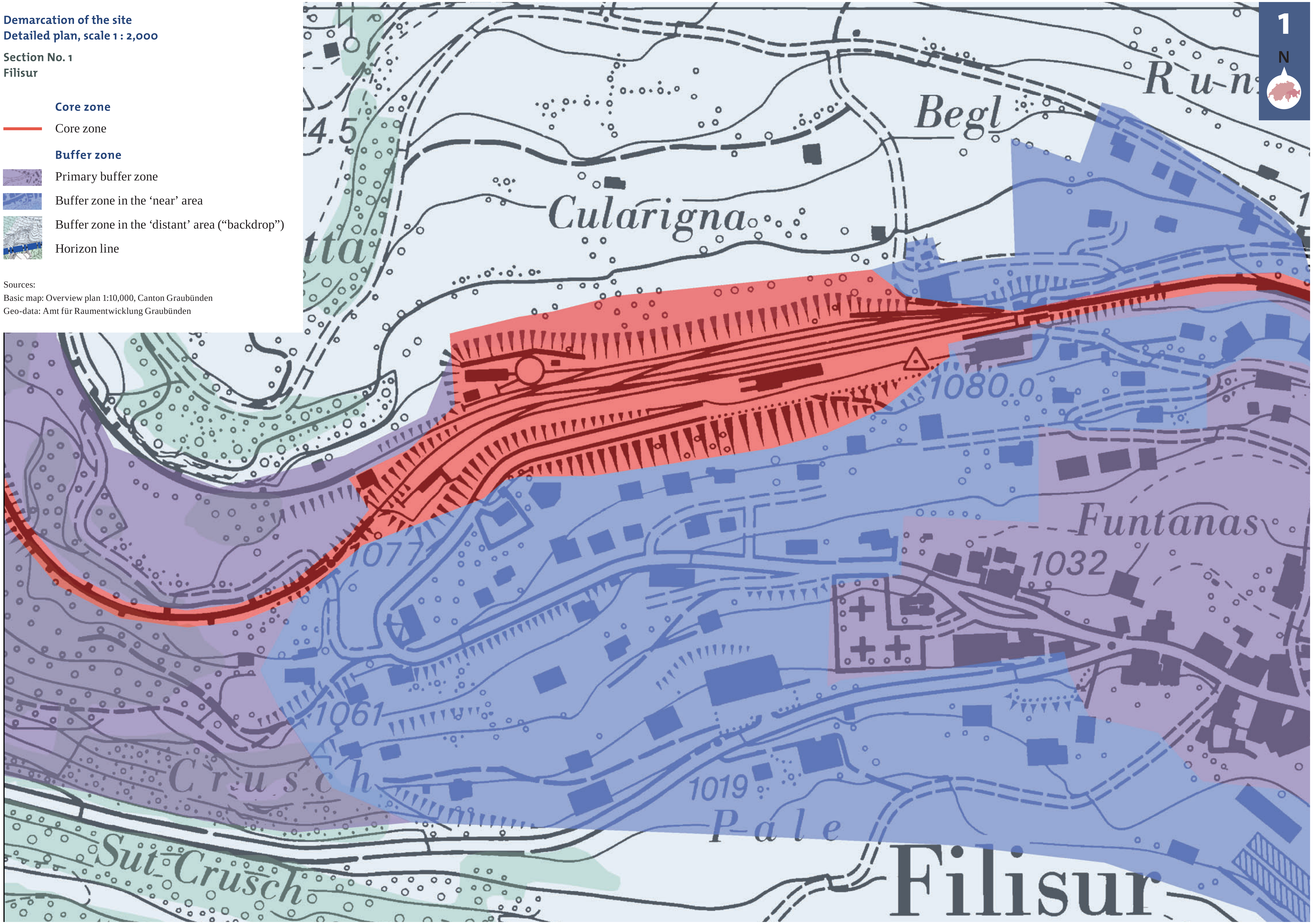
Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden



Selected sections, scale 1:2,000

Section No. 2

Stugl/Stuls

Demarcation of the site
Detailed plan, scale 1 : 2,000

Section No. 2
Stugl/Stuls

Core zone

Core zone

Buffer zone

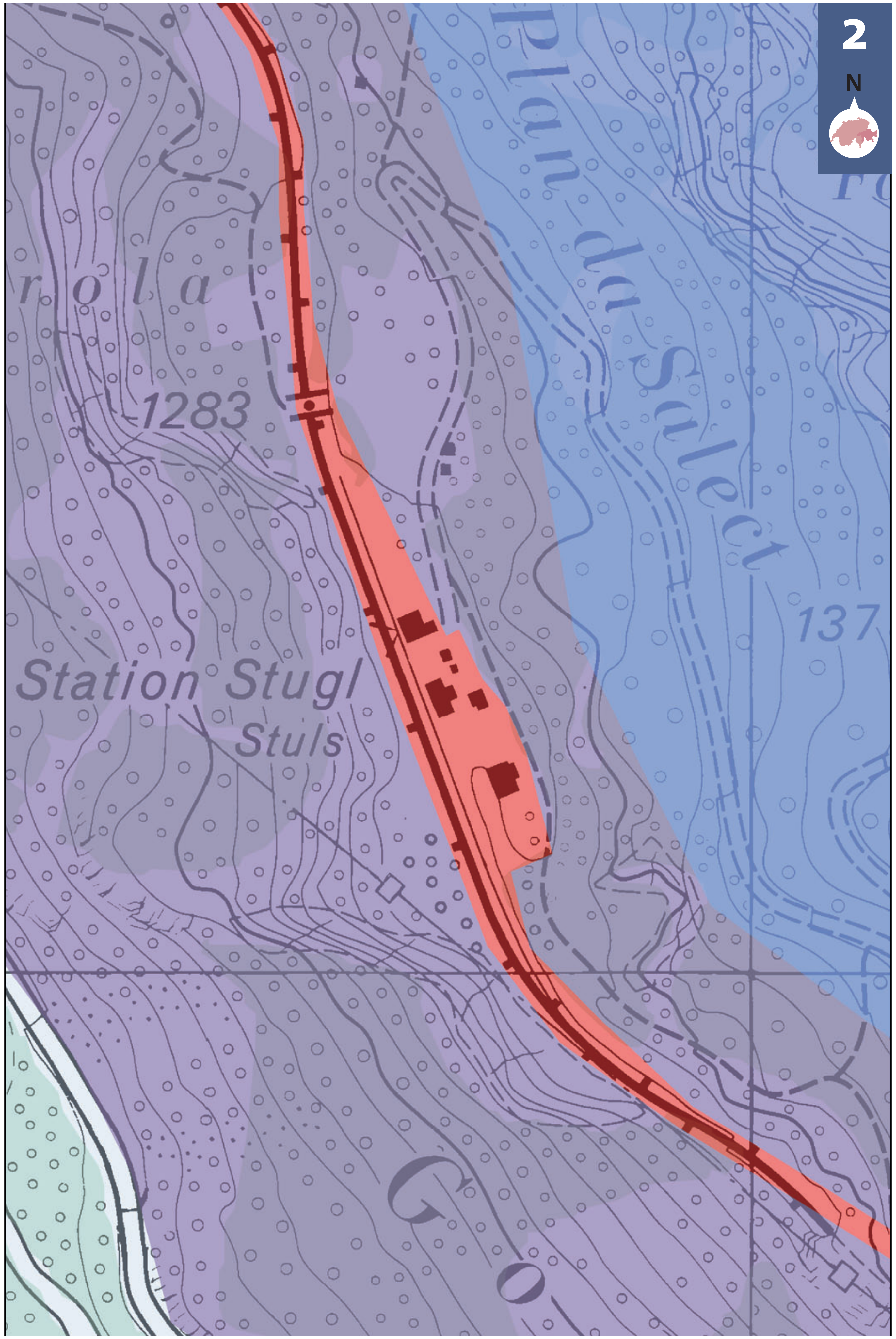
Primary buffer zone

Buffer zone in the ‘near’ area

Buffer zone in the ‘distant’ area (“backdrop”)

Horizon line

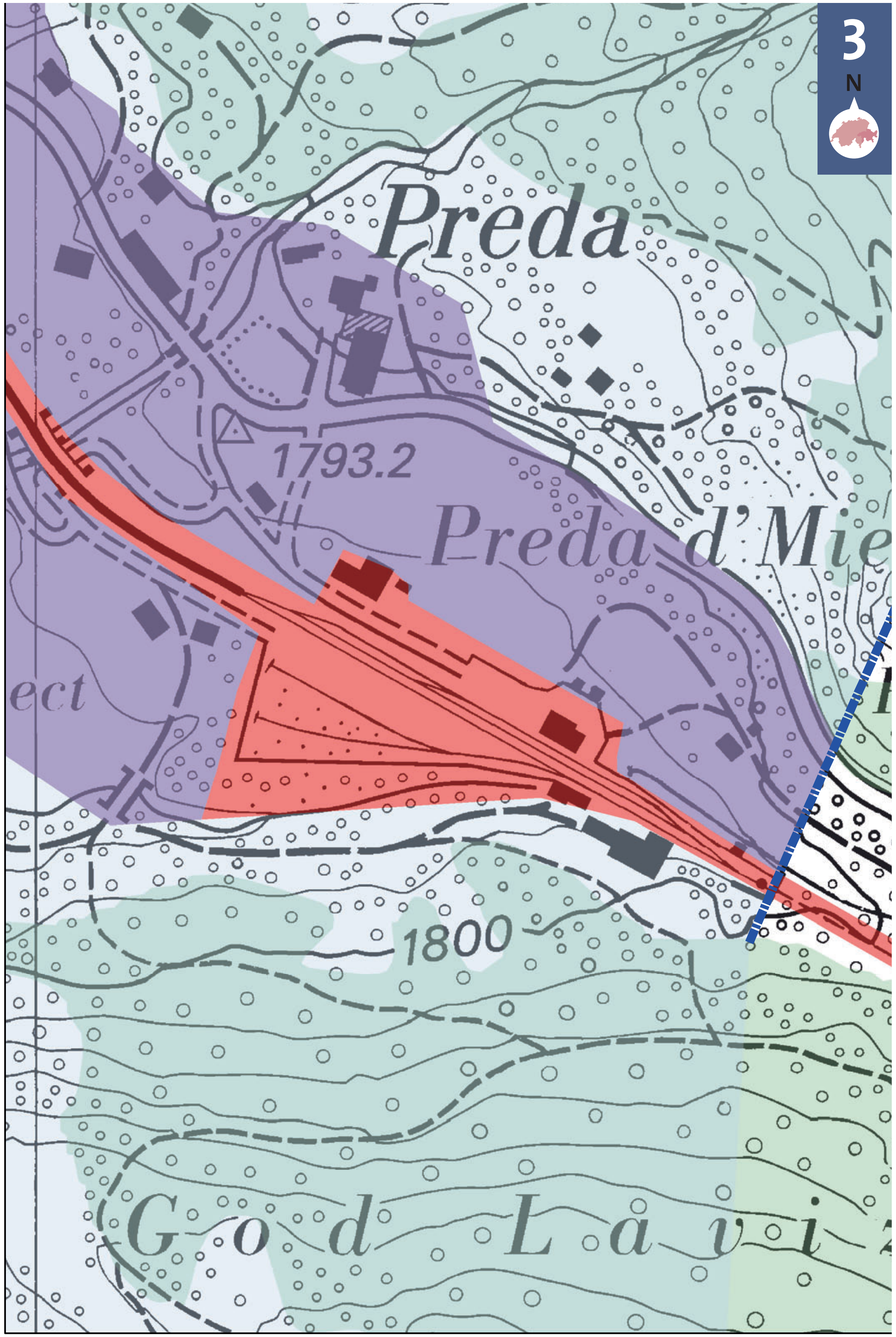
Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden



Selected sections, scale 1:2,000

Section No. 3

Preda



Demarcation of the site
Detailed plan, scale 1 : 2,000

Section No. 3
Preda

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

Selected sections, scale 1:2,000

Section No. 4
Bever

Demarcation of the site
Detailed plan, scale 1 : 2,000

Section No. 4
Bever

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the ‘near’ area

Buffer zone in the ‘distant’ area (“backdrop”)

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden

**Selected sections,
scale 1:2,000**

Section No. 5
Poschiavo

Demarcation of the site
Detailed plan, scale 1 : 2,000

Section No. 5
Poschiavo

Core zone

Core zone

Buffer zone

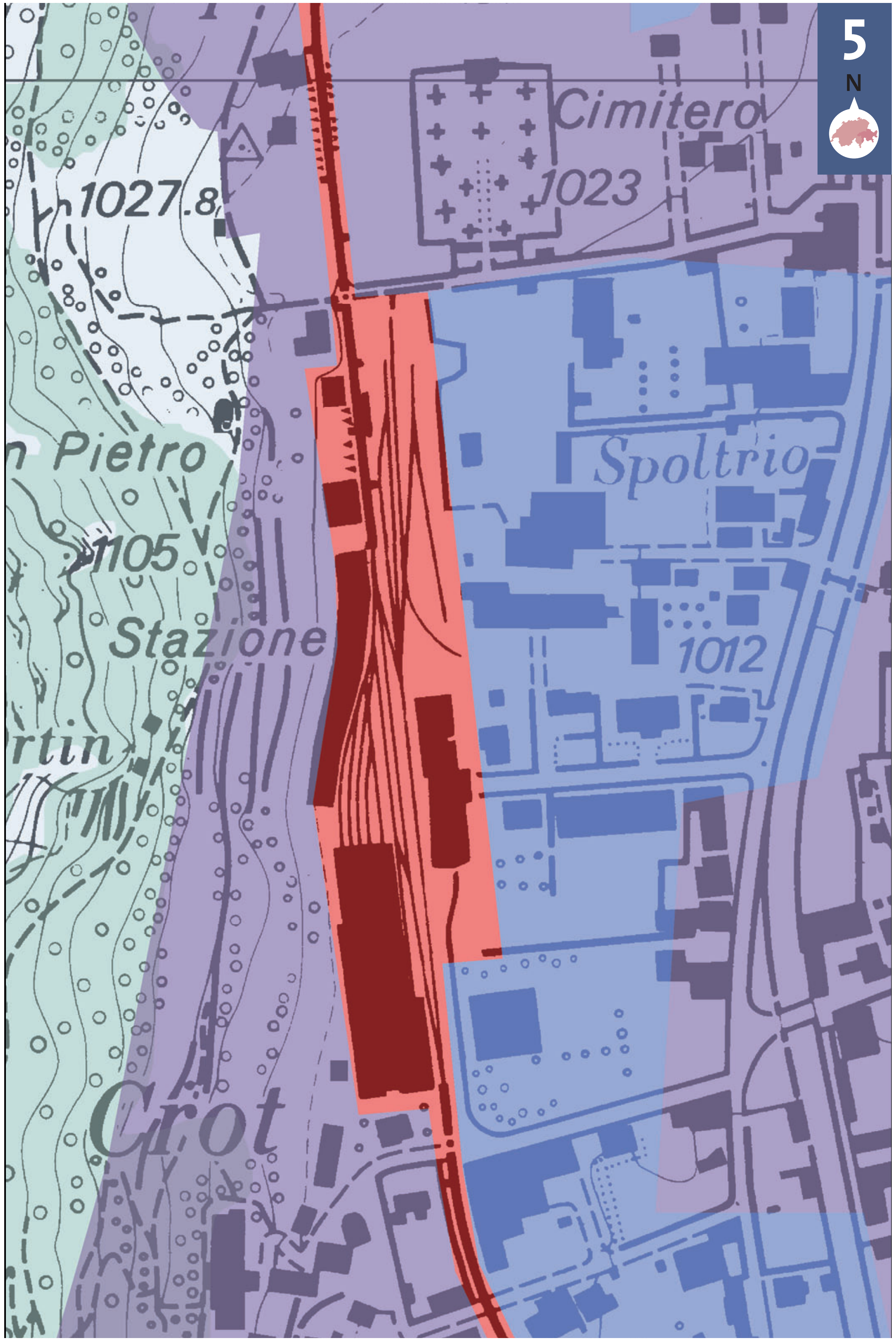
Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

Sources:
Basic map: Overview plan 1:10,000, Canton Graubünden
Geo-data: Amt für Raumentwicklung Graubünden



Management Plan

Candidature UNESCO World Heritage

Rhaetian Railway in the Albula/Bernina Cultural Landscape

Switzerland/Italy

21st December 2006

No. 1/14

Rhaetian Railway

Candidature UNESCO World Heritage

ALBULA/BERNINA CULTURAL LANDSCAPE

graubünden

Albula line > Glacier Express on the Landwasser Viaduct near Filisur.
D. Enz/Rhaetian Railway

Table of contents

Summary

Bernina line > The Rhaetian Railway's Bernina Express runs past fruit orchards below Campascio.
A. Badrutt/RhB

Summary

This Management Plan formally defines the international cooperation and organisational structure of the trans national candidature of the Rhaetian Railway in the Albula/Bernina Cultural Landscape. Specifically, it defines the mission statement and objectives for the future development of the site and sets out measures to assure its protection, preservation and sustained development.

Numerous administrative agencies in Switzerland and Italy currently implement the existing legal foundations and planning guidelines for the protection and development of the railway line and its associated cultural landscape. These are complex tasks, and the Convention Concerning the Protection of the World Cultural and Natural Heritage calls for special measures. At national level, the relevant Swiss and Italian authorities have concluded a "Memorandum of Understanding" about their future cooperation. A new body was founded for the specific work involved. It has the legal form of an Association whose activities and competences are defined in its binding articles. It can represent all those involved (administrative agencies of the government, communities, proprietors, non-governmental organisations and other interested parties). Several interdisciplinary panels of experts are formed to handle the various technical questions and to elaborate relevant measures on the basis of the required specialist knowledge and competences for their implementation.
At the time of the candidature, a charter was drawn up on the basis of the prepared mission statement: it represents a preamble to and forms part of the Articles of Association and is signed by all those involved. Taking into account the concept of sustained development, objectives were formulated for various topic sectors: they represent the starting point for the activity domains and measures to be implemented.

This main part of the Management Plan and in particular the agreed measures are understood in the sense of planning activities that are continuously developed in the coordinating discussions between the Association and all those involved. In addition, the Association is responsible for supervising the quality of the site. Indicators permit monitoring and controlling.

The management of the site is financed by existing and assured public funds and by contributions from the Rhaetian Railway. The Association is financed by graduated membership subscriptions: this means that the local members, especially the communities, are also integrated financially in the management of their site.

Finally, the Management Plan refers to the legal foundations, the spatial planning tools and the existing administrative structures that are used to implement the respective measures.

1. Introduction

Bernina line > The views of the Morteratsch glacier from the "Montebello" open loop are fascinating.
A. Badrutt/Rhaetian Railway

1. Introduction

The Management Plan sets out how the exceptional universal value of the Rhaetian Railway in the Albula/Bernina Cultural Landscape site will be preserved on the basis of a participative structure.

As presented in Chapter 5 of the candidature dossier, legal and planning measures are now in place for the protection of the Site and are implemented or supervised by various administrative agencies. The federal structure of the Switzerland means that the relevant competences are delegated to institutions at various government levels. Local government agencies are responsible for the Italian part of the stretch (municipality of Tirano). The management tasks do not involve implementation of the existing legal protection in the narrower sense (as this is handled by the duly legitimised government agencies), but rather the coordination of all the activities carried out on the site that are oriented to the qualities of the World Heritage. In addition, the management assumes specific tasks in connection with the nomination that had not hitherto arisen or were given insufficient attention. These include broadcasting the values and objectives of the UNESCO World Heritage Project as broadly as possible to the local inhabitants themselves, but also to the public and to political bodies. Even in existing close-knit regulatory systems such as those of Switzerland and Italy, high public awareness of matters concerning the cultural and natural heritage – and thus strong public interest in its preservation – strengthens both the statutory and planning aspects of the protection measures.

The first part of this Management Plan describes the management structures. All those involved must cooperate and coordinate their tasks in order to manage the site. Administrative agencies, proprietors, users and independent organisations can jointly implement interdisciplinary projects. An association in which governmental agencies are also represented and which is in principle open to all interested parties is the most suitable legal form for the sponsorship of the site. The Association's procedures are laid down in binding Articles of Association. Membership obligates all those involved to cooperate and to respect the values of the World Heritage Project as laid down in a Charter (Preamble). The international framework of the joint management between Switzerland and Italy was set out at national level in a "Memorandum of Understanding". The membership of the municipality of Tirano in the Association – as well as the membership of all other communities within the perimeter of the World Heritage Site – assures concrete cooperation in local and regional projects.

The second part of the Management Plan should be understood as a planning schedule for the work of the Association and its members. The Plan defines what the sponsors of the site understand by the key term of «sustained development». This definition assumes that the Rhaetian Railway is a unique cultural monument in the "living cultural landscape" of the Albula/Bernina region. Accordingly, it cannot be preserved as a mere museum piece with no real function: the railway must operate on a daily basis as a form of public transport in a cultural landscape that is utilised and cared for.

The planning schedule shows the manner in which the World Heritage Site of the Rhaetian Railway in the Albula/Bernina Cultural Landscape should be preserved over the long term. The site will be secured firstly by existing protection measures as well as new ones still to be set up (see Chapter 5 in the "Dossier" File), and secondly by active and dynamic further development oriented to the fundamentals of sustainable development as previously defined. For a detailed description of the unique values in line with the UNESCO Guidelines for the World Cultural Heritage, reference is made to the comprehensive candidature dossier which was worked out in scientific detail. The Management Plan is oriented to the municipal, cantonal, national and international administrative agencies, to the population, the environmental and cultural associations, the economy, to the scientific community and in general to all groups that are involved and interested in the protection and utilisation of the World Cultural Site of the Rhaetian Railway in the Albula/Bernina Cultural Landscape. In particular, however, the Management Plan represents an obligation for the sponsors and acts as an implementation tool.

2. Proposed Statement of Outstanding Universal Value

Albula line > The railway reaches the Engadin at Bever.
Photo: A. Badrutt/Rhaetian Railway

2. Proposed Statement of Outstanding Universal Value

The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" as proposed, comprises the railway line as a technical monument integrating – within precisely defined boundaries – the surrounding cultural landscape. The transnational perimeter of the site reflects all the mutually influential structural, cultural and natural factors of the phenomenon of railway in a broader context.

The outstanding universal value of the "Rhaetian Railway in the Albula/Bernina Cultural Landscape" can be substantiated with several arguments. The railway and its surrounding landscape constitute an inter-active "Gesamtkunstwerk". The construction of the railway line was made possible by the extraordinarily creative exploitation of technical, economic and socio-cultural influences: on the political level, the cohesion of the culturally and linguistically disparate areas of Canton Graubünden was an important objective that could be promoted with the construction of the railway. The Albula line, although designed as a narrow-gauge line due to the topography, was nevertheless conceived and operated like a standard-gauge mainline railway. The objective was to provide easy access to the Engadin, both in summer and winter. So the railway contributed to the development of a new branch of the economy: winter sports tourism. Tourism as such would become the key industry in the region. The railway line was subtly embedded in the varied cultural landscape, and continues to enrich it even today. The construction of the Bernina line was linked with that of the power plant to generate energy for Milan, which was then in progress following an Italian initiative, and benefited from the capital released by this project. Further, the demands of tourism were reflected in planning the alignment to enhance a special mountain experience for passengers travelling in the train. Consequently, a new technology was adopted for this section, building the mountain railway as an electric 'surface railway'. The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" is an outstanding example of a masterpiece, the creation by the diverse interaction between economics, politics, technology, culture and nature.

The complementary aspect – the combination of two different kinds of mountain railway, on the one hand with crest tunnels (and the equally technically demanding spiral tunnels) and on the other as a surface electric railway crossing a high altitude mountain pass in the open – the Albula/Bernina line is simultaneously unique and typical, an outstanding example of a railway in the mountains. Its major role in the history of railway construction and the quality of the achievement established the basis for the worldwide recognition it has enjoyed ever since it was first brought into service. It is essentially different from the mountain railways already figuring on the World Heritage List: the Albula line, as a masterpiece, constructed with lavish planning and excellent craftsmanship, represents the archetype of the mountain railway from the golden age of rail. With its many stone viaducts of varying heights and lengths, the complex, sometimes overlaid structures of the helical tunnels and the long crest tunnel, the meticulous and architecturally valuable design of the elevated structures, and finally the actual operation itself, it displays all the characteristics of a mainline railway, even though it was constructed with a narrow gauge. The Bernina line, on the other hand, an electric surface railway at a great altitude and with the extreme gradient of 70 ‰, opened up new technical territory. The Albula/Bernina section represents a special type of "high-altitude mountain railway": over a distance of some 130 km and with a maximum difference in altitude (1,550 to 1,700 m) it crosses a mountain range, from one side to the other. As a transnational line, it is a binding element in a separative topography: along its brief route, it crosses diverse landscape forms and several climatic zones, as well as three cultural regions, each with its own language and traditions.

Even at the time the railway was built, the outstanding quality of the landscape to be traversed was recognised and deemed worthy of preservation. Emphasis was put on harmonious integration of the railway infrastructure, while at the same time the alignment – particularly in the case of the Bernina line – was planned, as far as possible, to present the landscape to the traveller in all its magnificence as a landscape experience. The structurally created measures to enhance perception of the landscape during a rail journey together with the railway landscaping realised during construction are unique. Over a relatively short distance, the passenger can experience varied and spectacular natural phenomena and types of cultural landscape, each with its typical agricultural usage and very significant historic monuments. From the high alpine glaciers of the Bernina to the characteristically southern air of the Poschiavo and Veltlin, from the worldly tourist location of St. Moritz to the primal, alpine agrarian landscape of Bergün/Bravuogn, past a dense concentration of characteristic sacred and secular buildings: thanks to modern technology the traveller can experience the wonderful diversity of the alpine region almost in 'fast forward mode'. The "Rhaetian Railway in the Albula/Bernina Cultural Landscape" displays emblematically this synthesis of nature, culture and technology which has exerted a powerful influence on how the Alps have been perceived over the years: a vignette of cultural history.
At the same time – and closely linked with the aspect of landscape experience – the Heritage Site is an outstanding example for the development of a tourism-oriented Alpine cultural landscape. The extensive utilisation of the landscape for tourism, throughout the year, was only feasible with the advent of the railway. High-quality cultural landscape elements such as hiking and rambling paths, scenic vantage points with mechanical aids to reach them, such as on Muottas Muragl or the golf course in Samedan – the highest golf course in Europe when it was built (1,700 metres above sea level, founded in 1893) – and other exceptional structures, such as the impressive Grand Hotels, make this cultural landscape with its railway an exceptionally representative reflection of alpine tourism.

The characteristic elements of the Albula / Bernina cultural landscape are extremely well conserved. Even the entire infrastructure of the railway (alignment, engineering structures and buildings) is very well preserved in its original state. This is unique considering the railway is operating full time. Today, as a regular, scheduled railway, it transports both passengers and freight just as it did 100 years ago. It also has a unique fleet of historic rolling stock.

While the “Semmeringbahn” UNESCO World Heritage Site marks the beginning of accessing mountainous areas by rail, the Albula/Bernina line represents the golden age of mountain railway construction: it was only with the development of mechanical tunnelling machines in the second half of the 19th century that long tunnel constructions and special types of tunnel (such as spiral tunnels) could be erected within acceptable time and cost constraints. The construction of alpine mountain railways came to an end with the First World War. Since then, no new trans-alpine railways have been completed, while spiral tunnels no longer feature in contemporary rail construction.

3. Management Mission Statement

Bernina line > Bernina Express at Alp Grüm The Palü Glacier in the background.
A. Badrutt/Rhaetian Railway

3. Management Mission Statement

All activities and measures decided within the scope of the site management are based on a specific mission statement. It forms the foundation for the management of the nominated World Heritage Site and the various objectives, activity domains and concrete measures are derived from it.

Protection and preservation: Its designation as a UNESCO World Cultural Heritage Site implies the will to preserve – over the long term – the Rhaetian railway route in the Albula/Bernina Cultural Landscape, which is unique in the world. Careful use of this monument will allow the unique cultural historical characteristics of the railway and the Albula/Bernina Cultural Landscape to be preserved sustainably. Its protection and preservation presuppose its continued development as a World Cultural Heritage Site.

Sustainability: All actions affecting the World Heritage Site should be based on the principle of sustainability.

Use of the railway: As a mode of transport for occupational, leisure and tourist uses that preserves its environment, the railway is subject to changing natural, economic and social impacts. A high quality of further development adapted to these impacts should preserve the railway in accordance with its status as an exceptional cultural monument.

Use of the cultural landscape: The symbiotic interplay between the Cultural Landscape and the railway is a significant characteristic of the World Heritage Site. Suitably adapted cultivation and permanent settlement will create the conditions for preserving its unique historical features characterised by their traditional utilisation in the Albula/Bernina Cultural Landscape into the future.

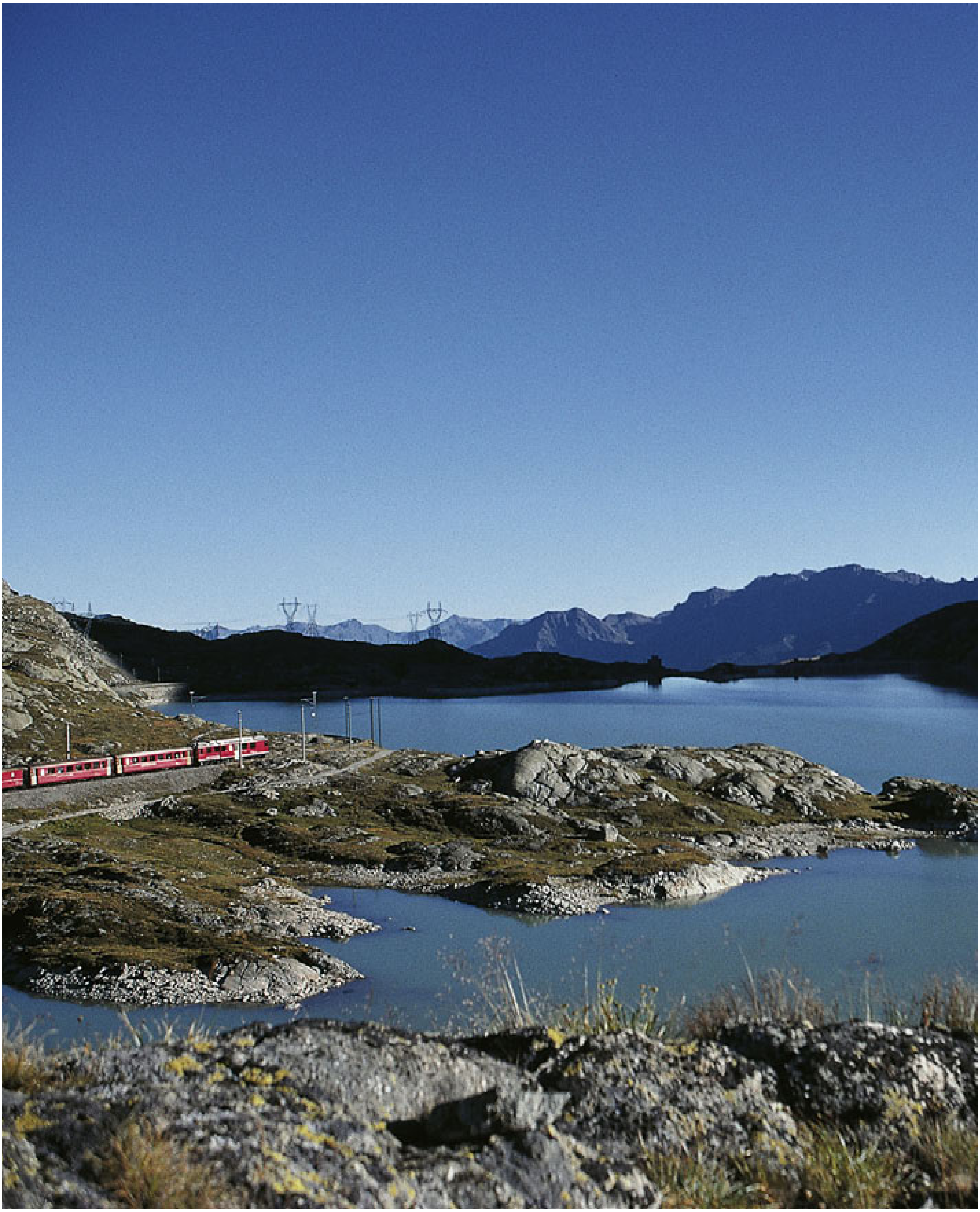
Identity and cultural diversity: The Albula/Bernina railway route links cultures, language regions and diverse landscape areas. The railway is a symbol of the cultural and natural diversity of the region and a former of identity as a part of the collective memory of the local inhabitants.

Awareness and information: The values and aims of the UNESCO World Heritage concept should be recognised and understood. The desired sustained development should be made authentically visible and accessible. Regional value added should be promoted and the local population as well as the broader public should simultaneously be made aware of the importance of preserving this cultural heritage.

International position and accessibility: The railway route in the Albula/Bernina Cultural Landscape is a unique internationally significant cultural asset with a high tourist reputation. These circumstances are communicated in a focussed way both internally and externally. The awareness of the cultural heritage among the regional population along the railway line and in the wider surroundings will be improved and the utilisation of the railway will be promoted. Relevant projects will be set up to allow the World Heritage Site to be more easily experienced and utilised for tourism.

4. Management Structure and Organisation

4. Management Structure and Organisation



Bernina line > Crossing the ridge of the Bernina alongside the Lago Bianco (white lake).
T. Keller/Rhaetian Railway

4. Management Structure and Organisation

4.1 Trans-border cooperation

The perimeter of the proposed World Heritage Site of the Rhaetian Railway in the Albula/Bernina Cultural Landscape extends from Thusis in Switzerland (start of the Albula line) to Tirano in Italy (end of the Bernina line). In the meaning of Art. 134 (b) of the “Operational Guidelines for the Implementation of the World Heritage Convention”, this is a proposal for a trans-national candidature. Consequently, Swiss and Italian institutions are jointly involved in the management of the site. The relevant national authorities of the two countries have concluded a “Memorandum of Understanding” for this purpose. It sets out the cooperation between the two contractual states at national level within the scope of their internal governmental organisations and affirms their joint obligation to protect and preserve the site. The Memorandum of Understandin was signed by the competent authorities on September 25, 2006.

4.1.1 Memorandum of Understanding

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Ministero per i Beni e le Attività Culturali

Dipartimento federale dell'interno DFI
Ufficio federale della cultura UFC

Dipartimento Ricerca, Innovazione ed
Organizzazione DRIO

Memorandum of Understanding

between the competent authorities of Switzerland and Italy

Ufficio federale della cultura

and the

Ministero per i Beni e le Attività Culturali

concerning

the joint World Heritage transnational nomination
„Rhaetian railway in the Albula/Bernina cultural landscape"

The *Ufficio federale della cultura* and the *Ministero per i Beni e le Attività Culturali* thereafter mentioned in the present document as the Parties submit together the "transnational Nomination of the *Rhaetian Railway in the Albula/Bernina cultural landscape* for inscription of the World Heritage List."

The Albula and Bernina railway lines are the central element of the World Heritage candidature. The Albula railway was completed in 1903, the Bernina Railway in 1910. The Albula line (Thusis to St. Moritz in Switzerland) was constructed as a classical mountain railway for operation with steam engines, the layout of the line and the engineering structures in local quarried stone mark the zenith of the classic railway building era. The Bernina railway (St. Moritz to Tirano in Italy) is an innovative adaptation of the electric interurban railway with an exceptionally clever layout integrated in a high alpine landscape. Today the Bernina railway is unique the world over: it is the highest altitude transalpine railway in Europe and one of the steepest adhesion railways in the world. The surrounding cultural landscape is proposed to be included in the World Heritage List in conjunction with the railway line being an integral part of the landscape. The cultural landscape's features of the past and the present interact with an alpine to high alpine natural landscape of spectacular beauty. Opening the Bernina line in 1910, the traditional historic routes between Italy and Switzerland – or between north and south – had been completed by a modern transport system. Ever since, the Rhaetian railway linked the two countries and became the emblematic sign of the strong common historic and cultural relations.

In 2004, the site was inscribed on the World Heritage Tentative List for Switzerland by the Swiss government. From the very beginning, the declared aim was to include the complete railway between Tirano in Italy and Thusis in Switzerland, thus to intend to collaborate between the Swiss and Italian authorities in order to prepare a joint nomination. In 2005, Italy inscribed its part on the Tentative List of Italy and in 2006, the nomination file had been completed by the collaborating responsible institutions in Switzerland and Italy and under the combined authority of the *Ufficio federale della cultura* in Switzerland and the *Ministero per i Beni e le Attività Culturali* in Italy.

According to the common procedures and guidelines based on the World Heritage Convention, each country is responsible to take care of the preservation and other management of the property within its territory. With their World Heritage candidature, the Rhaetian Railway and the *Cantone dei Grigioni* in Switzerland as well as the *Provincia di Sondrio* in Italy are expressing their commitment to the protection and preservation of the Albula and Bernina lines together with their cultural landscape. In section five of the Nomination Document are described the status and procedures of the national legislations, preservation and management. All this kind of activities are ruled and guided by each country itself, i. e. the basic responsibility for all kind of management and actions of individual properties must rest with the individual State Party and be carried out by each of them in accordance of their legislative and management systems.

However, there is a need for additional management collaboration. For this reason and according to the *Operational Guidelines for the implementation of the World Heritage List*, an Association is to be founded. The articles of association and its effective operational implementation are also described in the management plan. With this instrument, the commitment of the local communities both in Switzerland and Italy for a coherent management of the site is guaranteed and the same best practices and management rules for common issues concerning the World Heritage status are assured.

On the national level, the two Parties declare with this *Memorandum of Understanding* their common will to preserve the nominated transnational site following to the obligations of the World Heritage Convention.

The two Parties,

recognizing that the "Nomination of the Rhaetien Railway in the Albula/Bernina cultural landscape" is submitted together by Switzerland and Italy,

looking forward to continue the cooperation for the benefit and success of the nomination,

noting the Operational Guidelines for the Implementation of the World Heritage Convention,

recognizing the importance and the need of management collaboration in order to give the rules for joint management and to guide practical actions in both countries,

noting that all expenditures resulting of the actions foreseen in the management plan are to be borne by the management association or its members following the articles of association and that this agreement does not cause any direct financial contributions of the two signatories,

state to collaborate continuously after the successful nomination in order to protect and conserve this common heritage of outstanding and universal value, *aim* at a sustainable development of the cultural landscape, preserving its high quality and authenticity,

strive to preserve the cultural landscape's cultural and natural diversity and to enhance the Rhaetian railway as a common element of collective memory and cultural identity,

aim at reinforcing awareness of the importance of cultural heritage issues in general and of the quality and unique character of this border crossing heritage site in particular.

SWITZERLAND
Ufficio federale della cultura

Johann Mürner
Capo Sezione
Patrimonio culturale e monumenti storici

25/09/2006

ITALY
Ministero per i Beni e le Attività Culturali

Giuseppe Proietti
Capo Dipartimento
Ricerca, Innovazione ed Organizzazione

4.2 Association for the World Heritage Site of the Rhaetian Railway in the Albula/Bernina Cultural Landscape

A railway line and the cultural landscape surrounding it represent a complex monument, especially from the viewpoint of legal protection. Numerous monument-preservation, regional-planning and additional legal regulations relating to railways and spatial utilisation must be implemented. Within their scope, public authorities at national, regional and local level as well as private organisations and companies with diverse competences carry out various tasks. A coordinating body that includes everyone concerned has consequently been founded in order to manage this site in the sense of the World Heritage Convention: the Association for the World Heritage Site of the Rhaetian Railway in the Albula/Bernina Cultural Landscape (Rhaetian Railway World Heritage Association).

The Association has the objective of promoting the preservation and sustainable utilisation of this World Heritage Site. It aims at the coordination of all institutions concerned with the preservation and further development of the site. Its members are the Swiss Federation, the Canton Graubünden, the Rhaetian Railway, the communities within the perimeter of the Site (including the Italian municipality of Tirano) as well as organisations and persons having an interest in the Site, in particular also non-governmental organisations. The relevant Swiss national authority, namely the Federal Office of Culture (BAK), also represents the national Italian authority in this matter.

The Association is setting up a number of panels of experts in order to discuss specific technical questions and develop appropriate solutions. Three are initially planned: they will focus on the “Railway”, the “Cultural Landscape” and “Information and Use of Label”.

The legal form of the Association is laid down in Art. 60 ff of the Swiss Civil Code (ZGB; SR 210). Its organisation and activities are defined in binding Articles of Association. It is planned to attach the Association’s offices to the Rhaetian Railway. The Articles of Association also cover the financing of the Association: they stipulate that its activities will be funded principally from membership contributions.

4.2.1 Articles of Association

ARTICLES OF ASSOCIATION OF THE "UNESCO WORLD HERITAGE RHAETIAN RAILWAY IN THE ALBULA/BERNINA CULTURAL LANDSCAPE"
Draft: October 2006

CHARTER

The Rhaetian Railway in the Albula/Bernina Cultural Landscape, is a cultural asset of exceptional universal value. In assuming responsibility for it, members of the Association undertake to:

> safeguard the internationally significant monument of the Rhaetian Railway in the Albula/Bernina Cultural Landscape with appropriate measures for the protection and maintenance of its appearance, character and substance and to further develop it in observance of and compliance with the defined provisions, values and objectives of UNESCO and the charter for the protection of the Natural and Cultural World Heritage;
> coordinate and further develop the current protection and planning instruments for the railway and the cultural landscape;
> appraise the condition of the asset continuously using appropriate monitoring and surveillance measures and take all necessary steps to improve management of the Site;
> work together to this end, exchange information and resources and cooperate in order to achieve the common objective;
> secure, enhance and promote the cultural diversity of the region by implementing appropriate measures;
> recognise the identity-forming, conserving and protective qualities of the intangible values of the heritage and act accordingly;
> promote and support economically efficient and sustainable utilisation of the railway as an ecological means of transport;
> foster regional value-added with projects that underpin the precious cultural and historical attributes of the railway and the cultural landscape;
> assure the future of the UNESCO World Heritage by protection, economic utilisation and consequent value-added;
> attract the attention and increase the awareness of guests and inhabitants by providing high quality, authentic information and tourism services.

I. GENERAL PROVISIONS

Article 1
Name and Domicile of the Association
An association domiciled in Chur under the name Rhaetian Railway in the Albula/Bernina Cultural Landscape is constituted pursuant to the provisions of Art. 60ff. of the Swiss Civil Code ZGB.

Article 2 Purpose of the Association
The Association supports the "Rhaetian Railway in the Albula/Bernina Cultural Landscape" candidature for UNESCO World Heritage. In the event of inscription of the Site on the World Heritage List, it shall promote the conservation and sustainable utilisation of the World Heritage asset "Rhaetian Railway in the Albula/Bernina Cultural Landscape" and shall undertake the task entrusted to it by Canton Graubünden, the Federal Office of Culture and the Rhaetian Railway in the Management Plan.

Article 3 Financing of Activities

The requisite financial resources will be raised by:

a) membership contributions;
b) patron contributions;
c) sponsor income;
d) contributions from the public purse;
e) dues in connection with use of the label;
f) other yields and income.

Article 4 Use of Resources

[1] Association funds may only be used for the purposes stipulated in the Articles. Contributions paid will not be reimbursed in the event of resignation from or winding up of the Association.

[2] In the event of winding up and disbanding of the Association, or cessation of the previous purpose of the Association, the Assembly of Delegates shall decide on the utilisation of Association funds.

Article 5 Responsibility

The assets of the Association, and solely the assets, may be called on to meet the Association commitments. The Members are released from any personal financial obligation, in particular the obligation to replenish funds.

Article 6 Foundation of the Association

The Association shall be constituted by the acceptance of members on the occasion of a foundation meeting. This meeting shall approve the Articles of Association and the Organisation Regulations.

II. MEMBERSHIP

Article 7 Categories of Membership

The Association comprises the following categories of membership:

a) A-Members (with voting rights);
b) B-Members (without voting rights);
c) Honorary Members;
d) Patrons.

Article 8 A-Members (with voting rights)

[1] A-Members of the Association with voting rights may be

a) the Rhaetian Railway;
b) communities within the perimeter of the UNESCO World Heritage (core zone);
c) the Canton Graubünden;
d) the Federation.

[2] The Rhaetian Railway and the Canton shall each hold 60 votes, the Federation 40 votes and the communities together a maximum of 75 votes at the Assembly of Delegates.

[3] The distribution of the votes of the communities within the perimeter shall be determined in the Organisation Regulations taking into account specific interests and involvement (e.g. area within the core zone, tourism interests or number of inhabitants).

[4] A-Members acquire membership status by resolution of the foundation meeting or the Assembly of Delegates. Application for membership shall be made in writing.

Article 9 B-Members (without voting rights)

[1] B-Members of the Association without voting rights may be

a) organisations or institutions concerned by World Heritage;
b) persons or organisations fulfilling the conditions for utilisation of the label.

[2] B-Members have no voting rights and acquire membership status by resolution of the Executive Committee. Application for membership shall be made in writing.

Article 10 Honorary Members

[1] Honorary Members are natural persons or organisations who have been of service to the World Heritage.

[2] Honorary Members are appointed by the Executive Committee and have no voting rights.

Article 11 Patrons

[1] The Association may appoint Patrons to perform its tasks. Patrons have no voting rights.

[2] The Executive Committee shall decide on the acceptance of Patrons. Acceptance may be refused without stating the grounds.

Article 12 Members' Obligations

Members are bound to further the interests of the Association to the best of their ability. They shall comply with the Articles of Association, the Organisation Regulations and the resolutions of the Association's corporate bodies.

Article 13 Membership Contributions

[1] A-Members (with voting rights) are required to pay the membership contributions set out in the Organisation Regulations. These Regulations must be approved by the Assembly of Delegates. The Federation is exempted from the obligation to pay an annual contribution, but it may make financial allocations at its discretion.

[2] The sum total of contributions by A-Members shall be maximum CHF 78,000 per year divided between the Rhaetian Railway, the Canton and the communities in proportion to the number of votes held. The membership contribution for a single community within the perimeter shall not be less than CHF 200 and not more than CHF 2,800 (minimum CHF 200 and maximum CHF 400).

[3] Contributions by B-Members shall be at least CHF 100 and at most CHF 1,500, according to the specific interests and financial resources of each member.

[4] Honorary Members do not have to pay a contribution.

[5] The annual contribution for patrons shall be CHF 500 for organisations and CHF 100 for natural persons.

[6] Membership contributions shall be payable at the beginning of the association year.

Article 14 Termination of Membership

[1] Membership shall lapse upon voluntary resignation, or exclusion from or winding up of the Association. Resignation is subject to a one-year term of notice per end of year. Notice of resignation shall be submitted to the Executive Committee in writing.

[2] The Executive Committee may exclude members who have breached the purpose of, or been detrimental to the Association, or have not paid their contributions. Such resolution shall be adopted by simple majority and the excluded member notified in writing.

[3] Members who have resigned or been excluded shall not be entitled to any claim whatever against the Association. They shall lose all membership rights; nevertheless they shall be required to meet all commitments extant at the time of termination of membership. Membership contributions already paid in shall not be reimbursed.

III. ORGANISATION

Article 15 Corporate Bodies

The corporate bodies of the Association are:

a) the Assembly of Delegates;
b) the Executive Committee;
c) the Panels of Experts;
d) the Office(s) and;
e) the Auditors.

Article 16 Assembly of Delegates

[1] The Assembly of Delegates is the supreme governing body of the Association.

[2] The Assembly of Delegates shall comprise A-Member delegates.

[3] A-Members shall be entitled to one delegate each. Their voting rights are set out in the Organisation Regulations.

[4] B-Members, Patrons and Honorary Members may attend the Assembly of Delegates. They have no voting rights but may submit motions to the Assembly.

[5] The Executive Committee shall hold an Ordinary Assembly of Delegates annually.

[6] The Assembly of Delegates shall be held no later than six months after the accounts are closed. Every member shall be informed in writing of the items on the agenda 20 days before the scheduled date of such Assembly.

[7] The Assembly of Delegates shall be chaired by the President; his/her deputy if the President is incapacitated .

[8] All elections and resolutions approved by the Assembly of Delegates require a simple majority of votes of the members present. In the event of a parity result, the Chairman shall have the casting vote. In the event of a parity result at an election, the decision shall be taken by casting lots.

[9] An Extraordinary Assembly of Delegates shall be convened by the Executive Committee or the Assembly of Delegates in response to a duly substantiated motion put forward by at least 1/5 of the members or upon request of the auditors within 30 days of such application.

Article 17 Duties of the Assembly of Delegates

The Assembly of Delegates has the following prerogatives:

a) Approval of the minutes of the previous Assembly of Delegates;
b) Acceptance and approval of the annual and activity reports;
c) Acceptance and approval of the financial statements;
d) Acceptance and approval of the auditors' report and grant of discharge to the auditors;
e) Resolution on acceptance and exclusion of members;
f) Election of the Executive Committee, the President, the Vice President and the auditors;
g) Determination of the amount of membership contributions and budgets;
h) formation of an Appeals Board to deal with refusals of candidates for membership and exclusion of members by the Executive Committee;
i) Resolution on amendments to the Articles of Association and the Organisation Regulations;
j) Resolution on the winding up of the Association;
k) Resolution on motions;
l) Approval of further panels of experts.

Article 18 Association Year

The Association year shall run from 1st January to 31st December.

Article 19 Motions

Resolutions of the Assembly of Delegates shall only be valid for items of business shown on the agenda. Motions to the Assembly of Delegates shall be submitted to the Executive Committee in writing before the close of the Association year.

Article 20 Executive Committee

[1] The Executive Committee shall comprise five persons and be chaired by the President. The various communities, the Canton and the Federation shall each be entitled to one seat and the Rhaetian Railway to two seats on the Executive Committee.

[2] Subject to the exceptions provided for in Art. 17 f, the Executive Committee shall constitute itself.

[3] Members of the Executive Committee may also be delegates.

[4] Term of office for the Executive Committee shall be four years. By-elections shall apply solely for the remaining term of office.

[5] The Executive Committee shall be convened by the President or the Vice President if the President is incapacitated, stating the items on the agenda. The Executive Committee shall also be convened upon request of at least three of its members.

[6] Resolutions of the Executive Committee shall only be valid for items of business entered on the agenda. Resolutions may only be adopted on items of business not duly entered if the Executive Committee has expressly resolved that such business may be handled. The Executive Committee shall pass its resolutions by a simple majority. In the event of a tie, the President shall have the casting vote.

[7] The Assembly of Delegates may dismiss the entire Executive Committee or individual members from office at any time. Members of the Executive Committee may at any time give written notice to the President that they wish to step down; the resignation of the entire Executive Committee shall be tendered to the Assembly of Delegates. In the event of the President stepping down, the Association shall be chaired by the Vice President until the next Assembly of Delegates.

Artikel 21 Aufgaben des Vorstandes

[1] The President shall represent the Association, vis-à-vis authorities, organisations and third parties. He/she convenes sessions and meetings and presides over them.

[2] Operation of the Association is incumbent on the Executive Committee. It shall assume such duties as are not the prerogative of other constituent bodies of the Association pursuant either to the law or the Articles of Association. In particular, the competence of the Executive Committee shall be responsible for:

a) Organisation of the business office(s) insofar as these are not provided by the Rhaetian Railway;
b) Allocation of tasks to the office(s) and monitoring of work done by the office(s);
c) Compilation and approval of the internal regulations for the business office;
d) Acceptance and exclusion of B-Members, Honorary Members and Patrons;
e) Motion for approval of the financial statements to the Assembly of Delegates;
f) Motions on the budget and membership contributions to the Assembly of Delegates;
g) Administration of Association assets;
h) Performance of the duties set out in the Management Plan in conjunction with the partners concerned;
i) Preparation of annual and activity reports for the Assembly of Delegates;
j) Convocation, organisation and conduct of the Assembly of Delegates;
k) Execution of resolutions adopted at the Assembly of Delegates;
l) Regulation of the mode of authorised signature of the Association;
m) Appointment of the panels of experts, issue of instructions to and surveillance of the same;
n) Constitution of working groups.

Article 22 Panels of Experts

[1] The Executive Committee shall set up the following panels of experts:

a) Panel of Experts – Railway (monitoring and controlling – railway);
b) Panel of Experts – Cultural Landscape (monitoring and controlling – cultural landscape);
c) Panel of Experts – Information and Use of Label.

[2] Further consultative panels may also be appointed. The Assembly of Delegates shall determine when a new panel should be formed.

[3] Depending on their area of expertise, members of these panels are drawn from representatives of the Federation, the Canton, the Rhaetian Railway, the communities within the UNESCO World Heritage perimeter and Graubünden Ferien or from the ranks of other specialists. Persons who are not members of the Association may be members of the panels of experts.

[4] The panels of experts promote and support the efforts of the Association and perform the tasks assigned to them by the Executive Committee to the best of their ability. They facilitate contacts with the regional, cantonal, national and international bodies in connection with the UNESCO World Heritage, channel information to the authorities at these levels and ensure that the objectives and activities of the Association comply with the federal and cantonal laws and strategies.

Article 23 Office(s)

[1] The Office is run by the Rhaetian Railway. If not organised by the Rhaetian Railway, the Executive Committee shall elect and appoint the central Office(s).

[2] The powers and responsibility of the Office(s) are set out in internal regulations.

Article 24 Statutory Auditors

[1] The Assembly of Delegates shall elect two statutory auditors and a substitute auditor none of whom may be members of the Executive Committee.

[2] The auditors are responsible for supervising the financial administration, monitoring cash-in-hand and auditing the closing of accounts. They report on their findings to the Assembly of Delegates.

[3] The auditors' term of office shall be four years. The auditors may be re-appointed for a maximum of two further terms.

[4] The provisions governing the exclusion and resignation of members of the Executive Committee apply analogously for auditors.

[5] Instead of two auditors, an independent auditing company may be entrusted with these duties.

Article 25 Cooperation with Italy

The Federation shall regulate cooperation with Italy in a Cooperation Agreement and represent the interests of Italy on the constituent bodies of the Association.

IV. FINAL PROVISIONS

Article 26 Voluntary Dissolution of the Association

[1] The voluntary dissolution of the Association may be resolved by a 2/3 majority of the votes cast at an Extraordinary Assembly of Delegates convened for this purpose.

[2] The Assembly of Delegates shall decide on the distribution of the positive assets of the Association at the time of dissolution.

Article 27 Concluding Provisions

[1] Cases not regulated in the present Articles of Association shall be decided by the Executive Committee subject to the reserve of approval by the next Assembly of Delegates.

[2] Further, the relevant legal provisions pursuant to Art. 60 ff of the Swiss Civil Code (ZGB) shall apply.

Place:

The President: The Recorder:

4.2.2 Agencies

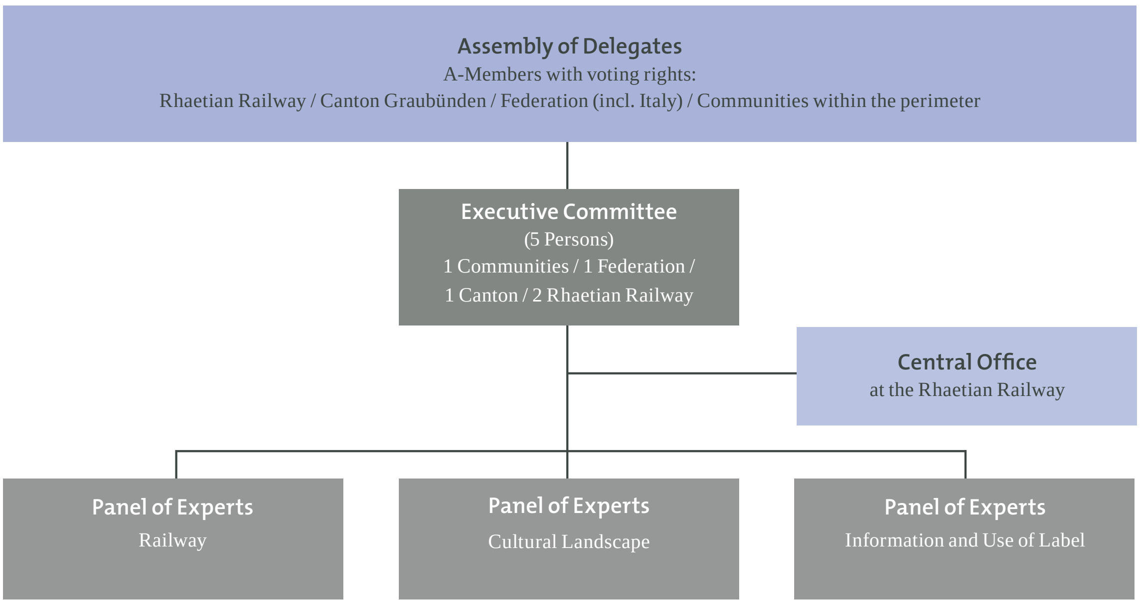
The following administrative offices, public-law institutions, associations and private companies are responsible for various aspects of the World Heritage Site:

> Swiss Federal Office of Culture
> Swiss Federal Office of the Environment
> Swiss Federal Office of Spatial Development
> Graubünden Office of Spatial Development
> Graubünden Office for Nature and the Environment
> Graubünden Office for Agriculture and Geo-Information
> Graubünden Office of Culture, Care of Historic Monuments Section
> Rhaetian Railway
> Regional Associations within the perimeter of the World Heritage Site
> Municipalities within the perimeter of the World Heritage Site
> Environmental and Cultural Associations

The following partners are responsible for providing information and preparing initiatives:

> Rhaetian Railway
> Graubünden Vacation
> Tourist organisations within the perimeter
> National organisations such as Swiss Tourism (IG Swiss Heritage)
> Other participating funding agencies and tourism organisations

Structure and constituent bodies (Association "UNESCO World Heritage Rhaetian Railway in the Albula/Bernina Cultural Landscape")



5. Funding

Albula line > Aerial view of Tiefencastel; above left the Carolingian monastery church of St. Peter, Mistail.
D. Enz/Rhaetian Railway

5. Funding

The Association for the UNESCO World Heritage Site of the Rhaetian Railway in the Albula/Bernina Cultural Landscape (Rhaetian Railway World Heritage Association) is funded by the contributions of its members. An annual budget of between CHF 50,000 and 100,000 is planned: most of this will be funded by the Canton Graubünden, the Rhaetian Railway and the communities. The remainder will be borne by the other members

The measures for the preservation and sustained development of the railway and its cultural landscape will in principle be funded by the proprietors of the nominated World Heritage Site. These endeavours will also be supported by state funding. Thus the Rhaetian Railway receives significant public funding for its transport services as well as for the maintenance and overhaul of its railway infrastructure.

The Albula and Bernina route with all its fixed railway installations and the entire rolling stock is financed by the Rhaetian Railway. The latter's principal sources of income are the revenues from passenger and goods traffic as well as public funding: the Swiss Federation and the canton pay transport companies a regional traffic subsidy for unfunded costs arising from services in the transport or infrastructure sector (as stipulated in the Railway Law EBG; SR 742.101). Additional investments in the infrastructure sector that are not covered by this subsidy may be eligible to payments from a special infrastructure fund of the federation and canton. These sums are interest-free loans repayable under certain conditions. In 2005 payments for traffic and infrastructure totalled CHF 116.2 million (Federation CHF 103.5 million and Canton Graubünden CHF 12.7 million). Public investments used for the renovation and extension projects of the Rhaetian Railway totalled CHF 78.4 million in 2005 (Federation CHF 66.4 million and Canton Graubünden CHF 12 million). Moreover, uninsured damages due to stormy weather that exceed the railway's financial resources can be underwritten by the federation. The federation also contributes financially to promoting combined traffic and the transport of accompanied motor vehicles by rail.

In addition to the Railway Law, public funding may be based on other legal foundations. Thus investments may also be made on the basis of the law for the equal treatment of disabled persons or on noise protection regulations. The various financial flows in public transportation are in principle component parts of the financial planning of the federation and canton. The funding of the railway infrastructure is currently being reorganised.

The framework conditions for assuring the authenticity and integrity of the cultural landscape over the long term are specified by the spatial planning guidelines. Ultimately, however, the proprietors themselves are responsible for maintaining the cultural landscape and developing it in line with sustainability criteria. Existing promotional tools and systems may be used to secure funding. Thus agricultural businesses receive direct payments based on land areas: they are linked to ecological conditions. Direct payments to farming operations in the Albula/Bernina region currently amount to approximately CHF 16 million annually. In addition, annual contributions of CHF 4 million are paid to the agricultural sector (investments and transhumance). Payments are also made to the forestry sector. Regional policy instruments are available to promote mountain areas, rural areas and border regions. The costs for the advisory services for planning buildings and installations (cf. Chapters 6 and 7 as well as 5b of the candidature dossier) are as a rule passed on by the communities (building authorities) to the building contractors.

Subsidies are made available by the federation and/or the canton for the appropriate restoration of buildings in accordance with the guidelines for preserving monuments as stipulated in the relevant legislation.

All PR work, such as public information programmes, is carried out by the sponsors, the Rhaetian Railway and interested organisations. It is financed separately by those concerned. Additional specific projects such as visitor guidance or the development of tourist programmes are carried out by the partners involved.

6. Activity planning

6. Activity planning

Bernina line > Bernina Railway on the Morteratsch plain. "Piz Palü" in the background.
A. Badrutt/Rhaetian Railway

6. Activity planning

All activities concerning the site are subject to the principle of sustainability. Because the term sustainable development tends to be very broadly defined, it must be modified to express the reality of the nominated site. What does sustainable development mean in this specific case? What principles are the sponsors obliged to observe? To answer these questions, the principle of sustainability is defined specifically for the Site and relevant actions are derived from it.

The management of the railway line and the cultural landscape surrounding it touches on various activity domains: the railway, the cultural landscape, economics and tourism, organisation, international and national cooperation. Objectives have been formulated for these domains and their various sectors, and specific measures have been derived from them. Responsibility for these measures devolves on the Association as the sponsor or the relevant technical committees and competent authorities represented in the Association. These assure their correct implementation.

Structure of the activity planning programme: activity domains, objectives, sectors and measures.

SUSTAINABLE DEVELOPMENT
(activity maxims)

Activity domains

	1 Railway	2 Cultural landscape	3 Economy/Tourism	4 Organisation	5 Cooperation
Objectives O	Railway O1	Cultural landscape O2	Economy/Tourism O3	Organisation O4	Cooperation O5
Sectors S	Railway S1	Cultural landscape S2	Economy/Tourism S3	Organisation S4	Cooperation S5
	S 1.1 Protection, maintenance and further development S 1.2 Documentation S 1.3 Safety S 1.4 Public transport S 1.5 Railway museum/information center	S 2.1 Protection and care, biodiversity, landscape aesthetics S 2.2 Forestry S 2.3 Agriculture S 2.4 Settlement and building consulting	S 3.1 Railway programmes S 3.2 Natural and cultural landscape programmes S 3.3 Agricultural and forestry programmes S 3.4 Tourist programmes S 3.5 Regional development S 3.6 Networking S 3.7 Logo use and brands	S 4.1 Quality management association S 4.2 Coordination with administrations S 4.3 Monitoring and controlling S 4.4 Finances S 4.5 Communications	S 5.1 Cooperation with Italy S 5.2 National and international cooperation projects
Measures M	Railway M1	Cultural landscape M2	Economy/Tourism M3	Organisation M4	Cooperation M5

6.1 Sustainable development

6.1.1 Clarifying the concept of sustainability

At the Earth Summit in Rio de Janeiro in 1992, 180 countries undertook to implement a plan of action for the 21st century. This action plan, also known as Local Agenda 21 or LA21, attempts to find a balance between economic, social and ecological demands in development questions.

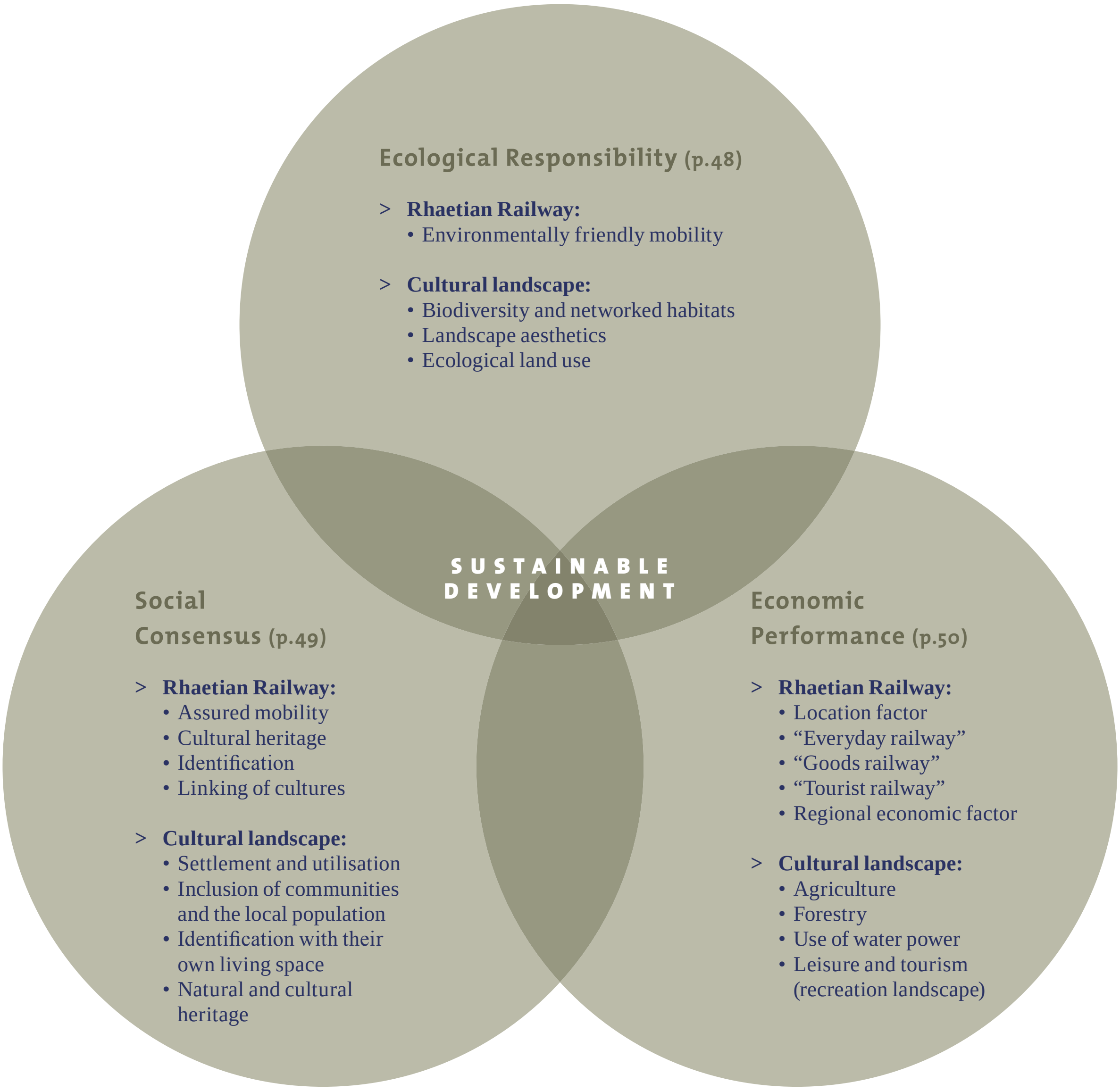
By signing the Rio Declaration (1992) and Agenda 21, the Swiss Federation has committed itself to sustainable development and consolidated its intention by integrating this concept in its revised Federal Constitution (1999). In the year 2002, the Swiss Federal Council passed the "Strategy for Sustainable Development 2002": the Management Plan takes this report into account.

The definition of sustainable development that has acquired the greatest significance is the one stated in the Brundtland Report (World Commission on Environment and Development, 1987): "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This anthropocentric definition of sustainability underscores the future aspect of sustainable development. This means that sustainability is inevitably liable to uncertainty. So there can be no final criteria and definitions of sustainability. The objectives of sustainability must be continuously examined and negotiated within the political process. In particular, it is clearly essential to apply generally applicable statements and target formulations in the sector of sustainability to concrete conditions and specific contexts.

6.1.2 Understanding and defining sustainability for the World Heritage Site

Like those who drafted the Brundtland Report, the sponsors of the Rhaetian Railway World Heritage place the human being at the centre of the sustainability concept. Our ancestors created the cultural asset of the Rhaetian Railway over a century ago with a unique and pioneering engineering feat. The cultural landscape reflects the cultivation of the land by man over centuries and right up to our present time. The Rhaetian Railway has continued to mould the identity of the local population up to the present: it connects the trilingual Canton Graubünden with the Veltlin valley in Italy and thus promotes an understanding for cultural diversity. The intact cultural landscape and the imposing natural landscape form the economic basis for agriculture and tourism, the latter being the economic mainstay of the Canton Graubünden. The Rhaetian Railway continues to play an important role in the daily life of the population as well as for visitors and the economy as a system of public transport for passengers and goods.

The sponsors of the World Heritage Site see sustainable development – in reference to the cultural landscape and the Rhaetian Railway – as a balance of interests between economic performance, social consensus and ecological responsibility



Ecological responsibility

Rhaetian Railway:

> ***Environmentally friendly mobility:*** From an ecological standpoint, increasing mobility has led to the greatest negative impacts. Individual motor traffic in particular gives rise to various environmental problems that also damage the associated living space in economic terms. The railway is a form of public transport that preserves the environment and offers a high level of performance.

Cultural landscape:

> ***Biodiversity and networked habitats:*** Large parts of the cultural landscapes within the perimeter of the Rhaetian Railway World Heritage Site are characterised by closeness to nature and a high degree of biodiversity. Various methods of cultivation under diverse climatic conditions and among alternating geological formations have led to the emergence of unique forms of plant and animal life. The sustained utilisation of this landscape and the promotion of networked habitats contribute to the preservation of biodiversity in the region.

> ***Landscape aesthetics:*** Small-scale and highly structured landscapes, such as terraced landscapes, bring out the natural beauty of the countryside. The nomination for a World Heritage Site enhances the awareness of the landscape and thus assures its protection.

> ***Ecological cultivation:*** Swiss agricultural policy uses a system of direct subsidies and special incentives to support ecological cultivation of the farmed landscape. This corresponds to the objectives of the World Heritage, because biodiversity is supported, the landscape is cared for and its protection is assured. Local and ecologically grown produce is also becoming increasingly popular.

Social consensus

Rhaetian Railway:

> ***Assured mobility:*** The Rhaetian Railway is an important and safe mode of transport. Access by public transport is also important for social reasons, especially in rural areas.

> ***Cultural heritage:*** The Rhaetian Railway represents an outstanding cultural heritage. It was a major pioneering achievement that required a great deal of courage and skill when it was built over a hundred years ago. It is important to maintain awareness among the local population and the public for this historic cultural achievement.

> ***Identification:*** The Rhaetian Railway is part of the collective memory of the population living along the railway line. On the one hand as an everyday mode of transport, on the other as an outstanding cultural heritage that attracts many visitors and whose reputation has spread around the world in numerous images.

> ***Linking of cultures:*** The Rhaetian Railway connects areas of great cultural diversity extending beyond its national borders. The Albula/Bernina route traverses three language regions. It links localities and cultural landscapes that are worth preserving.

Cultural landscape:

> ***Settlement and utilisation:*** A cultural landscape has been marked by human activity and is subject to cultural change. Without settlement and utilisation, it loses the character of a cultural landscape and its cultural values. So the settlement and utilisation of the landscape represent central preconditions for its continued existence as a cultural landscape.

> ***Inclusion of communities and local population:*** Close cooperation with the affected communities already began during preparation of the candidature. The communities and interested groups will be included in the sponsorship and consensus-finding process with regard to questions of general development and specific subprojects resulting from the World Heritage label as well as for future interaction with the World Heritage Site.

> ***Identification with the living space:*** Only by being aware of the background and the quality of their own living space can its inhabitants learn to appreciate it and use it in a responsible manner. Educational and experiential programmes enhance the awareness of both the local population and visitors to the region for the natural and cultural values of the cultural landscape.

> ***Natural and cultural heritage:*** The natural and cultural heritage is preserved by carefully focused development. The cultural landscape continues and will continue to be managed and used.

Economic performance

Rhaetian Railway:

> ***Location factor:*** The Rhaetian Railway in the Albula/Bernina Cultural Landscape encompasses the Albula, Upper Engadin, Poschiavo and Veltlin valleys. This makes it an important location factor for the regional economy. A region's accessibility plays a key role for its economic activity and population numbers.

> ***Everyday railway:*** The Rhaetian Railway is an "everyday railway" for the local population. It is the everyday mode of transport for numerous commuters and thus enhances the attraction of the residential localities in the otherwise remote valleys. Additional initiatives and awareness programmes can increase the attractiveness of the Rhaetian Railway still further as a mode of public transport.

> ***Freight railway:*** The Rhaetian Railway also opens up the Albula/Bernina regions as a "freight railway" and thus makes a significant contribution to a form of goods transport that minimises the impact on the environment.

> ***Tourist railway:*** Tourism is the principal industry of the Canton Graubünden. The Rhaetian Railway allows visitors to arrive with minimum environmental impact and represents a local form of transport that offers them a rich variety of experience. If existing transport schedules can be optimised and extended, demand for the Rhaetian Railway as a "tourist railway" can be further enhanced.

> ***Regional economic factor:*** The Rhaetian Railway is operated on the basis of sound business principles. It is a source of employment in the regions through which it passes.

Cultural landscape:

> ***Agriculture:*** The cultural landscape is maintained and managed by agriculture. The mountain landscape is of great economic significance in the Albula/Bernina region. Agriculture produces food and other produce specific to the region. Together with government support for ecological farming, all sectors of agriculture offer an income to large parts of the population in the valleys.

> ***Forestry:*** The forest plays a diverse role for nature and for people, principally as protective ground cover, as a recreation area and for timber production. The mountain forest has an irreplaceable protective function for settlements and transport installations. To allow the forest to fulfil its function, it must also be appropriately managed.

> ***Harnessing water power:*** The importance of the Alps as "Europe's reservoir" will become even greater in future: On the one hand as a source of drinking water, on the other for ecologically sustainable power generation with renewable resources. Hydroelectric power has traditionally been an important economic factor in the Albula/Bernina region and is a pronounced feature of the cultural landscape.

> ***Leisure and tourism (recreational landscape):*** The region's landscape with its wealth of natural and cultural attractions allows visitors to relax and recuperate. These qualities of the landscape should be preserved, it should be kept accessible and used with care.

6.2 Aims, activity domains and measures

The aims and activity domains as well as the concrete measures derived from them for the protection and development of the World Heritage Site will be defined in the following section. This represents the actual planning schedule – divided up into various activity domains – of the Rhaetian Railway World Heritage Association.

The Rhaetian Railway World Heritage Association was founded to enable clearly oriented cooperation between the responsible institutions. This cooperation is directed specifically to the preservation and development of the World Heritage Site. By coordinating the activities of all participating institutions, correct implementation of jointly formulated measures should be assured.

The plan of measures will be further processed in the implementation phase – following inclusion in the World Heritage List – by the relevant technical committees or in thematic participatory processes. The activity domains and measures listed below represent the initial steps of the actual implementation. Further measures will be coordinated and decided on in the newly formed Association. They will be implemented by the legally responsible administrative agencies represented in the Association.

6.2.1 Activity Domain 1: the Railway

Responsibility for Activity Domain 1

> Rhaetian Railway
> Panel of Experts - Railway and Rhaetian Railway World Heritage Association
> Executive Committee Rhaetian Railway World Heritage Association
> Responsible administration agencies

Aims

> The unique structural and cultural heritage of the Rhaetian Railway in the Albula/Bernina region is to be preserved by maintenance and renovation measures appropriate to the care of historical monuments. In view of the historical significance of the railway, its technology should be continuously adapted to changing requirements without its infrastructure losing its original character.
> Safety will be assured by suitable protective measures for the cultural monument and the users of the railway.
> The cultural values of the railway will be authentically and competently implemented by improving existing services and developing new ones.
> As a public and environmentally benign mode of transport, the railway will be promoted with attractive offers for visitors, the local population and users of the freight services.
> The effective frequency of use of the railway as a mode of transport for tourists and commuters will be increased within the scope offered by the infrastructure. The volume of freight transported will be maintained. This will create the economic basis for the long-term preservation and sustainable development of the Albula and Bernina route.

Sector

1 .1 Protection, maintenance and further development

Measures

M 1.1-1 The condition of all railway structures (bridges, tunnels, supporting walls, protective structures, above-ground structures, tracks, electrotechnical installations, catenaries) will be systematically recorded and evaluated.

M 1.1.-2 The systematic recording of these conditions will be regularly reworked.

M 1.1.-3 Necessary renovations and adaptations of the cultural structures will be carried out with modular modes of construction and concepts with the aid of external experts and/or the cantonal monument preservation service.

M 1.1-4 Design advice: External experts or the cantonal monument preservation service will be called in to design new above-ground structures and in the event of significant changes in the appearance of existing structures of this kind.

Sector

1.2 Documentation

Measures

M 1.2-1 Further processing and set-up of an archive and documentation centre for the World Heritage Site within the Rhaetian Railway company.

M 1.2-2 Identification of existing material (from the government, private sources, organisations and associations) and set up a documentation system.

M 1.2-3 Initiation and support of cooperation within the scope of research projects in connection with the cultural and natural heritage of the site.

Sector

1.3 Safety

Measures

M 1.3-1 Preparation of safety concepts in the sector of natural hazards in cooperation with experts.

M 1.3-2 Recording the condition of the railway infrastructure and periodically evaluating it.

Sector

1.4 Public transport

Measures

M 1.4-1 Developing offers and initiate awareness measures.

M 1.4-2 Checking mobility concept as an integral part of new offers and implementing it in the event of a positive result.

Sector

1.5 Railway museum/Information centre

Measures

M 1.5-1
Inclusion and coordination with the Bergün Railway Museum Project (Albula railway experience).

M 1.5-2 Setting up an information centre and an information platform.

6.2.2 Activity Domain 2: Cultural Landscape

Responsibility for Activity Domain 2

> Technical agencies of the cantons
> Panel of experts for the cultural landscape, Rhaetian Railway World Heritage Association
> Executive Committee, Rhaetian Railway World Heritage Association

Aims

> The valleys within the perimeter of the World Heritage Site should remain a populated and attractive living space whose future is assured: the cultural landscapes should be managed on the basis of ecological principles.
> The settlements and landscape should be developed sustainably.
> The local population and all interested parties should be made clearly aware of the unique character and beauty of the natural and cultural landscape.
> Highlighting the natural and cultural qualities of the site should enhance the added value of the region.
> The local population, structures and cultural landscape should be protected from natural hazards.
> Agricultural and forestry utilisation should assure the maintenance of the cultural landscape and preserve the diversity of species over the long term.
> Suitable tools and measures for spatial development should assure the high design quality of new and reconstructed structures and their harmonious integration in the landscape and localities.

Sector

2.1 Protection and maintenance, biodiversity, landscape aesthetics

Measures

M 2.1-1 Promoting coordination and improving results by early information and consultation when implementing the law for the protection of nature and the local heritage (especially caring for ecologically valuable areas by management agreements and promotion of biodiversity) with the communities, the sponsors Parc Ela and the cantonal office for nature and the environment (cf. also M 2.3-1).

M 2.1-2 Promoting coordination and improving results by early information and consultation when implementing the spatial planning law (especially guideline planning/local planning/building approval procedures) with the regional associations, communities and the cantonal office for spatial development.

Sector

2.2 Forest

Measures

M 2.2-1 Promoting coordination and improving results by early information and consultation when implementing the forestry law (especially as regards forest development plans (WEP), forestry management, protection from natural hazards, forest reserves, forest recreation) with the forestry agency and regional forestry offices

M 2.2-2 Developing a forest clearance concept along the railway with the aim of optimising particularly attractive views of the cultural landscape or its elements from the standpoint of railway passengers.

M 2.2-3 Developing and carrying out awareness measures in the regions and communities with the use of existing aids and specialists from the cantonal administration.

Sector

2.3 Agriculture

Measures

M 2.3-1 Promoting coordination and improving results by information and consultation in good time when implementing the agricultural law (especially eco-quality regulations, networking concepts) between the regional farmers' associations and the cantonal office for agriculture and geo-information.

M 2.3-2 Developing awareness projects for the high architectural quality of agricultural structures and installations (including access installations) for agriculture and local farmers (cf. M 2.4-2).

Sector

2.4 Settlement and building advice

Measures

M 2.4-1 Developing awareness projects and campaigns for the high architectural quality of new and renovated structures in the World Heritage Site. Present concepts in the communities for design measures and design planning for the integration of these structures in the locality and settlement pattern.

M 2.4-2 Carrying out awareness measures in the communities with the use of existing aids from Interreg Project IIIB 'Alpine Space' CULTURALP (www.siedlungsgestaltung.gr.ch). Coordination with the relevant specialists from the cantonal agencies for monument preservation and spatial development.

6.2.3 Activity Domain 3: Economy/Tourism

Responsibility for Activity Domain 3

- Rhaetian Railway and Graubünden Holidays
- Panel of experts for information and use of labels – Rhaetian Railway World Heritage Association
- Executive Committee Rhaetian Railway World Heritage Association

Aims

- The Rhaetian Railway should offer and create socially acceptable employment.
- Ecological endeavours in landscape preservation and in the production of food should be promoted in accordance with Swiss agricultural policies.
- Methods of production and preservation in agriculture should maintain the cultural landscape and be implemented on the basis of ecological criteria.
- Typical regional products and traditional crafts should be promoted as significant factors for the income of the regional economy.
- Businesses and tourist service providers should make joint efforts to communicate the values and aims of the UNESCO World Heritage Site with the support of its sponsors.
- The generation of hydroelectric power within the perimeter of the World Heritage Site is of great economic importance for the region. Use of this renewable source of energy will continue to be assured within the site.
- Broad-based communication initiatives should extend awareness of the World Heritage Site beyond its borders.
- Tourist offers that promote the active involvement of visitors with the natural and cultural values of the World Heritage Site should be developed as authentic and high-quality tourist programmes highlighting the natural and cultural features of the region.
- The tourist service providers shall set up visitor guidance measures as required for new outdoor activities and tourist offers in the natural and cultural landscape.

Sector

3.1 Railway programmes

Measures

M 3.1-1 Support the creation of a Railway Museum in Bergün/Bravougn as an information centre for the World Heritage Site.

M 3.1-2 Set up a permanent exhibition of the Rhaetian Railway in the Albula/Bernina Cultural Landscape within the Bergün/Bravougn Railway Museum.

Sector

3.2 Natural and cultural landscape programmes

Measures

M 3.2-1 Identify hands-on and environmental awareness programmes and support them in line with the aims of the World Heritage Site.

Sector

3.3 Agricultural and forestry programmes

Measures

M 3.3-1 Extend awareness of the aims and values of the World Heritage Site to existing platforms designed for developing, coordinating and selling relevant programmes.

Sector

3.4 Tourist programmes

Measures

M 3.4-1 Promote coordination of existing marketing channels (Rhaetian Railway, Graubünden Holidays, Graubünden brand, Engadin/St. Moritz, Valposchiavo) and optimise the procedures by early information and consultation.

Sector

3.5 Regional development

Measures

M 3.5-1 Ensure coordination and exchange of know-how with existing organisations (Parc Ela, regional associations, tourist organisations, foundations etc.) and service providers (companies).

M 3.5-2 Take visitor guidance measures for existing and new programmes if the number of visitors jeopardises the sustainability of the offer (e.g. information signs, periodic access prohibitions, quantity restrictions, structural measures etc.).

Sector

3.6 Networking

Measures

M 3.6-1 Continuous coordination with current development projects within the World Heritage Site.

Sector

3.7 Use of logos and brands

Measures

M 3.7-1 Use elements of the World Heritage Site whose logos and brands are protected in accordance with UNESCO guidelines and Swiss federal regulations.

M 3.7-2 Set up a system for monitoring the legitimate use of logos and names.

6.2.4 Activity Domain 4: Organisation

Responsibility for Activity Domain 4

> Executive Committee and central office of the Rhaetian Railway World Heritage Association
> Rhaetian Railway

Aims

> The sponsoring organisation should be lean and efficient and be based on existing organisational units and responsibilities as far as possible.
> The sponsors shall cooperate with the administration agencies at community, cantonal, national and international levels.
> The sponsors shall monitor and control the applicable protection status for the cultural values of the Rhaetian Railway and for the cultural landscape with the aid of the responsible government agencies.
> The sponsors shall, on behalf of the Swiss Federation and on the basis of the guidelines of the UNESCO World Heritage Committee, monitor the communications of the regional producers, tourist service providers and local businesses who wish to support and promote the aims of the World Heritage Site with relevant offers.
> The sponsors shall develop their own projects or support interested groups in their development of projects that support the broadcasting of the values and aims of UNESCO.
> The sponsors shall coordinate the funding of the organisational tasks and shall participate in implementing the various measures.
> Both the local population and visitors should be informed about the unique features as well as the cultural and natural diversity of their region on the basis of a communication concept. They should also be made aware of the cultural and historical importance of the railway installations and of the natural and cultural values of the World Heritage Site landscape.

Sector

4.1 Quality management for the Association

Measures

M 4.1-1 Preparation of organisational rules for the Association.

Sector

4.2 Coordination with the administration

Measures

M 4.2-1 Assure the division of tasks within the organisation and coordination with the administration (in the sense of the internal communication concept M 4.5).

Sector

4.3 Monitoring and controlling

Measures

M 4.3-1 Select practical data for the monitoring concept of the Rhaetian Railway in the Albula/Bernina Cultural Landscape from basic data systems (Condition reports of the Rhaetian Railway, cantonal spatial observation system, MONET, Italian data).

M 4.3-2 Design standardised data sheets and select their periodicity.

M 4.3-3 Carry out pilot monitoring and evaluate qualified statements.

M 4.3-4 Implement a monitoring and controlling system.

Sector

4.4 Finances

Measures

M 4.4-1 Setting up financial planning for the Rhaetian Railway World Heritage Association over several years.

M 4.4-2 Checking possibilities for obtaining third party funding.

Sector

4.5 Communication

Measures

M 4.5-1 Preparation of a communication concept.

M 4.5-2 Coordinating existing communication channels and check their contents and aims (Rhaetian Railway, Graubünden Ferien, Graubünden brand, Engadin/St. Moritz, Valposchiavo).

6.2.5 Activity Domain 5: Cooperation

Responsibility for Activity Domain 5

> Executive Committee and Central Office of the Rhaetian Railway World Heritage Association
> Swiss Federal Office of Culture (BAK)
> Canton Graubünden
> Rhaetian Railway

Aims

> The sponsors of the Rhaetian Railway World Heritage Site in the Albula/Bernina Cultural Landscape shall develop trans-national projects in cooperation with the Swiss Federation and the canton as well as the responsible Italian partners.
> The sponsors of the Rhaetian Railway World Heritage Site in the Albula/Bernina Cultural Landscape shall promote international and national cooperation and exchange, knowledge transfer (Best Practice) in the sector of the World Heritage Site, especially with other World Heritage Sites from the railway sector, the World Heritage Monastery of Müstair and with other national and international projects aiming to preserve the cultural heritage.

Sector

5.1 Cooperation with Italy

Measures

M 5.1-1 Development of concepts in cooperation with the Swiss Federal Office of Culture and the Ministero per i Beni e le Attività culturali for trans-national projects in connection with promoting the World Heritage Site of the Rhaetian Railway in the Albula/Bernina cultural landscape.

Sector

5.2 National and international cooperation

Measures

M 5.2-1 Definition of cooperation with national UNESCO World Heritage Sites (e.g. exchange of know-how, knowledge transfer or joint awareness campaigns).

M 5.2-2 Proposal for an expert meeting on urgent questions in connection with the topic of the Railway/World Heritage Site in cooperation with UNESCO/ICOMOS.

7. Instruments and Fundamentals

7. Instruments and Fundamentals

Albula line > Glacier Express at Samedan.
A. Badrutt/Rhaetian Railway

7. Instruments and Fundamentals

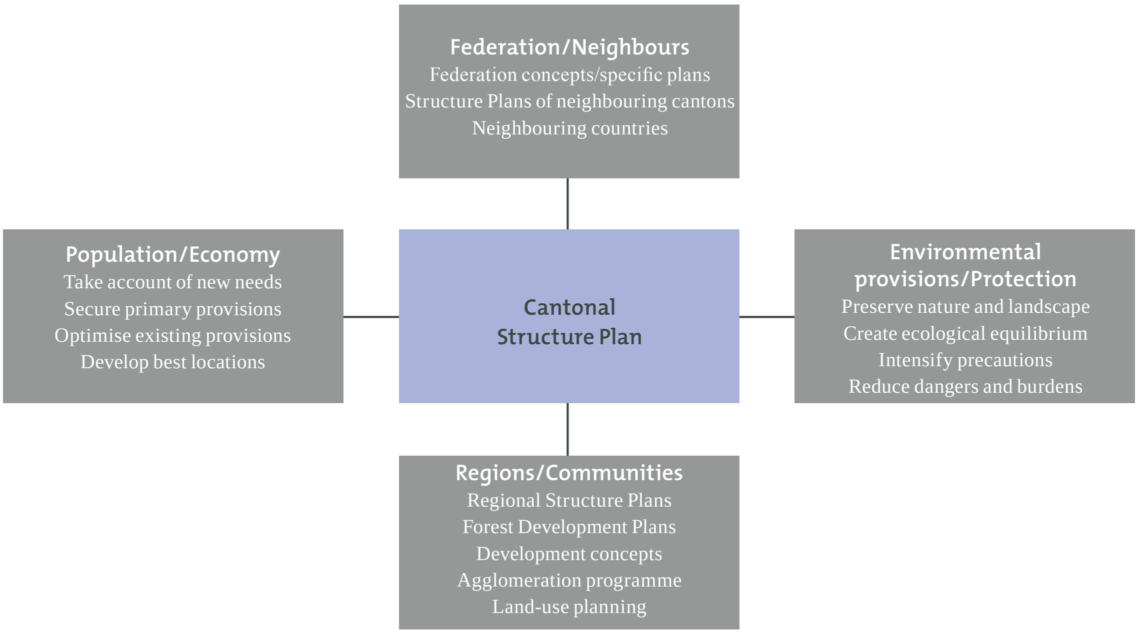
7.1 Implementation of conservation and sustainable development measures

7.1.1 Statutory protection and planning

The "Rhaetian Railway in the Cultural Landscape Albula/Bernina" is protected by several legislative measures. In the first instance, the railway facilities (structures and civil engineering) are subject to the legislation for preservation of the natural heritage and conservation monuments. The Rhaetian Railway also commits itself, in regard to the nominated route, to comply with more extensive protective measures. Additionally, various laws require that the cultural landscape be protected, utilised in a sustainable manner and further developed. Planning measures and the legislation for spatial planning also place qualitative demands on buildings and facilities to ensure that these blend harmoniously with the townscape and/or landscape. Consequently, as the nominated asset is documented in the Cantonal Structure Plan, the special protection and sustainable development of the proposed World Heritage Site in its entirety is assured.

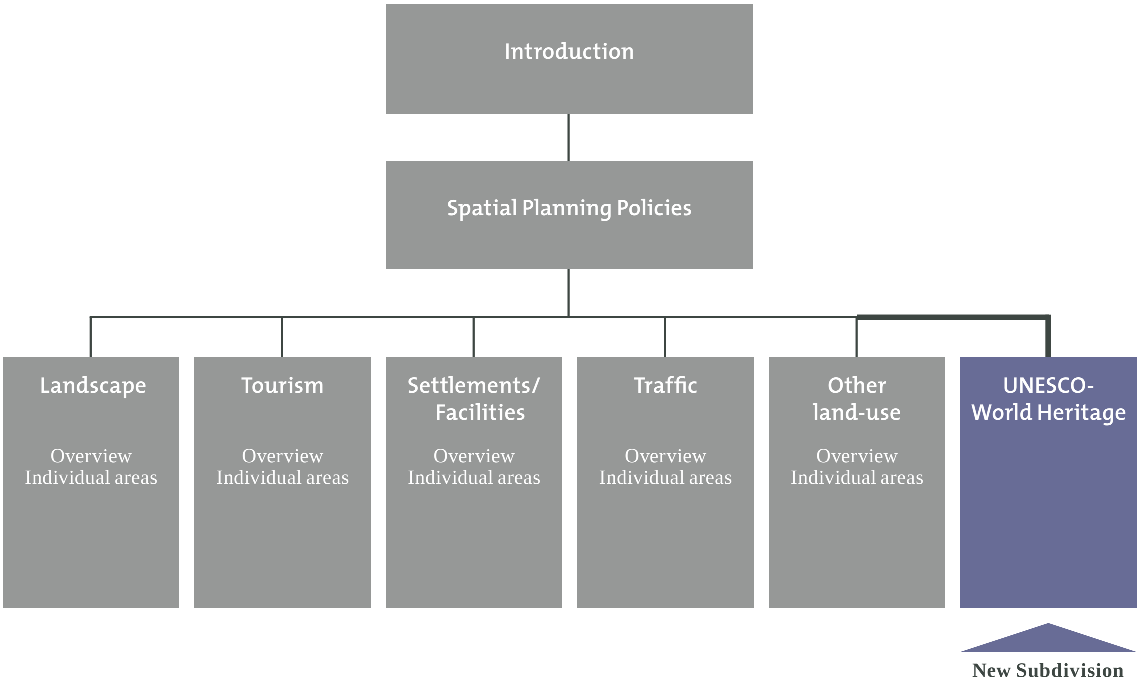
The Cantonal Structure Plan is the central instrument for the regulation of spatial development in Switzerland and thus also for the protection of the countryside; inscription of the "Rhaetian Railway in the Cultural Landscape Albula/Bernina" on the UNESCO World Heritage List would be integrated in this plan.

The objective and function of the Cantonal Structure Plan is to balance the various demands on habitat or living-space, especially those made from the disparate protection and utilisation interests, with a view to sustainable spatial development. The Cantonal Structure Plan is binding for the authorities at federal, cantonal and community levels and primarily comprises a text and the appended maps. It is continuously amended to incorporate the latest facts and is revised in its entirety at least every ten years.



The Canton Graubünden Structure Plan is broken down into five subdivisions: Landscape – Tourism – Settlements – Traffic – Other land-use. Each of these subdivisions is clearly summarised in the introduction and further divided into three to ten sub-chapters. Each theme has binding guiding principles and objectives which the authorities must comply with when planning, granting authorisations and concessions, and the like.

In the event of acceptance of the nominated property on the UNESCO World Heritage List, the creation of a new subdivision is planned as well as the formulation of specific protection provisions. With the integration of the World Heritage Site in the Cantonal Structure Plan, the regulations for both the protection and the sustainable development of the site will also be defined.



During the preparation of the candidature dossier, the new subsector of the Structure Plan "UNESCO World Heritage – Rhaetian Railway Albula/Bernina in the Cultural Landscape" was drafted. This draft draws orients to the core and buffer zones of the nominated property. It was presented to the communities and regions involved and both discussed and further developed together with them. At this juncture the guiding principles from the draft can be quoted as follows:

7.1.2 Guiding principles of the Cantonal Structure Plan

Objective

In compliance with the protective provisions of a World Heritage site, the Albula / Bernina line of the Rhaetian Railway and the cultural landscape around it shall be used and further developed, in such a way that the particularities and specific qualities pursuant to the UNESCO Convention shall be preserved in the long-term.

Principles

Railway infrastructure in the UNESCO core zone

In the event of new buildings, conversions and renovations of the railway infrastructure (buildings, underground engineering, engineering structures) along the Albula and Bernina line, special attention will be paid to the preservation of character and appearance as well as their integration into the architectural tradition and the landscape. This is guaranteed by professional technical counselling. In the case of renovation of the engineering structures, modular building procedures will be developed, in cooperation with construction experts, to preserve the character and appearance of the railway while complying with the requirements of running a modern railway system. These principles, are imperative to the extent that they do not have a detrimental effect on the operation of the railway in the long-term.

Settlement areas and open cultural landscape in the UNESCO core zone

In the case of new buildings, conversions and renovations of buildings and installations, heightened awareness and sensitivity is called for in matters of execution and design, to ensure harmonious integration into the architectural heritage and landscape. In terms of their position, type and design, new buildings and installations shall respect the particular landscape and cultural values. They shall be executed to such a high quality standard that the intrinsic value of the region's cultural landscape will be enhanced, or at least not impaired. A strong focus on urban development consultancy or similar measures is key to ensuring compliance with these principles.

The cultural landscape in the UNESCO buffer zone close to the railway

Urban development consultancy is recommended for interventions in the UNESCO buffer zone, in particular for zoning or upgrading zones (higher land use density or an increase in the number of storeys in existing building zones). The decision on whether to follow this recommendation rests with the communities.

Keep the horizon as free of intrusive buildings and installations as possible

The scenic horizon is an important element of the mountain railway character and the perception of the landscape. Basically, the horizon shall be kept free of new structures and installations. If these are necessary, careful placing of the structural elements is essential in order not to disrupt the continuous line of the horizon.

Forest stewardship along the Rhaetian Railway's Albula/Bernina line

In the area close to the Albula/Bernina line, the forest will be managed in such a way that passengers' appreciation of the landscape and cultural values is impaired as little as possible by afforestation. This means ensuring an obstructed view of parts of the landscape and special structural elements of the cultural landscape. As part of this landscape, the forest, is managed according to the sustainability principle set out in the regional forest development plans. Where the forest has a protective function, this may not be impaired by any measures whatever.

Integrate special features as part of the tourist offer

Particular elements such as the Rhaetian Railway engineering structures, historic routes, particularly valuable architectural monuments, historic settlement nuclei, building complexes, individual buildings and installations and also natural monuments are deemed part of the tourist offer. As far as possible, access to them will be via the existing network of paths and roads. These paths must be kept safe and passable and provide suitable places for rest and refreshment that blend into the landscape unobtrusively.

Utilisation of the cultural landscape and technological change support the objective

Various utilisations (e.g. farming, harnessing water power, tourism etc.) have left their stamp on the cultural landscape in the World Heritage perimeter. The resulting value added contributes directly and indirectly to the care and conservation of the cultural landscape. The spatially effective activities are judged by weighing up the various interests. The use of modern technology by the railway and in handing the cultural landscape encourage efficient and respectful treatment and therefore long-term conservation of value.

UNESCO World Cultural Heritage sponsoring association and Management Plan

The sponsoring association for the UNESCO World Heritage promotes the preservation and sustainable utilisation of the World Heritage and is responsible for the coordination of monitoring. A UNESCO World Heritage management plan as required by the UNESCO directives is extant. Its objective is to create a binding framework for the activities of the association.

7.1.3 Areas of responsibility

The objectives and the guiding principles are realised by following the relevant procedures and by the authorities responsible for them. The corresponding areas of responsibility are defined in the Structure Plan. Responsible for and in charge of these are the Federation, canton and the communities. For all matters regarding structures and facilities for the railways the Rhaetian Railway must obtain permission from the Federation. All these authorities are also represented in the sponsor Association.

> On the Albula and Bernina lines, planning, development and, as required, the execution of new constructions, conversions and the rehabilitation of railway facilities (structures and civil engineering) are subject to consultation with specialists brought in by the Rhaetian Railway with the aim of preserving the character and appearance of the railway.
In charge: Rhaetian Railway

> For plan approval procedures pursuant to railway law or cable car law, as well as specialist planning and provisions of the Federation under Art. 13 RPG, the unique circumstances of the UNESCO World Heritage "Rhaetian Railway in the Cultural Landscape Albula/Bernina" are to be taken into account. The relevant assessment is made by the Federal Office for Culture – as specialist instance of the Federation for the care of historical monuments, archaeology and protection of local architectural heritage – and handed over to the approval authority.
In charge: Federal Office of Transport

> The character and appearance in residential areas in the UNESCO core zone is safeguarded primarily through specialist consultation in the design sector. Should this not be possible, equivalent measures must be sought, for example through appropriate building legislation or design guidelines. Switching the UNESCO core and buffer zones into local planning is not expedient.
In charge: Communities and BAB Authorities (BAB = Structures outside the building zone) (Office of Spatial Development)

> Design consulting is backed up by specialised information and technical aids for community planning. This supportive work is realised in coordination and in cooperation with the involved specialist services.
In charge: Office of Spatial Development

> Aid to agricultural structures in the UNESCO core zone is only granted if they blend well with the architectural heritage and the landscape. Any additional costs will be handled analogously to special claims under the Conservation of the National Heritage (Art. 19 Fed. Structure Improvement Ordinance).
In charge: Office for Agriculture and Geo-Information

> The special requirements of forest development planning and forest management will be taken into account. The particular views to be kept free of woodlands, as well as the special vistas from the railway will be defined in the forest development plans after consultation with the UNESCO World Heritage Association and subject to consideration of the forest function (protective forest).
In charge: Office for Forestry

> A sponsorship Association comprising the canton, communities, Rhaetian Railway and the Federation will be founded to realise the objectives of the UNESCO World Heritage. This Association will be responsible for the maintenance and promotion of the sustainable utilisation of the World Heritage “Rhaetian Railway in the Cultural Landscape Albula/Bernina” in general, and in particular for the monitoring of the railway and cultural landscape, as well
as for information and use of label issues.
In charge: Sponsorship Association

In accordance with the statutes of the “World Heritage Rhaetian Railway Association” and the corresponding charter, the authorities constituting the Association engage to treat the World Heritage Site with respect and consideration for its heritage value. This is an additional commitment defining the interface between Association activity and authorities activity and ensures implementation in the spirit of the World Heritage Convention. Chapters 5.b to 5.d of the candidature dossier set out the details for realisation of the conservation and sustainable development in the spirit of the UNESCO World Heritage, the means and mechanisms for this conservation, as well as the planning fundamentals. The most important bases in this context (legislation, inventory, planning) are listed in the annex to the Management Plan.

7.2 Monitoring and Controlling

The monitoring indicators are defined on the basis of the condition status of the World Heritage property and the factors influencing it in as detailed in chapter 4 of the candidacy dossier.

The following table lists these indicators for railway and cultural landscape; this list may be adapted and expanded as a result of experiences acquired.

Table of Indicators

Theme / Target Value	Indicator	Source	Periodicity
Railway			
Protection and preservation of the civil engineering structures	Timely renovation of the - Bridges - Tunnels - Protective structures - Supporting walls	Rhaetian Railway, status reports	Every 10 years
Protection and preservation of the superstructures	Timely renovation of the - Stations	Rhaetian Railway, status reports	Every 10 years
Protection and preservation of the route infrastructure	Timely renovation of the - Railroad - Electro-technical facilities - Telegraph wires	Rhaetian Railway, status reports	Every 10 years
Passenger frequencies	Number of passengers transported on the Albula and Bernina route	Rhaetian Railway, Surveys at regular intervals	Annually
Freight	Freight transported in tonnes on the Albula and Bernina route	Rhaetian Railway, Freight traffic statistics	Annually
Spatial development			
Population in the World Heritage area	Number of inhabitants per community (core and buffer zones)	- Federal Office of Statistics, Population Census ESPOP - Centro per l'impiego di Tirano	Annually
Number employed in the 2nd and 3rd sectors within the World Heritage area	Number employed per community	- Federal Office of Statistics, Business Census - Centro per l'impiego di Tirano	Every 4 years
Commuter situation	Incoming commuter communities Outgoing commuter communities Number of incoming/outgoing commuters as a % of the workforce	- Population Census - Centro per l'impiego di Tirano	Every 10 years
Ratio of residents, jobs and tourism per community	Inhabitant reference value (inhabitants + employed + ½ hotel beds + ²/₃ beds in self-catering)	- Federal Office of Statistics, Business Census - Ufficio informazioni turistiche di Tirano	Every 4 years
Settlements			
Size of building zone	Changes in size of building zones according to categories and communities	- Office for Spatial Development - Comune di Tirano	As required
Number of homes	New builds/homes	- Federal Office of Statistics, Building statistics - Comune di Tirano	Annually
Ratio 1st homes / 2nd homes	Proportion of second homes by community	- Federal Office of Statistics, Homes statistics - Comune di Tirano	Every 10 years

Theme / Target Value	Indicator	Source	Periodicity
Building activity			
Investments in building	Investments in buildings and public works by community	- Federal Office of Statistics, Building statistics - Comune di Tirano	Annually
Building inside the building zone	Number of building permits issued by community	- Federal Office of Statistics, Communities - Comune di Tirano	Annually
Building outside the building zone	Number of building permits issued by community	- Office of Spatial Development - Comune di Tirano	As required
Agriculture			
Area under agriculture	Agricultural area as a % of total area (without Alpine meadows)	- Federal Office of Statistics, Area Statistics - Provincia di Sondrio	Every 12 years
Management of cultural landscape	Number of farm units Number employed in agriculture	- Federal Office of Statistics, Agricultural unit Census - Provincia di Sondrio	Every 4 years
Melioration projects, structural improvement measures	Total expenditure	- Office for Agriculture and Geo-information - Provincia di Sondrio	As required
Creating favourable conditions	Number of relocations Sum of contributions to building animal sheds	- Office for Agriculture and Geo-information - Provincia di Sondrio	As required
Ecological aspects of the cultural landscape	Communities with ecological networking concepts	- Office for Nature and the Environment/ Office for Agriculture and Geo-information - Provincia di Sondrio	As required
Forestry			
Forested area	Forested area as a % of total area	- Federal Office of Statistics, Area Statistics - Provincia di Sondrio	Every 12 years
Timber utilisation	Volume of timber felled	- Federal Office of Statistics, Forestry Statistics - Provincia di Sondrio	Annually
Protective measures			
Area in the protected landscape zone, in core and buffer zones in the Structure and Land-Use Plans	Protected landscape area as a % of the core and buffer zones	- Office of Spatial Development - Provincia di Sondrio	As required
Number and area of nature reserves in the core and buffer zones in the Structure and Land-Use Plans	Nature reserves as a % of the core and buffer zones	- Office of Spatial Development - Provincia di Sondrio	As required
Protection of cultural assets	Number of protected cultural assets in the community planning	- Office of Spatial Development - Provincia di Sondrio	As required
Protection of local character	Type and cost of protective measure	- Office of Culture, Care of Historic Mounuments Section - Provincia di Sondrio	As required
Natural risks			
Natural risks, frequency	Number and type of occurrences in the core and buffer zone	- Office for Forestry, Damage Cadastre - Provincia di Sondrio	As required
Natural risks, costs for safety measures	Type and costs of protective measures to ensure safety of the World Heritage area	- Office for Forestry / Rhaetian Railway - Provincia di Sondrio	As required
Natural risks, damages caused	Cost of damages within the perimeter of the core and buffer zones	- Property Insurance Institute / Rhaetian Railway - Provincia di Sondrio	As required

8. Signature on behalf of the State Parties

Signature on behalf of the Swiss State Party

Ernst Iten
Ambassador
Permanent Delegate of Switzerland to UNESCO

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Signature on behalf of the Italian State Party

Giuseppe Moscato
Ambassador
Permanent Delegate of Italy to UNESCO

Annex

Bernina line > Aerial of the circular viaduct at Brusio.
D. Enz/Rhaetian Railway

Most Important Principles (Legislation, Inventories, Planning)

The following table presents the most important principles, listed according to political level (appended to the candidature documentation ["Annex" File] in electronic form). All federal laws can be found in the systematic collection at www.admin.ch/ch/d/sr/sr.html in the national languages of German, French and Italian. The cantonal legislation is available at www.gr.ch.

Level	Most important legal provisions	Bases, inventories	Specific plans and concepts (Federation) structure planning (canton and region), land-use plans (communities)
Federation	- Agreement of 23 November 1972 on the protection of the world cultural and natural heritage (SR 0.451.41) - Haag Convention of 14 May 1954 for the protection of cultural assets in the event of armed conflict (SR 0.520.3) - Federal law of 1 July 1966 on the protection of nature and the environment (NHG; SR 451). - Decree of 16 January 1991 on the protection of nature and the national heritage (NHV; SR 451.1) - Decree of 10 August 1977 on the federal inventory of landscapes and natural monuments (VBLN; SR 451.11) - Decree of 9 September 1981 on the federal inventory of Swiss Heritage Sites (VISOS; SR 451.12) - Decree of 28 October 1982 on the protection of riverside wetlands of national importance (Wetlands decree; SR 451.31) - Decree of 21 January 1991 on the protection of raised and transition bog lands of national importance (Raised bogs decree; SR 451.32) - Decree of 7 September 1994 on the protection of flat bogs of national importance (Flat bogs decree; SR 451.33) - Decree of 15 June 2001 on the protection of amphibian spawning grounds of national importance (Amphibian spawning grounds decree; ALGV; SR 451.34) - Decree of 1 May 1996 on the protection of moor landscapes of outstanding beauty and national importance (Moor and wetland landscapes decree; SR 451.35) - Federal law of 22 June 1979 on spatial planning (RPG; SR 700) - Spatial planning decree of 28 June 2000 (RPV; SR 700.1)	- Federal inventory of landscapes and natural monuments of national importance (BLN) - Federal inventory of cultural assets of national and regional importance - Federal inventory of Swiss Heritage Sites - Federal inventory of historic routes (IVS) - Federal inventory of the riverside wetlands of national importance - Federal inventory of raised and transitional bog lands of national importance - Federal inventory of the flat bogs of national importance - Federal inventory of the amphibian spawning grounds of national importance - Federal inventory of the moor landscapes of outstanding beauty and national importance - Federal inventory of glacier aprons and alluvial plains - Inventory of the federal no-hunting zones - National forestry inventory - Production cadastre for agriculture (extended transition zone, pre-alpine hill zone, mountain zones I-IV, summer grazing area)	- Swiss agricultural concept; (LKS), issued by the federal council by decision of 19 December 1997 - Specific crop rotation area plan; (FFF), issued by the federal council by decision of 8 April 1992 - Specific plan for transmission cables (SüL), issued by the federal council by decision of 27 June 2001 and updated continuously - Specific traffic plan, part programme, issued by the federal council by decision of 26 April 2006 - Specific military plan, issued by the federal council by decision of 28 February 2001 - Specific traffic plan, part programme, issued by the federal council by decision of 26 April 2006 - Specific aviation infrastructure plan (SIL), part i - IIIB, issued by the federal council by decision of 18 October 2000 with continuous updating of part IIIC, 1. – 6. Series - National sports grounds concept (NASAK), issued by the federal council by decision of 23rd October 1996 - Specific plan – AlpTransit, New Alpine Rail Axis (NEAT) issued by the federal council by decision of 15th March 1999

Level	Most important legal provisions	Bases, inventories	Specific plans and concepts (Federation) structure planning (canton and region), land-use plans (communities)
	- Federal law of 21 June 1991 on the melioration of water courses (SR 721.100) - Railway law of 20 December 1957 (EBG; SR 742.101) - Federal law of 24 June 1902 on electrical light and heavy power installations (EleG; SR 734.0) - Decree of 8 November 1978 on licensing of cableways (Cableway licence decree, LKV; SR 743.11) - Federal law of 7 October 1983 on the protection of the environment (USG; SR 814.01) - Decree of 19 October 1988 on the environment compatibility test (UVPV; SR 814.011) - Federal law of 24 January 1991 on protection of waters (Waters protection law, GSchG, SR 814.20) - Federal law of 29 April 1998 on agriculture (LWG; 910.1) - Decree of 29 March 2000 on summer alp grazing contributions (SöBV; SR 910.13) - Decree of 4 April 2001 on the regional promotion of quality and the network of ecological compensation surfaces in agriculture (Eco-quality promotion, ÖQV, SR 910.14) - Decree of 7 December 1998 on structural improvement in agriculture (Structural improvement decree, SVV; SR 913.1) - Federal law of 4 October 1991 on forestry (WaG; SR 921.0) - Federal law on hunting and the protection of mammals and birds in the wild (Hunting law, JSG; SR 922.0)		

Level	Most important legal provisions	Bases, inventories	Specific plans and concepts (Federation) structure planning (canton and region), land-use plans (communities
Canton	- Law of 24 October 1965 on the promotion of the protection of nature and national heritage in Canton Graubünden (BR 496.00) - Decree of 27 November 1946 on the protection of nature and the national heritage (BR 496.100) - Decree of 2 June 1972 on the protection of the Upper Engadin lake landscape (BR 496.150) - Spatial planning law of 6 December 2004 for Canton Graubünden (KRG, BR 801.100) - Spatial planning law of 24 May 2005 for Canton Graubünden (KRVO, BR 801.110) - Decree of 21 November 2000 on the repurposing of farmsteads and buildings and installations worthy of protection outside building zones (repurposing decree, UVO, BR 801.150) - Directives of 6 May 1997 on risk zone planning (BR 801.500) - Introductory law of 2 December 2001 in relation to the protection of the environment law (BR 820.100) - Cantonal protection of the environment decree of 13 August 2002 (BR 820.110) - Cantonal decree of 30 April 1991 on the environment compatibility test (KVUVP, BR 820.150) - Law of 25 September 1994 on the conservation and promotion of agriculture (BR 910.000) - Agricultural decree of 28 March 2000 (BR 910.050) - Canton Graubünden melioration law of 5 April 1981 (BR 915.100) - Cantonal forestry law of 25 June 1995 (KWaG, BR 920.100) - Cantonal forestry decree of 2 December 1994 (KWaV, BR 920.110) - Export provisions of 19 December 1995 pursuant to the cantonal forestry law (AbzKWaG, BR 920.120)	- Cantonal nature and landscape inventory - Cantonal inventory of monuments	- Canton Graubünden Structure Plan, issued by the government 19 November 2002, approved by the federal council 19 September 2003 (www.richtplan.gr.ch) - Forest development plans (cf. 5.d)

Level	Most important legal provisions	Bases, inventories	Specific plans and concepts (Federation) structure planning (canton and region), land-use plans (communities)
Region			- Regional structure plans (see list in Chapter 5.d)
Communities		- Detailed settlement inventories - Complementary inventories on biotopes and landscapes	Land-use planning comprising - Building law - Zoning plan - General urban organisation plan (or organisation directives) - General development plan (see list in Chapter 5.d)

Name and contact information of official local institution/agency

Candidature UNESCO World Heritage
Rhaetian Railway in the Albula/Bernina Cultural Landscape
c/o Rhätische Bahn
Bahnhofstrasse 25
CH-7002 Chur
Tel: +41 (0)81 288 63 66
E-mail: unesco@rhb.ch
http://www.rhb-unesco.ch

United Nations
Educational, Scientific and
Cultural Organization

Organisation
des Nations Unies
pour l'éducation,
la science et la culture

Organización
de las Naciones Unidas
para la Educación,
la Ciencia y la Cultura

Организация
Объединенных Наций по
вопросам образования,
науки и культуры

منظمة الأمم المتحدة
للتربية والعلم والثقافة

联合国教育、
科学及文化组织

Secteur de la Culture

S.Exc. M. Ernst ITEN
Ambassadeur, Délégué permanent
Délégation permanente de la Confédération suisse auprès de l'UNESCO
Maison de l'UNESCO

10 septembre 2008

Réf.: WHC/74/1052/CH/AB/KM/MR

Objet: **Inscription du bien *Chemin de fer rhétique dans les paysages de l'Albula et de la Bernina* (C 1276) (Suisse / Italie) sur la Liste du patrimoine mondial**

Monsieur l'Ambassadeur,

J'ai le plaisir de vous informer que le Comité du patrimoine mondial, lors de sa 32e session (Canada, Québec, 2 - 10 juillet 2008), a examiné la proposition d'inscription du ***Chemin de fer rhétique dans les paysages de l'Albula et de la Bernina*** et a décidé d'**inscrire** ce bien sur la Liste du patrimoine mondial. Veuillez trouver ci-joint en annexe 1 la décision du Comité concernant cette inscription (décision 32 COM 8B.38).

Je suis certain que votre Gouvernement continuera de prendre les mesures nécessaires à la conservation de ce nouveau bien du patrimoine mondial. Le Comité du patrimoine mondial et son Secrétariat, le Centre du patrimoine mondial, feront tout leur possible pour collaborer avec vous dans ce sens.

Les *Orientations devant guider la mise en œuvre de la Convention du patrimoine mondial* (*paragraphe 168*), demandent désormais au Secrétariat d'envoyer à chaque Etat partie disposant d'un nouveau bien inscrit une carte de la ou des zone(s) inscrite(s). Veuillez examiner la carte ci-jointe ainsi que le tableau d'inscription et nous informer de toute erreur éventuelle dans ces informations avant le **1er décembre 2008**.

L'inscription d'un bien sur la Liste du patrimoine mondial est une excellente opportunité d'attirer l'attention des visiteurs, tout comme des résidents, sur la *Convention du patrimoine mondial* ainsi que sur la valeur universelle exceptionnelle du bien. A cet égard, vous souhaiterez peut-être apposer une plaque avec les emblèmes du patrimoine mondial et de l'UNESCO. Vous trouverez dans les *Orientations devant guider la mise en œuvre de la Convention du patrimoine mondial* des suggestions à cet effet.

Comme vos autorités ont décidé d'organiser une cérémonie d'inscription du bien sur la Liste du patrimoine mondial, j'ai le plaisir de confirmer que les Certificats vous ont bien été fournis le 3 septembre dernier.

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www.unesco.org

Par ailleurs, je vous serai très reconnaissant de me faire parvenir le nom, l'adresse, les numéros de téléphone et de fax, ainsi que le courriel de la personne ou de l'institution responsable de la gestion du site, ce qui nous permettra de lui/leur envoyer les publications du patrimoine mondial ultérieurement.

Veuillez trouver ci-dessous une brève description de votre site, préparée par l'ICOMOS et le Centre du patrimoine mondial, en français et en anglais. Ces descriptions étant amenées à être reprises par la suite dans des publications, ou sur le site Internet du Centre du patrimoine mondial, nous aimerions avoir votre plein accord sur les termes employés. Je vous prierai donc d'examiner ces descriptions, et de nous informer au plus tard le **1er décembre 2008** d'éventuels changements devant être apportés. Si nous ne recevons aucune contestation d'ici là, nous en conclurons que vous approuvez le texte soumis.

De plus, comme vous le savez probablement, le Centre du patrimoine mondial possède un site Internet à l'adresse : http://whc.unesco.org, sur lequel on trouve des informations générales relatives aux biens du patrimoine mondial. Etant donné que nous ne pouvons fournir sur ce site qu'un nombre limité d'informations concernant chaque bien, nous essayons de relier nos pages avec celles provenant du site Internet de votre bien inscrit au patrimoine mondial ou de votre bureau, afin d'offrir au public des informations fiables et constamment mises à jour. Si vous possédez un site Internet pour le bien nouvellement inscrit, je vous remercie par avance de bien vouloir nous en transmettre l'adresse.

Une copie des Décisions adoptées par le Comité du patrimoine mondial lors de sa 32e session vous sera envoyée dès que possible.

Comme vous le savez, conformément au paragraphe 172 des *Orientations devant guider la mise en œuvre de la Convention du patrimoine mondial*, le Comité du patrimoine mondial invite les Etats parties à la *Convention* à l'informer, par l'intermédiaire du Centre du patrimoine mondial, de leurs intentions d'entreprendre ou d'autoriser, dans la zone protégée par la *Convention*, des restaurations importantes ou de nouvelles constructions, qui pourraient modifier la valeur universelle exceptionnelle du bien.

Je vous prie de croire, Monsieur l'Ambassadeur, à l'expression de ma haute considération.

Francesco Bandarin
Directeur
Centre du patrimoine mondial

Cc: Commission nationale de la Suisse pour l'UNESCO
Délégation permanente de l'Italie auprès de l'UNESCO
ICOMOS

Annex 1

Décision : 32 COM 8B.38

Le Comité du patrimoine mondial,

1. Ayant examiné les documents *WHC-08/32.COM/8B* et *WHC-08/32.COM/INF.8B1*,

2. Inscrit le **Chemin de fer rhétique dans les paysages de l'Albula et de la Bernina, Suisse** et **Italie**, sur la Liste du patrimoine mondial sur la base des **critères (ii)** et **(iv)** ;

3. Adopte la Déclaration de valeur universelle exceptionnelle suivante:

   Le Chemin de fer rhétique dans les paysages de l'Albula et de la Bernina représente un aménagement ferroviaire exemplaire pour le désenclavement des Alpes centrales, au début du XXe siècle. Ses conséquences socio-économiques ont été importantes et durables pour la vie en montagne, les échanges humains et culturels, l'évolution du rapport de l'homme à la nature en Occident. Le Chemin de fer rhétique offre une large diversité de solutions techniques pour l'établissement de la voie ferrée dans des conditions montagneuses souvent sévères. C'est une réalisation bien conçue et dont la réalisation est de grande qualité. Son homogénéité stylistique et architecturale est remarquable. L'ensemble ferroviaire s'inscrit en outre d'une manière particulièrement harmonieuse dans les paysages alpins traversés.

   Critère (ii) : Le chemin de fer rhétique de l'Albula et de la Bernina forme un ensemble technique, architectural et environnemental exceptionnel. Ces deux lignes aujourd'hui unifiées dans une voie transalpine unique présentent un ensemble de solutions innovantes très complet et très diversifié qui témoigne d'échanges culturels considérables dans le développement des technologies ferroviaires adaptées à la montagne, dans ses réalisations architecturales et de génie civil, dans son accord esthétique avec les paysages traversés.

   Critère (iv) : Le chemin de fer rhétique de l'Albula et de la Bernina illustre d'une manière très significative le développement des lignes ferroviaires de montagne dans la première décennie du XXe siècle, à de hautes altitudes. Il en donne un exemple achevé et de grande qualité, à la base d'un développement de longue durée des activités humaines en montagne. Il offre des paysages diversifiés en association avec le chemin de fer et significatifs de cette période d'épanouissement d'une relation entre l'homme et la nature.

   Les infrastructures ferroviaires des lignes de l'Albula et de la Bernina forment un ensemble authentique et intègre. Son fonctionnement technique et son entretien en assurent une conservation durable et de qualité. La Compagnie du chemin de fer rhétique qui les a unifiés et qui les gère techniquement a apporté des changements techniques et des innovations compatibles avec le concept d'authenticité des biens technologiques toujours en usage.

   La protection juridique en place est appropriée. Le système de gestion du bien est satisfaisant tout en souhaitant un renforcement de la présentation au public des fondements patrimoniaux du bien.

4. Recommande aux États parties d'envisager un renforcement significatif de la présentation des valeurs patrimoniales, historiques, sociales, et

environnementales du Chemin de fer rhétique dans les paysages de l'Albula et de la Bernina. Pour cela il serait par exemple bienvenu d'envisager la création d'un centre d'interprétation et de documentation d'une qualité en rapport avec la valeur universelle exceptionnelle du bien.

Annex 2

Brief Description

Rhaetian Railway in the Albula / Bernina Landscapes, brings together two historic railway lines that cross the Swiss Alps through two passes. Opened in 1904, the Albula line in the north western part of the property is 67 km long. It features an impressive set of structures including 42 tunnels and covered galleries and 144 viaducts and bridges. The 61 km Bernina pass line features 13 tunnels and galleries and 52 viaducts and bridges. The property is exemplary of the use of the railway to overcome the isolation of settlements in the Central Alps early in the 20th century, with a major and lasting socio-economic impact on life in the mountains. It constitutes an outstanding technical, architectural and environmental ensemble and embodies architectural and civil engineering achievements, in harmony with the landscapes through which they pass.

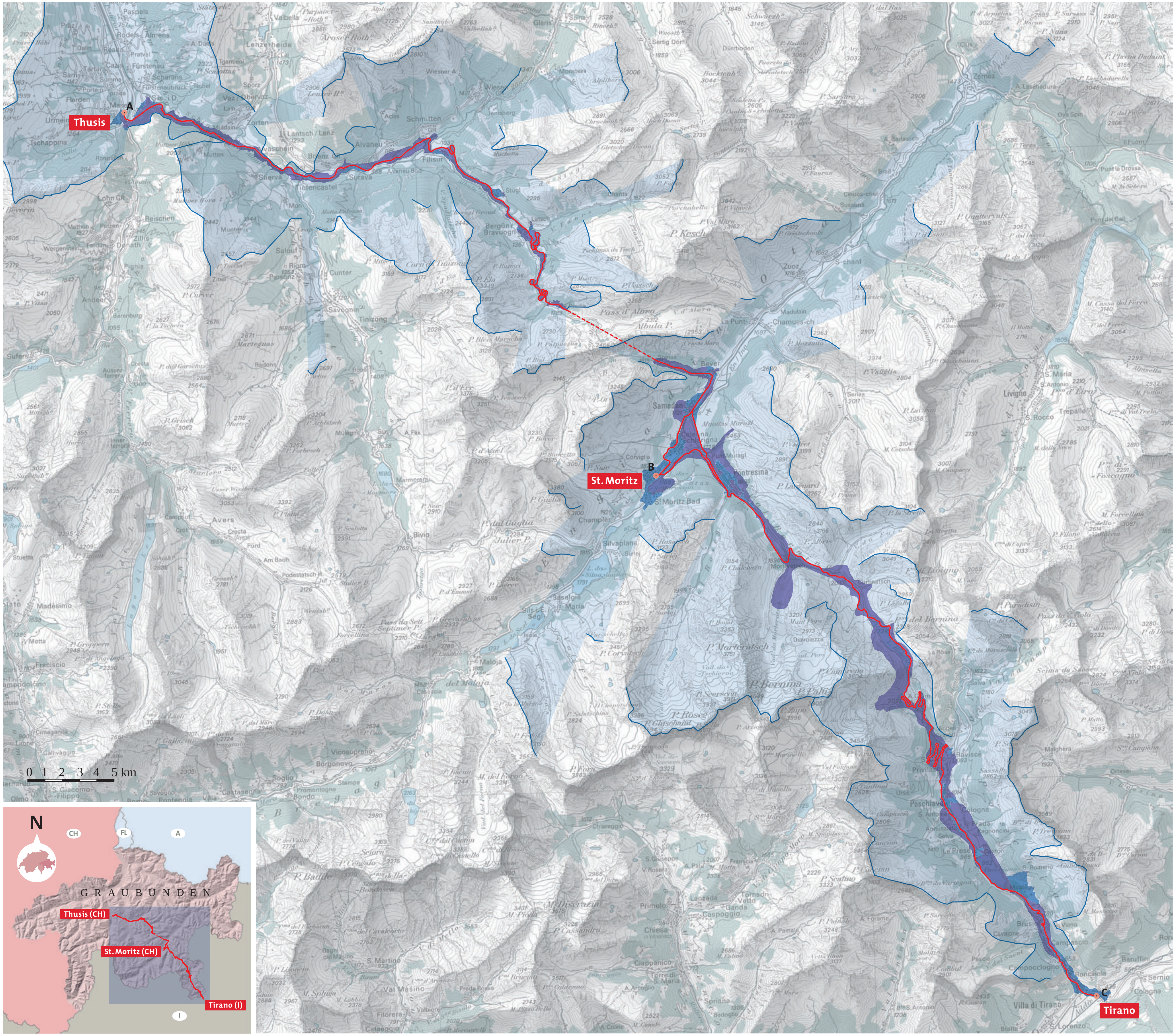
Brève description

Le chemin de fer rhétique dans le paysage de l'Albula et de la Bernina (Suisse/Italie) rassemble deux lignes ferroviaires historiques qui traversent les Alpes suisses par deux cols. Ouverte en 1904, la ligne de l'Albula, dans le nord de la partie nord-ouest du site, fait 67 km de long. Elle comporte un ensemble impressionnant d'ouvrages avec 42 tunnels et galeries couvertes et 144 viaducs et ponts. Les 61 km de la ligne de la Bernina totalisent 13 tunnels et galeries ainsi que 52 viaducs et ponts. Le bien montre une utilisation exemplaire du chemin de fer pour désenclaver les Alpes centrales au début du XXème siècle; ces deux lignes ferroviaires ont eu un impact socio-économique durable sur la vie en montagne. Les deux lignes présentent un ensemble technique, architectural et environnemental exceptionnel. Elles incarnent des réalisations architecturales et de génie civil en harmonie avec les paysages qu'elles traversent.

Annex 3

Superficie et coordonnées du bien inscrit sur la Liste du Patrimoine Mondial par le Comité du Patrimoine Mondial lors de sa 32e session (Québec, 2008) conformément aux *Orientations*

Etat partie		ID N	Superficie	Zone tampon	Coordonnées du point central
Suisse / Italie	Chemin de fer rhétique dans les paysages de l'Albula et de la Bernina	1276	152.42 ha	109385.9 ha	N46 29 54 E09 50 47



Demarcation of the site

Core zone

Core zone

Buffer zone

Primary buffer zone

Buffer zone in the 'near' area

Buffer zone in the 'distant' area ("backdrop")

Horizon line

Georeferenced points

A Thusis Exit Signal:
N 46° 41' 50'' E 9° 26' 28''

B St. Moritz Station:
N 46° 29' 54'' E 9° 50' 47''

C Tirano Station:
N 46° 12' 57'' E 10° 10' 00''

Sources:
Basic map: PK 200'000 swisstopo, Wabern
Geo-data: Amt für Raumentwicklung Graubünden
Design: Süsskind, SGD, Chur
Reproduced by permission of swisstopo (BM062220)

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Délégation permanente de la Suisse auprès de l'UNESCO

Monsieur Francesco Bandarin
Directeur
Centre de l'UNESCO pour le patrimoine mondial
Paris

6826
Dir WHC
rec d 20/11/08

MR
1. Ken
2. ABal.
+ fiee

Notre référence: 716.282.1 - GGC
Paris, le 18 novembre 2008

Liste du patrimoine mondial de l'UNESCO
Chemin de fer rhétique dans les paysages de l'Albula et de la Bernina

Monsieur le Directeur, (cher ami)

J'ai le plaisir de vous transmettre ci-joint une lettre de l'Office fédéral de la culture datée du 17 novembre 2008 concernant le site *Chemin de fer rhétique dans les paysages de l'Albula et de la Bernina*, inscrit sur la Liste du patrimoine mondial de l'UNESCO lors de la 32ème Comité du patrimoine mondial en juillet 2008.

Je vous prie d'agréer, Monsieur le Directeur, l'assurance de ma haute considération.

Le Délégué permanent de la Suisse
auprès de l'UNESCO

Ernst Iten
Ambassadeur

<u>Annexe mentionnée</u>

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Schweizerische Eidgenossenschaft
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Confederaziun svizra

Département fédéral de l'intérieur DFI
Office fédéral de la culture OFC

CH-3003 Berne, OFC **A-Priority**

UNESCO
Centre du Patrimoine mondial
M. le Directeur Francesco BANDARIN
7, Place de Fontenoy
75352 Paris 07 SP
France

Référence du document: 382.12
Notre référence: Mar
Berne, le 17 novembre 2008

Monsieur le Directeur,

C'est avec grand plaisir et satisfaction que nous avons pris connaissance de la décision du Comité du Patrimoine mondial d'inscrire le site *Chemin de fer rhétique dans les paysages de l'Albula et de la Bernina* sur la Liste du patrimoine mondial.

Les candidatures présentées par la Suisse ont été évaluées par un groupe d'experts dans le cadre de l'établissement de la liste indicative. L'élaboration de ce dossier de candidature a été suivie étroitement par l'Office fédéral de la culture ainsi que par le Ministero per i beni e le attività culturali de l'Italie afin de répondre de la meilleure manière possible aux exigences établies.

Comme vous le savez, le souhait de la Suisse est de contribuer avec différentes actions au bon fonctionnement du Centre du Patrimoine mondial. Nous aimerions saisir l'occasion de vous remercier de l'excellente et toujours agréable collaboration avec le Centre et ses collaborateurs.

Nous avons examiné avec soin les documents concernant le site que vous nous avez faits parvenir et nous n'avons pas de remarque à formuler. Le responsable de la gestion du site est :

Verein Welterbe RhB
M. Andreas BASS
c/o Rhätische Bahn
Bahnhofstr. 25
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Patrimoine culturel et Monuments historiques
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Ces indications ont été coordonnées avec le *Ministero per i beni e le attività culturali* de l'Italie.

En espérant avoir ainsi répondu à votre requête je vous adresse, Monsieur le Directeur, mes salutations les meilleures.

Oliver Martin
Chef de section adj.

RAPPRESENTANZA
PERMANENTE D'ITALIA
PRESSO L'U.N.E.S.C.O
L'AMBASCIATORE

 MR

6904

Prot. n° 1217

Paris, le 1er décembre 2008

Monsieur le Directeur,

je me réfère à votre lettre WHC/74/1053/IT/AB/KM/MR du 10 septembre 2008 concernant l'inscription du bien « Chemin de fer rhétique dans les paysages de l'Albula et de la Bernina » (Suisse/Italie) dans la Liste du Patrimoine Mondial.

A cet égard, les Autorités italiennes compétentes me prient de vous communiquer qu'elles confirment les indications contenues dans la réponse adressée à l'UNESCO par les Autorités suisses en date du 17 novembre 2008, dont copie ci-jointe. S'agissant d'un site de type transfrontalier, ces indications ont été établies d'un commun accord par le Ministère italien pour les Biens et les Activités Culturels et l'Office Fédéral de la Culture OFC de Suisse.

Veuillez croire, Monsieur le Directeur, à l'expression de ma meilleure considération.

Giuseppe Moscato

M. Francesco Bandarin
Directeur
Centre du Patrimoine Mondial
7 Place de Fontenoy,
75007 Paris