ABSTRACT

Title of Thesis: BRIDGING THE GAP:
CENTER FOR ENVIRONMENTAL
RESEARCH AND SUSTAINABLILITY IN
THE DMZ, KOREA

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Master of Architecture, Fall 2004

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Professor Roger Lewis

The DMZ (Demilitarized Zone) is a designation for a military demarcation line in accordance with 'the Korean Armistice Agreement' signed on July 27, 1953. Since then, civilian access over the DMZ is highly limited. Because of the limitation, the DMZ is naturally restored its ecosystem. In 1992 summit conference, North and South Korea reached an agreement to reconnect two railroad lines which had been destroyed by war. This is a given opportunity for both Koreas to examine the possibility of reunification. At the same time, it will be the challenge for the environment around the area where the railroads will pass.

This thesis explores the possible use of land where the railroad passes. Sustainability is considered as a main idea to develop the area surrounded as well as the building itself. Based on the program test, the suitable development plan for the

surrounding area is proposed. The idea of sustainable development is applied in conjunction with the symbolic meaning of the space.

This thesis also explores the role of architecture in which the reconciliation between North and South Korea as well as men and nature will take place. The Center for Environmental Research and Sustainability offers the space where scientists from different countries including North and South Korea can interact with each other for sharing ideas and developing new technologies. Public are invited to experience a life interrelated to nature.

BRIDGING THE GAP:
CENTER FOR ENVIRONMENTAL RESEARCH AND SUSTAINABLILITY
IN DMZ, KOREA

By

Seonhee Kim

Thesis submitted to the Faculty of the Graduate School of the
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Advisory Committee:
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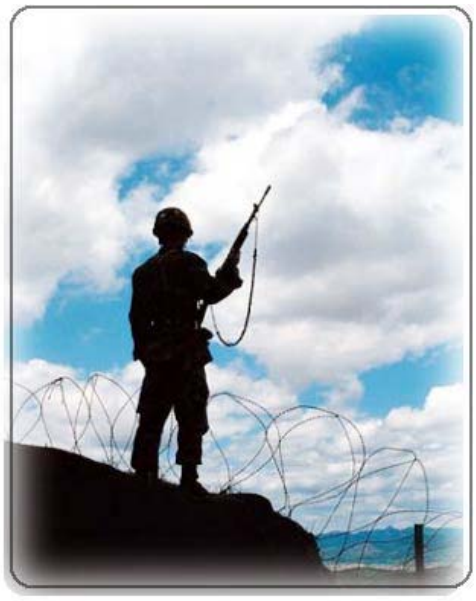

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Introduction

DMZ: Past, Present, and Future

The Second World War had ended with the surrender of Japan on August 15, 1945. Along with the end of the war, the Korean Peninsular had received liberation from the rule of Japanese imperialism. However, the independence was not achieved by Korean exertion, but was given by the Allied Force. The sudden surrender of Japan brought up the issue of the administration of Korean Peninsula. The conference of the foreign ministers of the United States of America, U.S.S.R, and U.K. was opened at Moscow to discuss the post war conditions of Japan, Germany and Korea. The conference decided Korea's trusteeship. Based on the agreement of the conference, U.S.S.R. took a charge of the northern part of Korea from 38th latitude and the Unite States of America took a charge of the southern part of Korea. Since then, the 38th parallel line became a military demarcation line separating country into two. Under this condition, North Korea and South Korea established two different governments based on the policies of different political standings of the Soviet Union and the United States of America, respectively.

The Korean War had broken out on June 25, 1950 and lasted about three years and ten months. About a year after the war started, a partial ceasefire negotiation began. On July 27, 1953, the ceasefire agreement was signed between North Korea, China and the United Nation forces formed by the United States of America and 15 other countries. This time, the ceasefire line was decided not along the 38th parallel but along the military frontiers of the two forces at the time of signing the agreement. Upon signing, they pulled back their armed forces immediately by 2km, respectively. The 38th parallel military demarcation line was transformed into today's Demilitarized Zone with its width of 4 km and the length of 250 km. Essentially, the Demilitarized Zone was formed around the

fiercest battlefield. Everything in that area got destroyed including buildings, roads, farmlands, forest, as well as people who lived in that area.

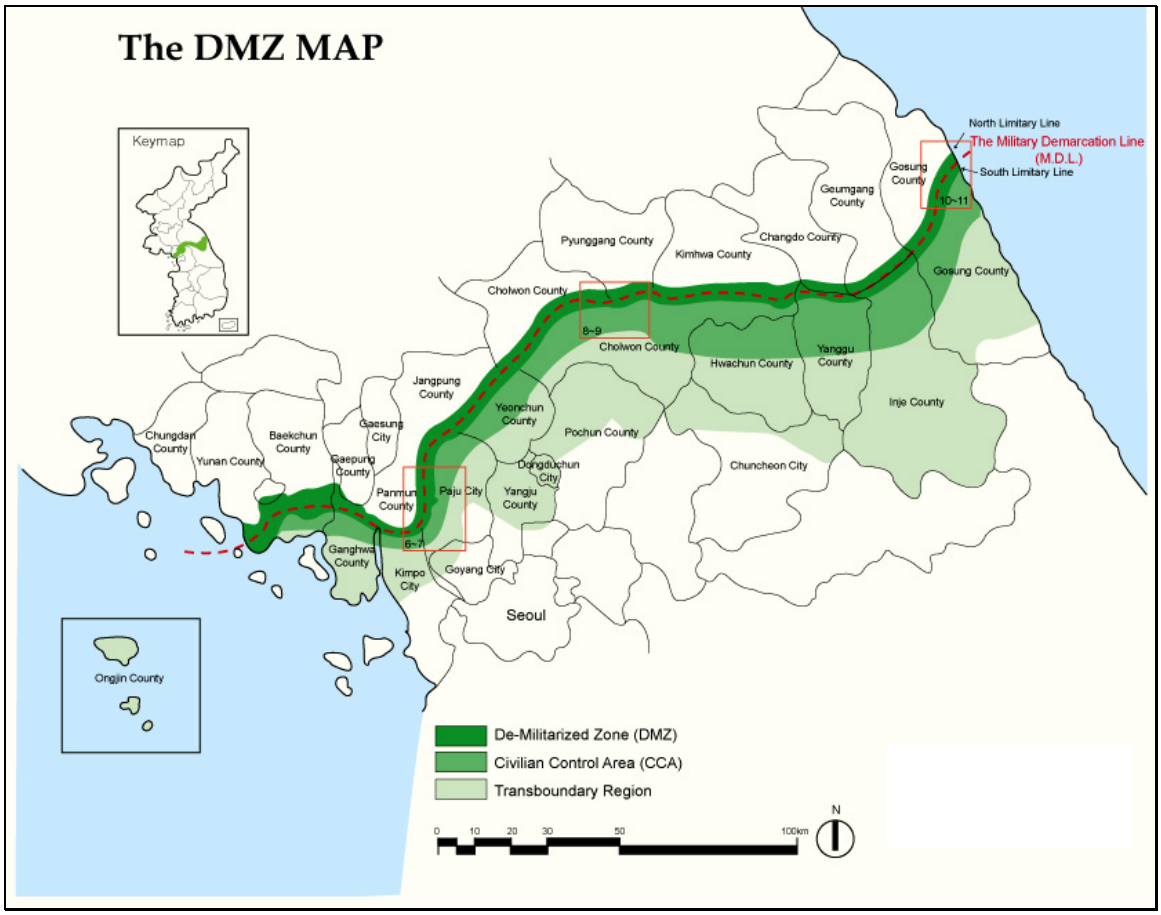

Figure 1 The Military Demarcation Line (DML) runs 248 km East to West. The Demilitarized Zone (DMZ) is established along whit the DML as a center, with the width of 4km. Outside of the DMZ is Civilian Controlled Area (CCA) where civilian access is restrained. The DMZ area is about 907km^2, and total area including CCA is 2,277km^2.[2]

Throughout the cold war situation, two Koreas' different political strategies defined each other as an enemy being overthrown. During the time of confrontation, the DMZ became a true buffer, and civilian access to the DMZ was highly limited. Over the

last 50 years, the control and limitation of civilian access to the DMZ made it possible that the DMZ turn back into nature. The land where people were restricted from had been taken over by nature. While the memory of fierce battles still remained, the land has started its own healing process.

During last 30 years, there were numerous attempts to reopen the possibility of reconciliation. To solve the problem of separated families, the talks between North and South Korean Red Cross Societies were open, and they supervised several meetings of dispersed families. At the end of 80's and the early 90's, the cold war situation broke down with the collapse of the Soviet Union and the unification of East and West Germany. Thanks to the lesson of Germany, North and South Korea realized that the multilateral exchange and cooperation would help to mitigate political and military confrontation. Finally in 1992, North and South Korea reached the written agreement of reconciliation and non-aggression between the two countries. Along with this agreement, various organizations are established and actively operated in areas such as economy, culture, nation's peace and so on. Unfortunately, only very limited numbers out of all these meetings were held within Korean territory. Also, in very few occasions, they came and went to meet each other through the DMZ. In September 2000, the summit conference had been held and the North and the South reached an agreement to reconnect two railroad lines, which were destroyed during the war, to ease transporting manufactured goods and people not only within Korean Peninsula but also to China and Russia. This decision could become a serious possibility for reconciliation of two Koreas. At the same time, it brings the DMZ under everyone's focus in terms of assessing its current condition, envisioning its future use, and so on.

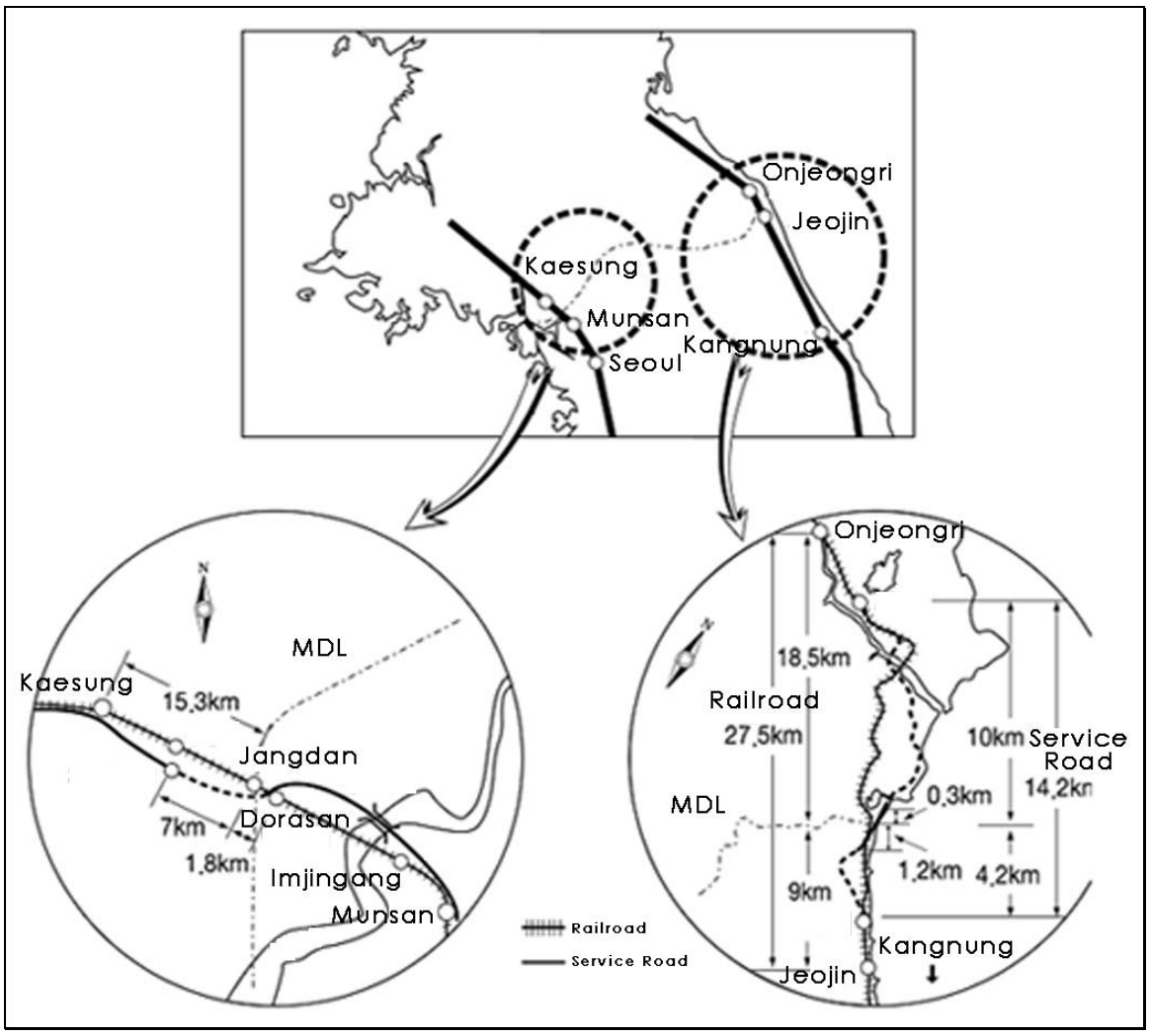

Figure 2 Plan for the Gyeongui and Donghae Railroad Reconnection.[3]

The DMZ is a very important piece of land in several different respects. First of all, the DMZ is an enormous museum and learning place of peace. Jean de Bloch, the founder of International Museum of War and Peace in 1902 in Lucerne, Switzerland, claimed war itself was the strongest testimony against war[4]. The DMZ with the tragic memory of war frozen in time could send out the anti-war message to the future generation and become a symbol of peace.

Figure 3 The tragic memory of war held in the DMZ is frozen in time.[5]

Second, the ecology of the DMZ is unique and valuable. Most of all, the biodiversity in the DMZ is prominent. The DMZ is the only place where the ecosystem is continuously connected from East to West. This continuity offers the easy migration route for the animals under threat. In addition, the limitation of human access helps to shelter animals who are under the thereat of extinction. Another reason why the DMZ is ecologically important is that the area has been naturally restored its ecosystem. Before the war, the area was highly populated agricultural field, and the war wiped out all the hint of civilization. Over 50 years from the war, nature restored this highly disturbed area into natural treasure house. The farmland turned back to wetland and forest. Instead of human population, native plants and animals became the host of the area. If people

wonder what would happen in 50 years if they start restoring the damaged environment, the DMZ is the answer for that question. The war totally destroyed the ecosystem 50 years ago, and the nature slowly revives the area. If this process and condition is researched in depth, the DMZ could be a model of ecosystem restoration.

Figure 4 The land where people were restricted from had been taken over by nature. [6]

Third, the DMZ can be a showcase of sustainable development. Several decisions made recently bring people's attention into the DMZ and the area surrounding DMZ. Some of the attention reflects the hope of new development which was hold back because of special circumstance (which is officially 'unfinished war'). The idea of sustainable development is "development that meets the needs of the present without compromising the ability of future generation to meet their own needs."[7] The DMZ is not a piece of 'property' or 'real estate,' but a piece of 'land.' The overall use of DMZ should be

decided to fulfill the people's needs seeking improvement of the quality of life as well as to preserve valuable natural resources.

Figure 5 View of Munsan: the area used to be a small town in 80's became a city with tall apartment. If unification becomes in reality without clear strategy for the use of DMZ, the area around could easily become a northern extension of Seoul.

[1] <http://www.korea-dmz.com>

[2] <http://www.kgdmz.com>

[3] Peace and Cooperation, Ministry of Unification, 2002

[4] Duffy, Terence. “The Peace Museum Concept,” *Museum International (UNESCO)* vol. XLVI, no. 1, 1993, pp 4-8.

[5] <http://www.worlddmz.com>

[6] <http://www.siwoo.pe.kr>

[7] Guidance in Preparing a National Sustainable Development Strategy: Managing Sustainable Development in the New Millennium, Division for Sustainable Development, UNDESA, 2002

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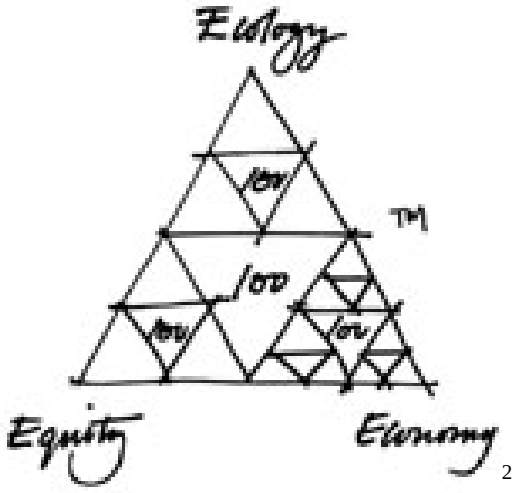

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Sustainability: the way things come to be

Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage on the environment and on critical resources. If not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know. Fundamental changes are urgent if we are to avoid the collision our present course will bring about.[3]

The growing awareness of environmental issues and possible crisis urge professionals in various fields to take an action to protect our natural environment and resources. One response to these issues is to express a concern for current building practices.

Starting in the 1930s, new building technologies changed the way of building's look in major cities and growing suburbs. Especially, heating and cooling controlled by HVAC system made it possible sealed "glass box" as an icon of modern architecture. Inexpensive energy generated by fossil fuel freed buildings from natural lighting and ventilation. Currently, the construction, maintenance, and operation of buildings in the United States consume about 40% of the country's raw material and energy. Buildings are also responsible for 65% of electricity consumption, 35% of greenhouse gas emissions and 16% of water consumption.[4] Although the issues of polluting environment and exhausting natural resources are not solely the responsibility of buildings, these figures suggest that architects need to play a major role in changing the attitude toward environment on the way we approach design.

Sustainability, Design, and Sustainable Architecture

The concept of sustainability has emerged from the idea of balance between human needs and nature's well being. Sustain means to keep in existence. To sustain, human society needs environment as a support system for all human activities. At the same time, people are responsible for protecting the environment. It is very important to have ecological perspective recognizing humans as part of nature. Nature and human are interdependent each other. At 1992, Rio Earth Summit introduced the notion of sustainable development: "meeting the needs of the present without compromising the ability of future generations to meet their needs." In ecological perspective, the meaning is expanded to all creatures on the planet to meet their needs now and in the future.

Design is a human activity to create or contrive for a particular purpose or effect. Conscience decisions are made in each and every step of design process based on the person or group's mindset. William McDonough claimed that, through the design, "things we make must not only rise from the ground but return to it, soil to soil, water to water, so everything that is received from the earth can be freely given back without causing harm to any living system."[5] Architect's conscience decision is not only related creating building but also connected to its impact on the environment.

Sustainable design covers a broad spectrum. In architecture, one of the conflicting approaches of sustainable design is the attitude toward technology. One extreme is called the pioneers of low-tech. The idea, rejecting modern technology, was proposed by a number of idealists, applied mostly in small-scale buildings. Often the natural materials, such as wood and earth, are used in this practice. This trend tends to be more closely related to vernacular architecture, as well as traditional structural systems. The other

extreme is high-tech architecture, symbolized by the towering office buildings and steel and glass structures. This group, including Sir Norman Foster, Renzo Piano, Richard Rogers, and Thomas Herzog, tries to solve the environmental problems by using technology, known as "eco-tech." There is no one right answer for these two extremes. As far as technology is concerned, sustainable buildings fall somewhere between these two extremes. What is right and wrong is determined not by its attitude toward technology itself, but by how appropriately those technologies are used in its given circumstance.

It is also true that different approaches are made to achieve sustainability in different aspects. Historical, cultural, climatic, economic, and/or political differences bring different solutions of sustainable architecture.

How Green is "Green"?

According to the office of the Federal Environmental Executive, green building is energy efficient building and site that uses less energy, water, and material. Green building practice is also characterized as low-impact on human health and the environment throughout the building's life cycle.[6] However, there are lots of interrelated issues on green design other than just energy efficiency or purely technical matters.

Through the exhibition, titled *Ten Shades of Green*, Peter Buchanan, curator of the architectural league of New York, provides ten key issues that need to be considered to create a green architecture: Low energy/ high performance; replenishable sources; recycling; embodied energy; long life, loose fit; total life cycle costing; embedded in place; access and urban context; health and happiness; and community and connection.[7]

Different buildings sit on different categories, thus it is difficult to judge whether one building is “greener” than others. US Green building council offers LEED (Leadership in Energy and Environmental Design) green building rating system. LEED rating system can be used for a design tool at the early stage of design. Also project certificate system raises the public awareness of green building’s benefits.

[1] <http://psp.com>
[2] McDonough, Braungart Design Chemistry
[3] <http://www.worldtrans.org/whole/warning.html>
[4] Wilson, Alex and Yost, Peter. "Building and the Environment: The Numbers," *Environment Building News*, May 2001, 1, pp. 10-13
[5] McDonough, William. "Design, Ecology, Ethics, and the Making of Things," *Colonnade* 10, no. 3 (Fall 1994), pp. 9-14
[6] "White Paper on Sustainability," *Building Design & Construction* 11.03
[7] "Ten Shades of Green," the Architectural League of New York

Site Specific: Site Analysis

General Characters of the DMZ and the Border (Transboundary) Region

General topographical characteristics of Korean peninsular are 1) Taebaek Ridge running parallel to the eastern shore line marks the highest point in the Korean Peninsular, 2) because of that, the altitude of eastern region is higher, 3) from the highest point, the altitude gradually drops toward west. The topography of overall DMZ area follows the general characteristics.

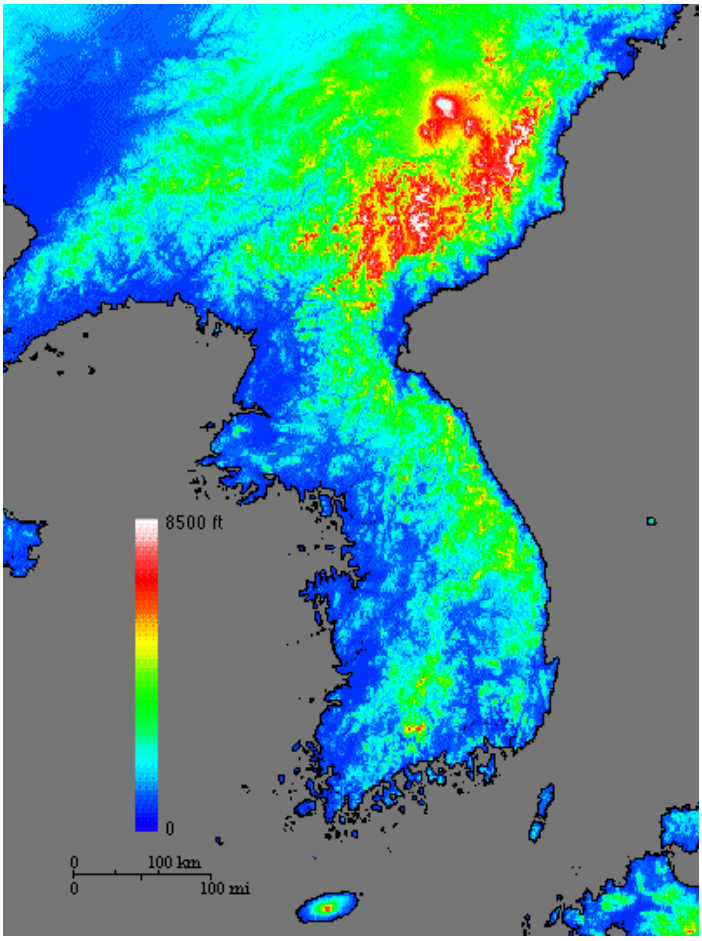

Figure 6 Topographic Map of Korea. White and Red indicate high elevations, and Blue indicates low elevations. The original data were obtained from the Global 30 Arc-Second Elevation Data Set, archived at the Distributed Active Archive Center (DAAC), located at The Earth Resources Observation Systems (EROS) Data Center. [1]

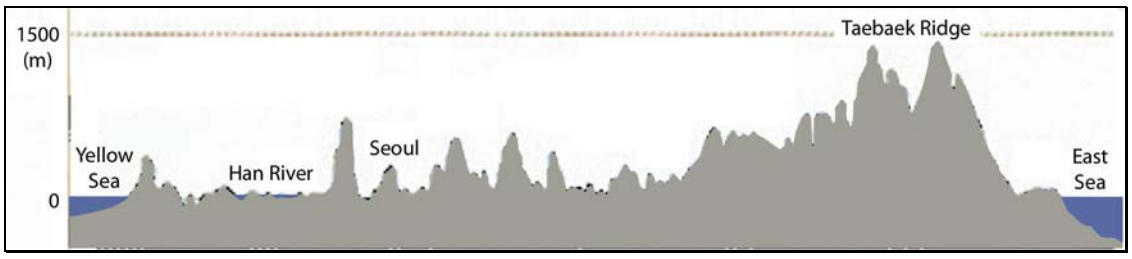

Figure 7 Section Diagram of the Korean Peninsular

Within the DMZ, the North Border Region under North Korean jurisdiction includes 11 Guns. The west region has agricultural field up to 90 % of the total land area. The highest mountain of this region is about 500m above the sea level. Entering the middle region, large agricultural plain is switched by woodland, and the altitude becomes higher. The east region has much higher altitude close to 1000 m above the sea level. More than 80 % of land area is covered with the coniferous forest.

The South Border region, which includes 13 Guns, is divided into three sub-regions: the west region, the middle region, and the east region. The east region is higher point where are lots of mountains higher than 1,000 m run along the Taebaek Ridge. The highest mountain is Seorak Mountain with the altitude of 1,708 m. The middle region is the place where the eastern mountain meets the western plain. Chulwon-gun is the most prominent area in the middle region because of the historical richness as well as the geological significance. Getting closer to the west coast, the landform became a low hill, or costal plain. The population is 656,247, which is 1.4% of total population. The area of the border region is 8,097 km^2 that is 8.1% of total area.

Land use of the DMZ and the Border Region

Based on the report of Forestry Research Institute, the total area of the DMZ is 907.3 km^2. The 75 % of the area is forest, 20 % is meadow, 2 % is agricultural field, and others are wetland, marsh, and river.

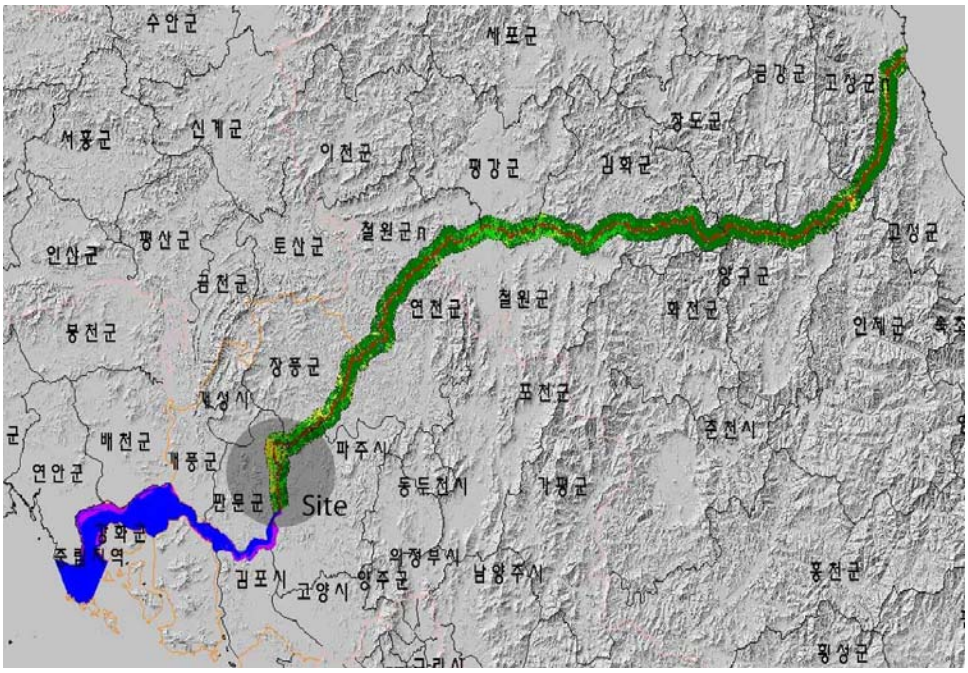

Figure 8 Land use map of the DMZ (end of 1990's). This map used IRS-1C/ID satellite data and LANDSAT data.[2]

Table 1 Forest type in the DMZ [3]

	Total		South Region		North Retion	
	Area (km^2)	%	Area (km^2)	%	Area (km^2)	%
Total	685.0	100	350.2	100	334.8	100
Coniferous Forest	11.9	1.7	7.1	2.0	4.8	1.4
Deciduous Forest	146.5	21.4	78.0	22.3	68.5	20.5
Mixed Forest	401.4	58.6	204.6	58.4	196.7	58.8
Shrubbery	125.2	18.3	60.4	17.2	64.8	19.4

The total area of Border region is 13,565.29 km^2, 6,960.97 km^2 of South Border region and 6,604.32 km^2 of North Border region.

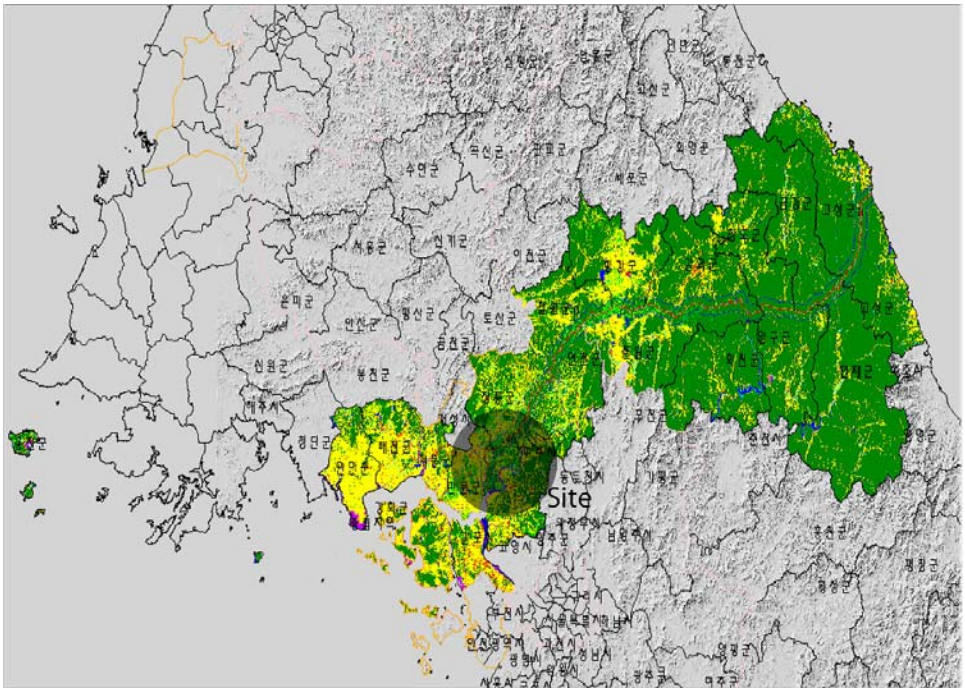

Figure 9 Land use map of Border Region at the end of 1980's

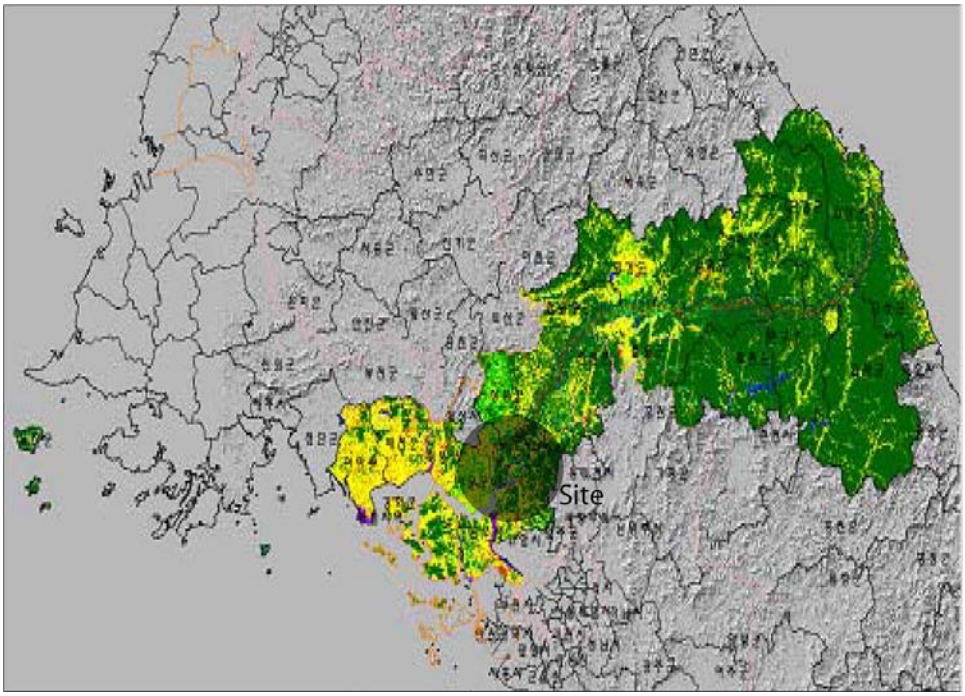

Figure 10 Land use map of Border Region at the end of 1990's

Table 2 Land Use of Border Region (1980~1990) [4] Unit : %

	Year	Urban Area	Agricultural Field	Forest	Meadow	Wetland	Others
South	1980	0.93	18.27	74.57	3.13	0.52	2.55
	1990	1.67 (44% increased)	16.21 (13% decreased)	74.96(0.53% increased)	3.54	0.59	3.04
North	1980	0.94	28.27	63.88	4.45	0.54	2.01
	1990	1.96 (52% increased)	29.35 (4% increased)	60.56 (5.5% decreased)	6.15	0.55	1.44

Forest is dominant ground cover in the Border region. However, urban area is drastically increased both in South and North Border region. In general, agricultural field and natural green area are decreased, and urban area is increased. Especially in North Border region, forest cover has been decreased. Urbanized area is focused in the west region where land is relatively flat, climate is milder than the eastern mountain region, and both Koreas' capitals are closely located.

Ecological Significance of the DMZ and Border Region

The limitation of human access makes the DMZ area unique and valuable ecosystem. The DMZ is the only continuous ecosystem from East to West. In addition, along with the Taebaek Ridge is another ecological corridor connecting north and south.

In the middle region, Chulwon Basin is one of the biggest red-crowned cranes' habitats in the world. In the west region, different types of wetlands are located, such as Han River Estuary, Imgin River Estuary, tidal flat, and so on. Large area of Jangdan peninsular is known as forested and seasonally flooded wetland which houses another large habitat for migratory birds. Uryoung reservoir, close to the Panmunjeom, is a large lake type marshland. This area is well preserved being an example of a prototype of habitat for various species of amphibia, pisces, and birds.

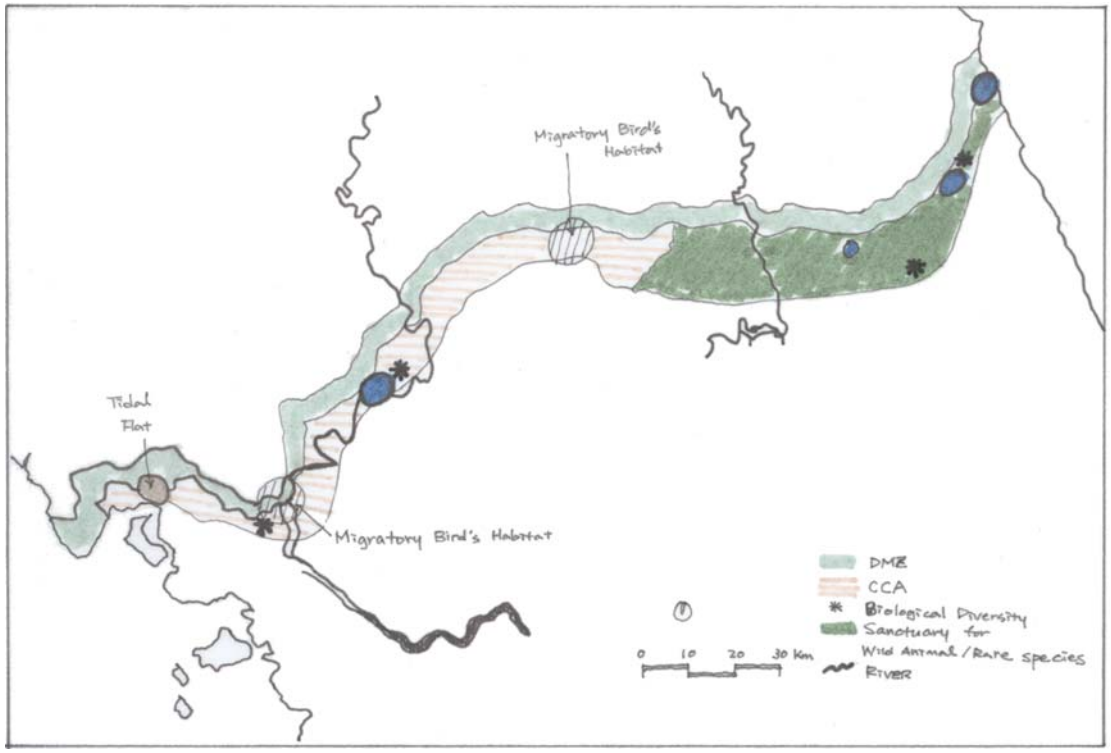

Figure 11 The ecologically significant area.

Historical Significance of the DMZ and Border Region

Geographically, the DMZ is located at the center of Korean Peninsular. This area has been important since prehistoric period. There are two major prehistoric sites located in or right next to the DMZ. Yeonchun and Gangwha have variety of prehistoric remains, including the Paleolithic era, the Neolithic era, the Bronze Age, and the Iron Age.

Gungye site is located near the Chulwon Basin within the DMZ. Gungye was the political leader in early 10th century who dreamed of the unification of three kingdoms. He had built his capital at the center of Korean Peninsular as a symbol of centralized and unified kingdom. Because it is located inside the DMZ, the site is well preserved except the damage that had been done during the war. Gaesung is another historically significant place. Gaesung is the capital of Koryeo dynasty in late 10th century.

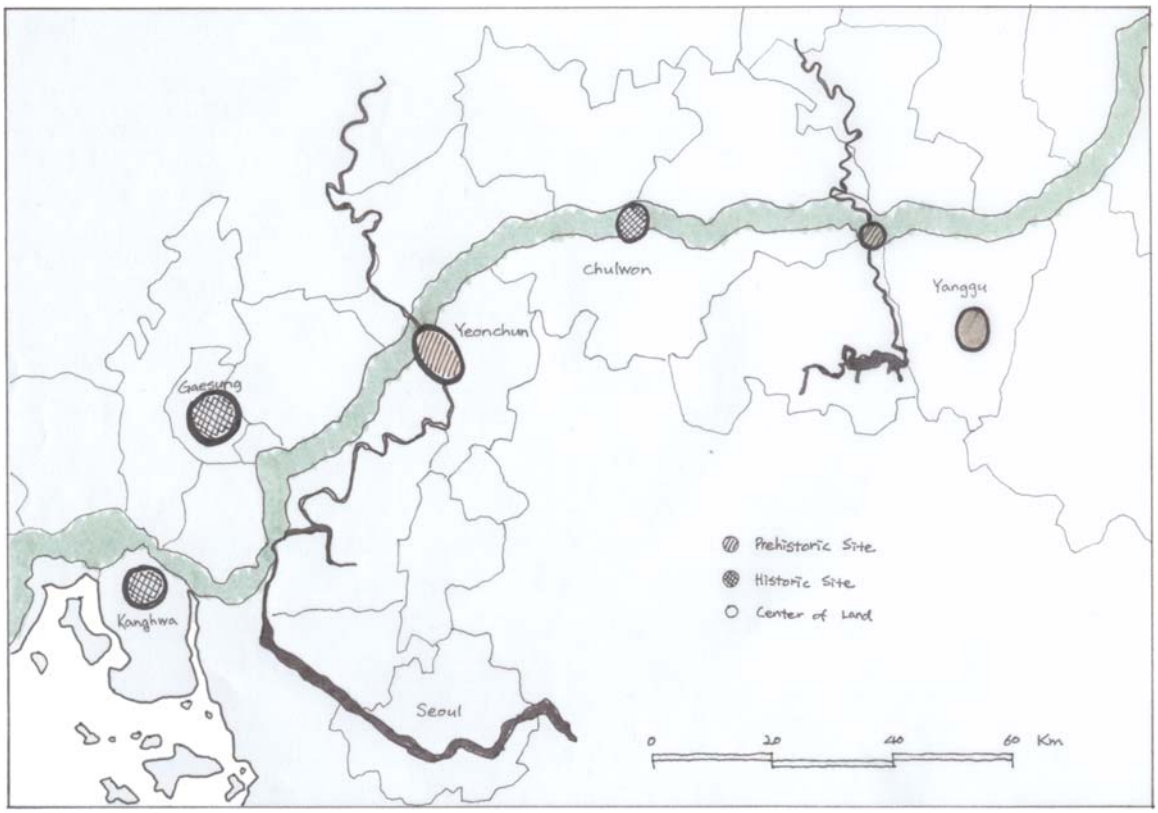

Figure 12 The historically significant area.

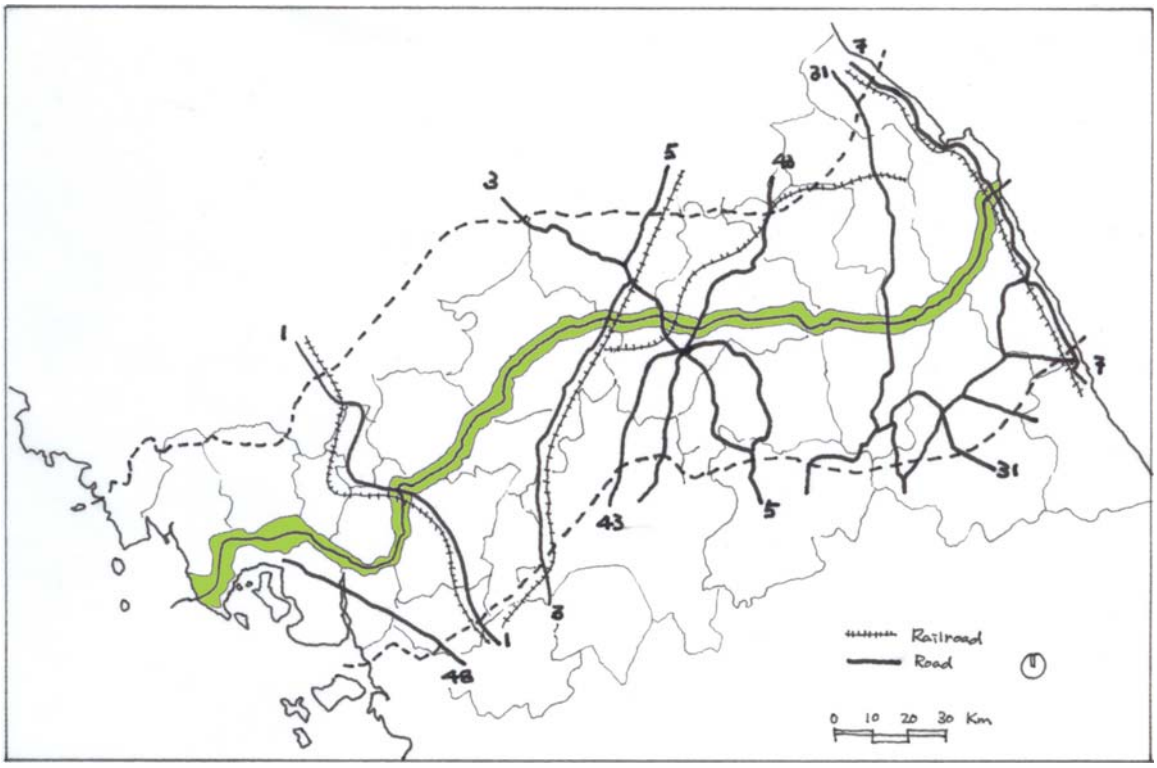

Figure 13 Major connection routes between North and South. Three train lines are, from west to east, Gyeongui line (1906), Gyeongwon line (1914) and Donghae line (1937), respectively. Currently, the North and the South agreed to reconnect Route 1, Route 7, Gyeongui Rail line and Donghae Rail line.

Context

The site of this thesis is located inside the DMZ. The distance from Seoul, the capital city of South Korea, is about 60 km, and that from Pyongyang, the capital city of North Korea, is about 200 km. The site is located near old Jangdan Station. Jangdan station is the last station where Gyeongui Railway Line stops before it crosses the Military Demarcation Line. The station is located about 20 m east to the Military Demarcation Line inside the DMZ. The train station was built in 1937. The actual building had been torn down during the war, but the ground is preserved in the DMZ.

The nearest city in North Korea is Gaesung located about 15.3 km northwest. Gaesung is being transformed into an industrial new town with factories built by South Korean capital and served by North Korean labor.

Transportation and Main Access to the site

About 2.2 km east from the site, outside of the DMZ, there is a new train station, named Dorasan Station, which was built on Feb. 2002 as a result of the summit conference. At this moment, Dorasan station is the last station on Gyeongui Line operated in South Korean territory. Only three trains are operated per day, and passenger number is limited about 500 persons per day. The train is used only for tourists to visit several tourist attractions near the station. In addition to the reconnection of railroad, the North-South connection road will be constructed parallel to the railroad for mainly service purpose. The site will take advantage of the existing rail line as well as the new service road.

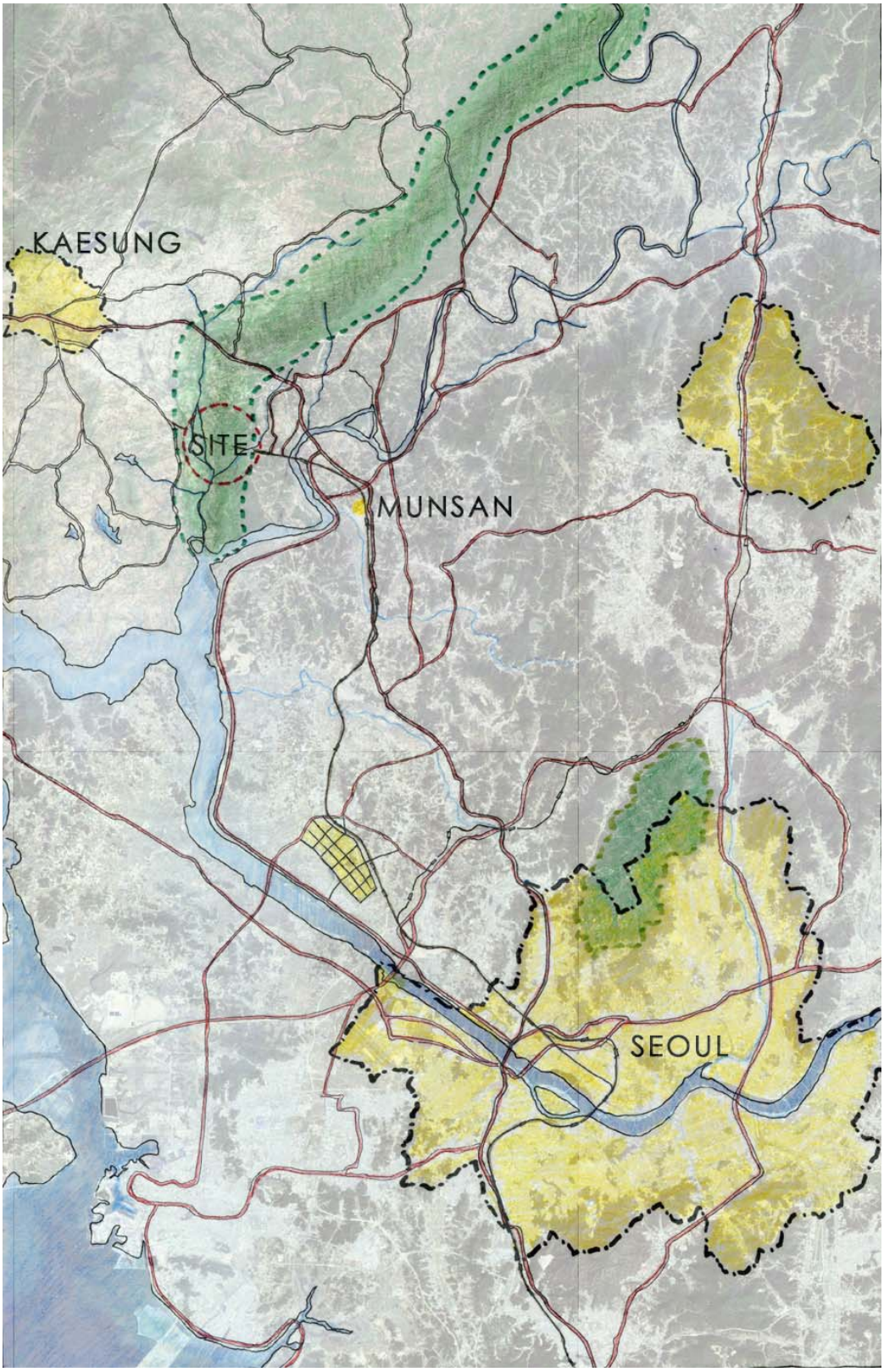

Figure 14 Context map showing adjacent cities

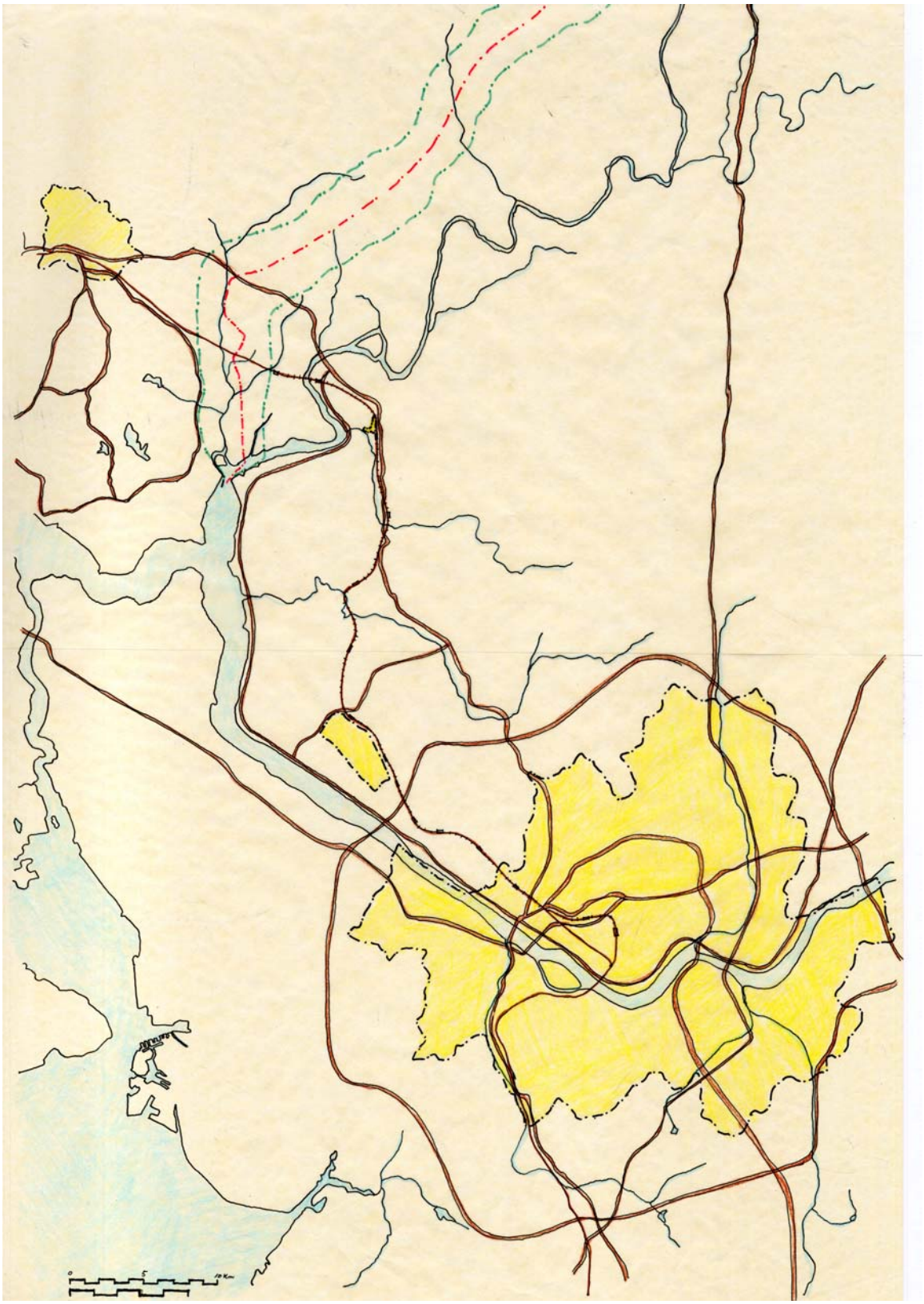

Figure 15 Existing Road Map

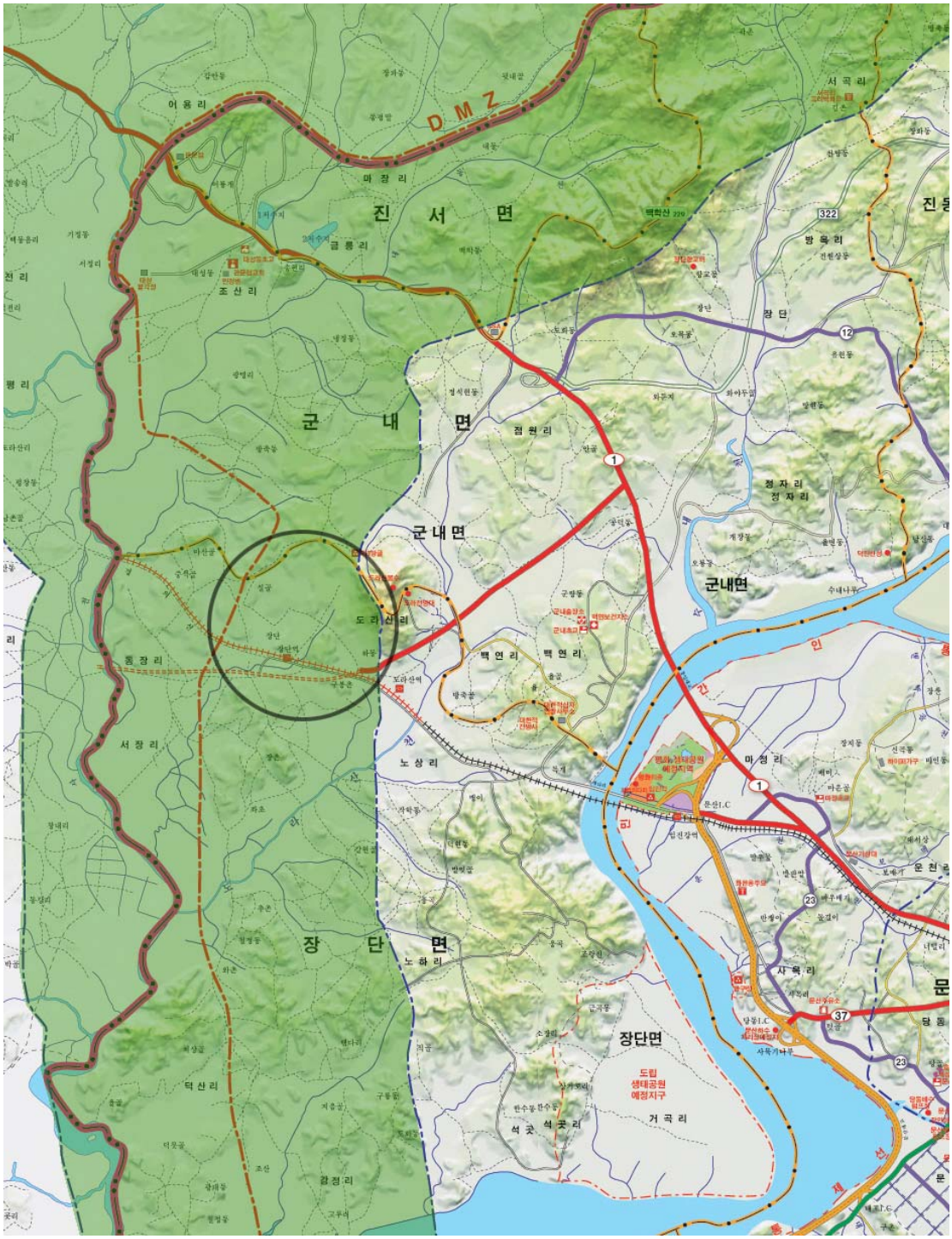

Figure 16 Area Map[5]

Ecology/ Hydrology/ Geology

The overall DMZ area including the site used to be highly populated agricultural fields, especially rice field. Except some area near the living village, most of the farmland turned into wetland and forest. Large areas close to rivers became various types of wetland, such as grassy marsh, forested swamp and so on. The inland area became meadow. This area is a natural habitat for migratory birds and rare plants. Millions of migratory birds pass through Korean Peninsular every spring and fall. The DMZ offers habitat for these birds.

The area around the site is composed with low hills and plains. The topography of this area is the miniature of topographical characteristics of Korean Peninsular, which is "higher east, lower west". The highest point is Gamak Mountain located far north east, 675 m above the sea level, and the nearest mountain is Dora Mountain whose altitude of 156m above the sea level. The average altitude of the site is 10 to 20 m above the sea level[6].

More than 75 % of the area around the site is covered with forest. The types of forest are a native deciduous forest, a native mixed forest, and a restored forest.

Figure 17 Native deciduous forest (left) and native mixed forest (right).[7] These pictures were taken around the site.

Figure 18 Native deciduous forest[8]

Figure 19 Restored forest. View from the observatory parking lot.[9]

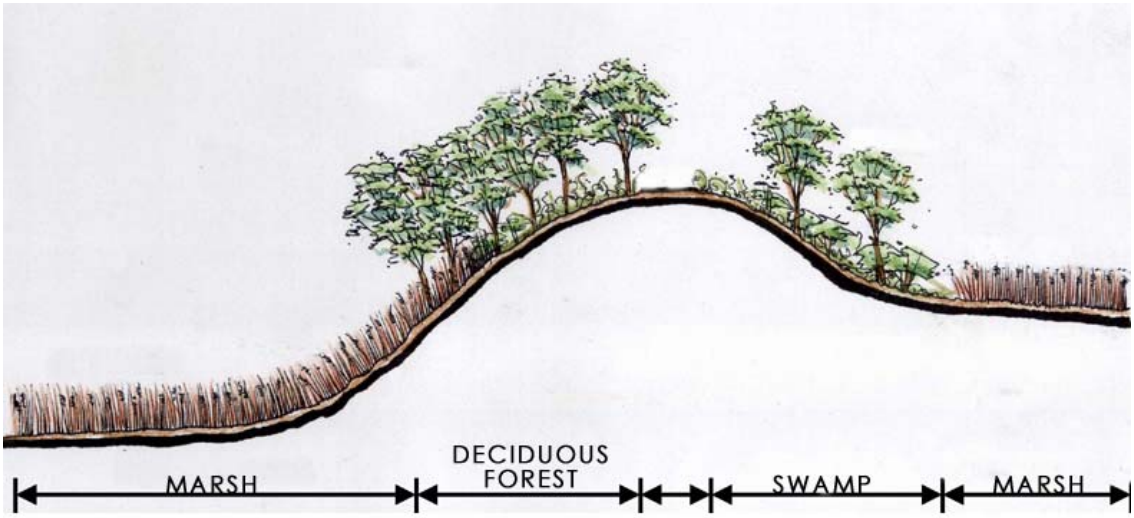

Figure 20 Typical section showing groundcover of the lowland [10]

Figure 21 Wet lands around the site[11]

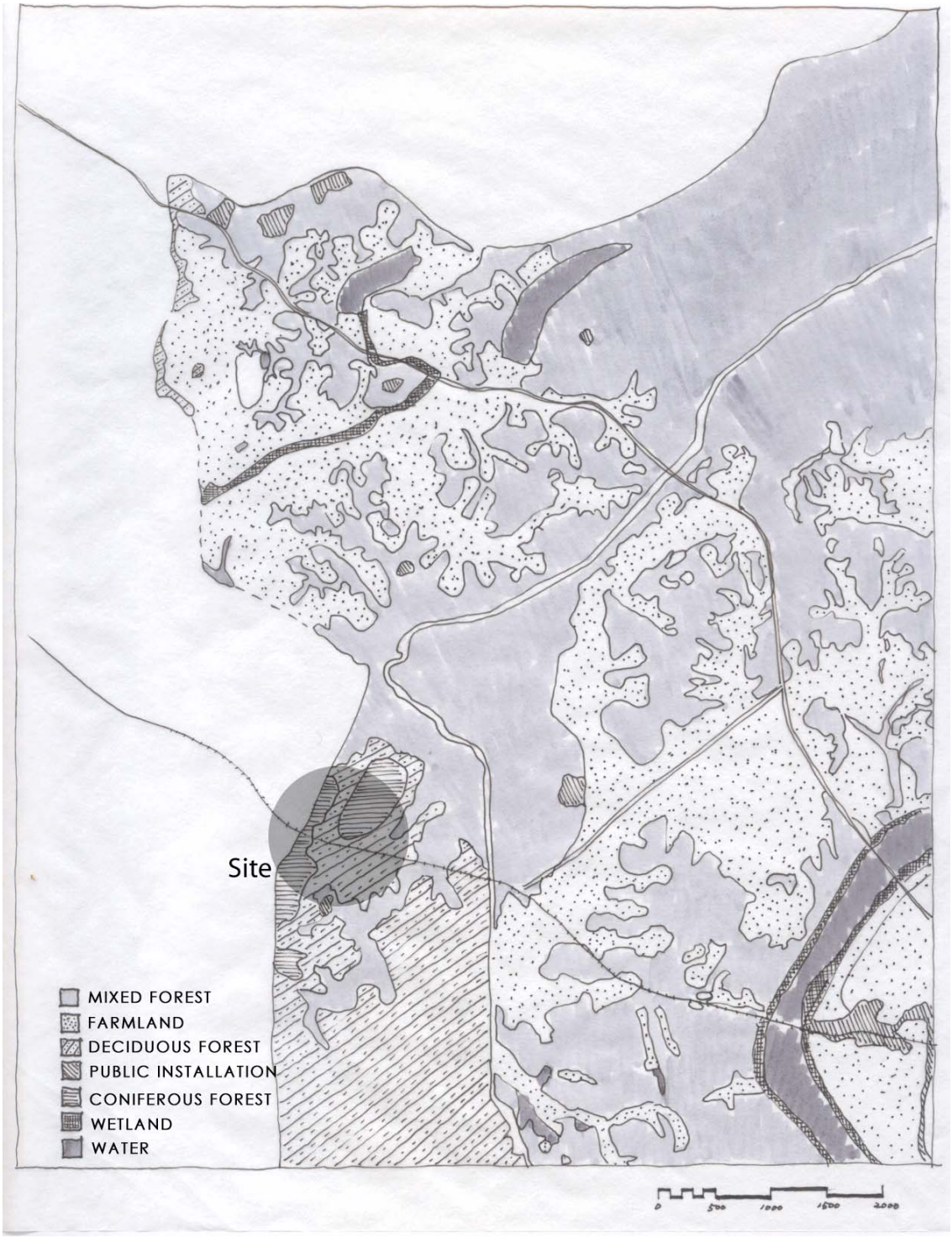

Figure 22 Groundcover map showing vegetation type and land use. The diagram only shows the land use of South Korean territory because, currently, the information of North Korean territory is not available.

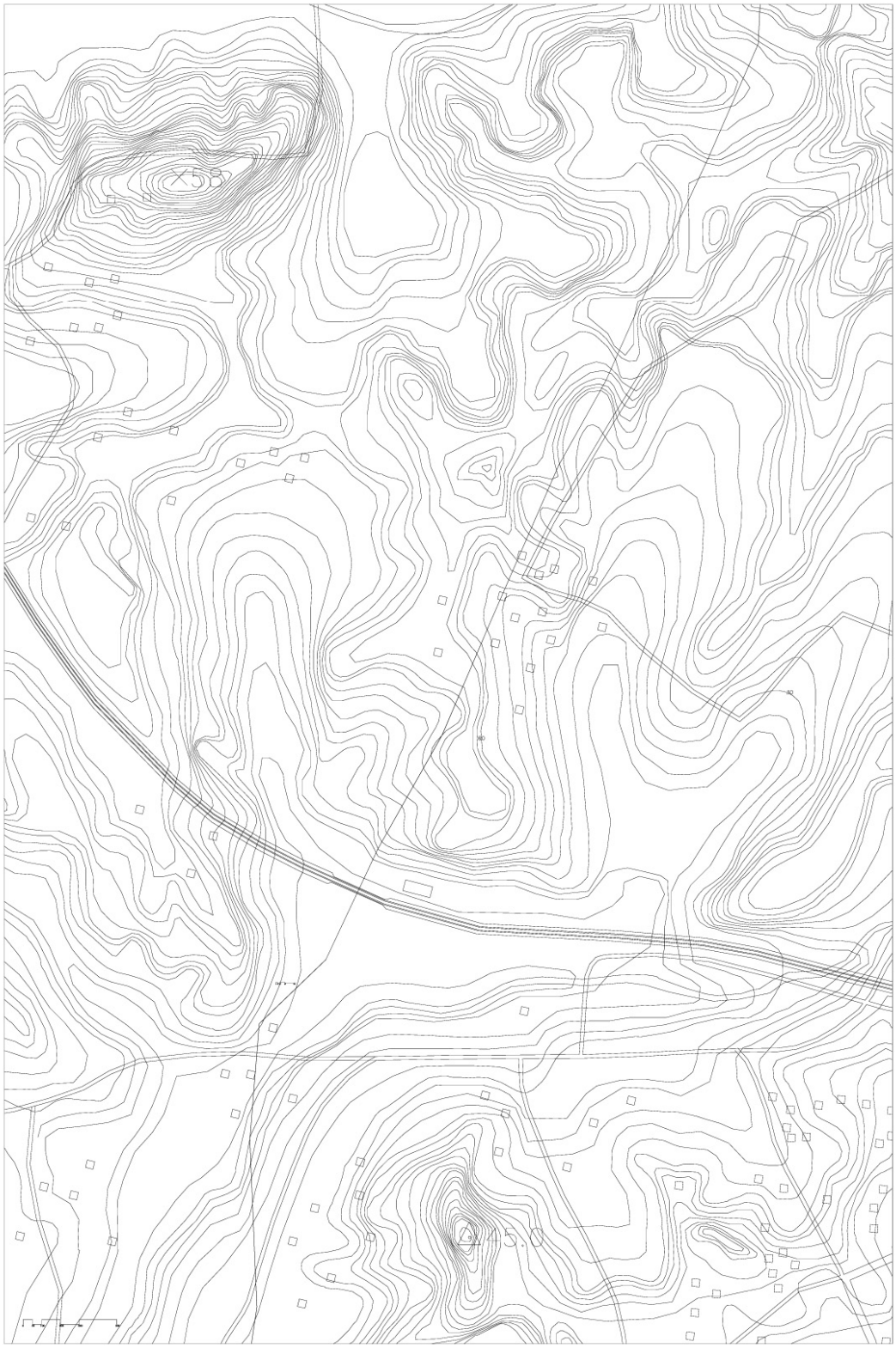

Figure 23 Topographic map. The interval of each line is 5 feet.

Climate Data

Table 3 Temperature from the weather stations near the site (Historic Data, 1935)[12]

Weather Station	Altitude (m)	Temperature (°C)							
		January			August			Annual Range	Annual Average
		Ave.	Ave. Min.	Min.	Ave.	Ave. Max.	Max.		
Gangwha	40	-4.1	-8.5	-24.0	26.0	30.1	36.4	30.1	11.6
Gaesung	35	-6.0	-11.4	-24.5	25.2	29.5	38.0	31.2	10.3

Table 4 Rainfall from the weather stations near the site (Historic Data, 1935)[13]

Weather Station	Rainfall (mm)							Survey Period
	January			July			Annual Total	
	Ave.	%	Ave. Rain Day	Ave.	%	Ave. Rain Day		
Gangwha	21.7	19	4.6	228.5	203	14.2	1125.8	1919-1934
Gaesung	23.7	18	4.6	282.1	219	16.1	1289.1	1919-1934

Table 5 Temperature from the nearest weather station [14] (Unit: °C)

	1980			1985			1990			1995			2000		
	Min	Max	Ann. Range	Min	Max	Ann. Range	Min	Max	Ann. Range	Min	Max	Ann. Range	Min	Max	Ann. Range
Paju	-4.6	23.5	27.3	-9.8	27.1	36.9	-5.0	27.4	32.4	-2.8	26.9	29.7	-0.5	24.8	25.3

Table 6 Rainfall from the nearest weather station[15] (Unit: mm)

	1980	1985	1990	1995	2000	Ave.
Paju	1,017.2	1,173.3	2,307.5	1,138.2	1,152.5	1,357.74

Tourist Attractions

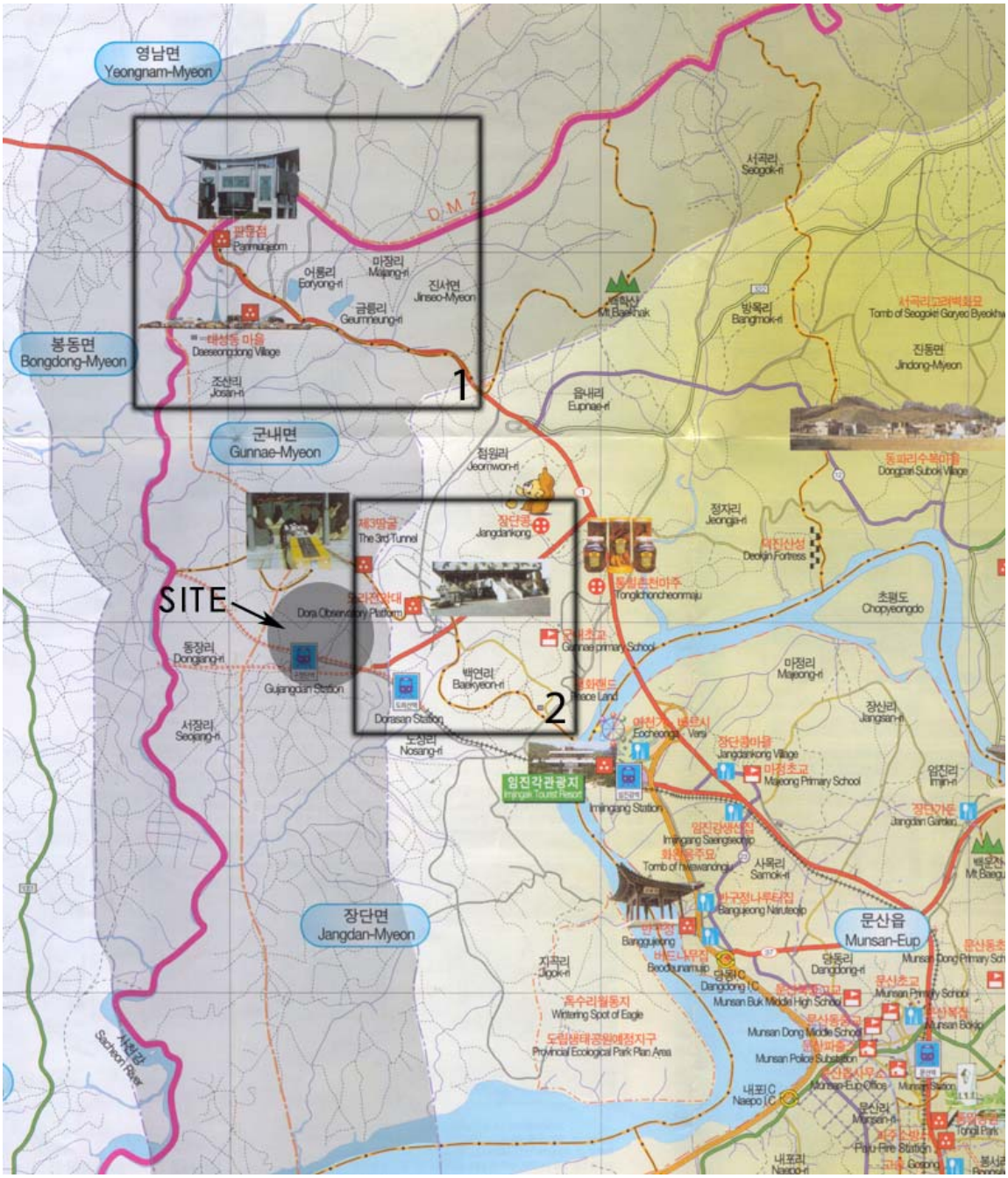

Figure 24 Tourist Map[16]

Panmunjeom (Area 1 in the tourist map)

Panmunjeom is the place for the South-North negotiation and the Military Cease-Fire Conference. It is located about 6.2 km north from the site.

Figure 25 Aerial view over the Panmunjeom, the Joint Security Area[17]

Figure 26 Panmunjeom, South Korean area[18]

Daeseongdong (Area 1 in the tourist map)

About 4 km north of the site, there is the only living village within the DMZ, named Daeseongdong. There are 53 households 212 people, who are South Korean, and most of them are farmers. Even before the war, agriculture was the major industry around this area. The agricultural product from the village is well known organic product.

Figure 27 View of Daeseongdong village[19]

Figure 28 Aerial view over Daeseongdong village[20]

Dorasan Station and Observatory Point (Area 2 in the tourist map)

On the east side of the site, there is an observatory point on top of the mountain. From this point, tourists can watch over the old train track, destroyed town, and the nearest North Korean village. The site plan will be designed to corporate the possible tracking path connecting the site and the mountain. Also, the military observatory point will be used as a science observatory and air quality monitoring station.

Figure 29 Dorasan Station and Observatory Point

Jangdan

The site of this thesis is located in Jangdan. Jangdan is located inside the DMZ, and not much is left after the war. However, because of the railroad reconnection, the access to the site becomes more convenient. Ground is covered with mixed forest, reeds, and other plants. Existing tourist attraction and access road make it possible to develop the area without further damaging impact of the natural condition.

Figure 30 Old municipal building of Jangdan, built in 1934 and damaged during the war.[21]

Figure 31 Building in Jangdan

Figure 32 Ground for old Jangdan Station, built in 1937 and destroyed during the war. It is registered as a cultural property.[22]

Figure 33 Locomotion destroyed by bombing and left near Jangdan station[23]

[1] <www.coft.edu> Copyright by Wheeling Jesuit University/NASA Classroom of the Future.

[2] Kim, Y.B., Lee, M. W., Lee, S. S., *A study on the peace belt blueprint in the border region in relation to the reconnection of Gyeongui and Donghae railroads*, Korea Research Institute for Human Settlements, 2003

[3] Forestry Research Institute, Forestry Administration, 2000

[4] Ibid.

[5] <http://www.gyeonggi.go.kr>

[6] Paju City Almanac, Gyeonggi Do, 2000

[7] The ecology of the DMZ, Ministry of Environment, 2003

[8] Ibid.

[9] Ibid.

[10] National Institute of Environmental Research, Ministry of Environment, 2001

[11] The ecology of the DMZ, Ministry of Environment, 2003

[12] Data from Meteorological Administration

[13] Ibid.

[14] Ibid.

[15] Ibid.

[16] Paju City, Gyeonggi Do

[17] <www.lifeinkorea.com>

[18] <www.kgdmz.or.kr>

[19] Ibid.

[20] <www.lifeinkorea.com>

[21] *The List of Cultural Properties*, Cultural Properties Administration, 2002

[22] Ibid.

[23] Ibid.

Precedent Study:

01 Sustainability as an Idea / 02 Laboratory Building

First Thought – Meeting Place [1]

Location: near Barnau, German-Czech border

Architect: Bruckner & Bruckner Architekten

Figure 34 View of Meeting Place

This small building is located on the German/Czech border where the hill separates the two countries. It is intended to be both a reminder of historically tormented border and a gesture of reconciliation.

The building is composed with two parallel walls and a little space in between. Each wall is made of Upper Palatinate granite from Germany and of Bohemian larch from Czech, respectively. The layers of glass are integrated with horizontal band of stone and wood. As the wall being closer to the sky, the layer of glass got bigger to increase luminous and transparency.

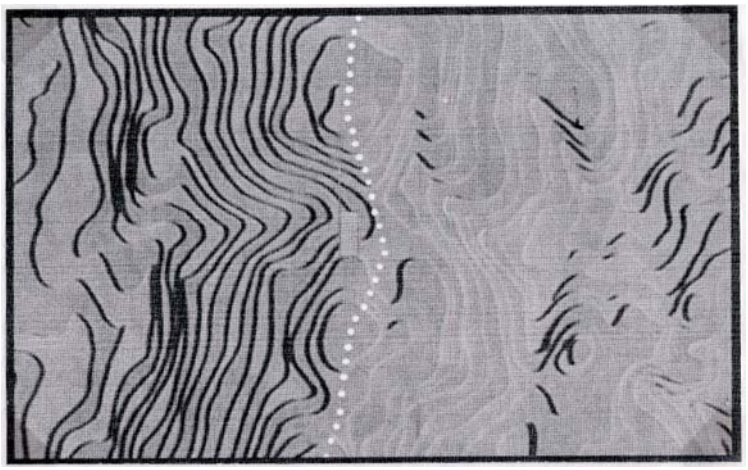

Figure 35 Site Model. Parallel to the borderline, this little building looks simply like a wall from the distance. As you get closer, the building reveals its second wall and the space in between.

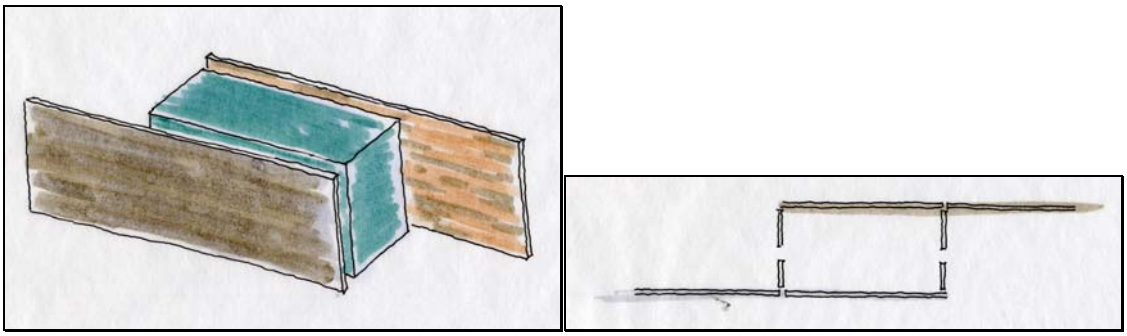

Figure 36 Axon and plan diagram.

In the distance, this small building seems just like a wall. As getting closer, staggered two walls and the space are revealed. Parallel lines never meet or across each other. However, those slid walls, which were made of representative materials of two countries, allow a space where two lines overlap, symbolizing the possibility of reconciliation.

Sustainability as an Idea 01:

- Adam Joseph Lewis Center for Environmental Studies, Oberlin College

Location: Oberlin, Ohio

Architect: William McDonough + Partners

Figure 37 View of Adam Joseph Lewis Center for Environment Studies at Oberlin, Ohio[2]

"A perfect building would be like a tree," says William McDonough[3], providing habitat for living creatures, producing oxygen, purifying water, and synthesizing primary source of food using sunlight as its energy source. Adam Joseph Lewis Center for Environment Studies at Oberlin College resembles a tree in many respects.

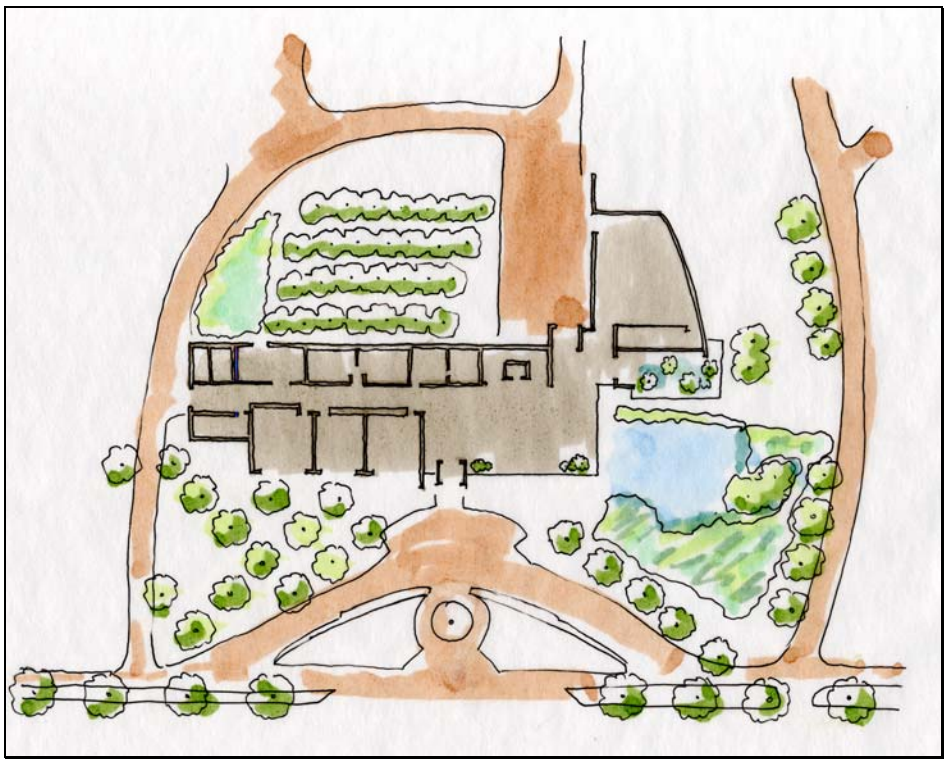

Figure 38 Site Plan

At the first phase of design process, the building program was characterized with three goals.[4] First, the building should be beautiful environmentally as well as aesthetically. In other words, the building would cause no harm to human or ecosystem, either on its site or somewhere remote, also now and sometime in the future. Second, the building and the landscape should be designed in a way that students would be able to be connected with nature, such as soils, trees, water, and the sun, and help to redefine the relationship between human and the environment. Third, the building would be as a part of education with incorporated curriculum related to analyzing the solar energy, monitoring the on-site water purification and so on.

The program goals were directly engaged with the design. As a result, the building itself and the surrounding landscape became a laboratory for environmental studies in various fields.

The building takes L-shape. A two-story rectangular building includes classrooms and offices. On its east end, smaller building is attached which contains an auditorium and a “Living Machine” that filters the building’s wastewater. Big atrium is placed at southeast corner of building which connects two structures. The classroom building has east-west axis, which allows long southern exposure for natural light.

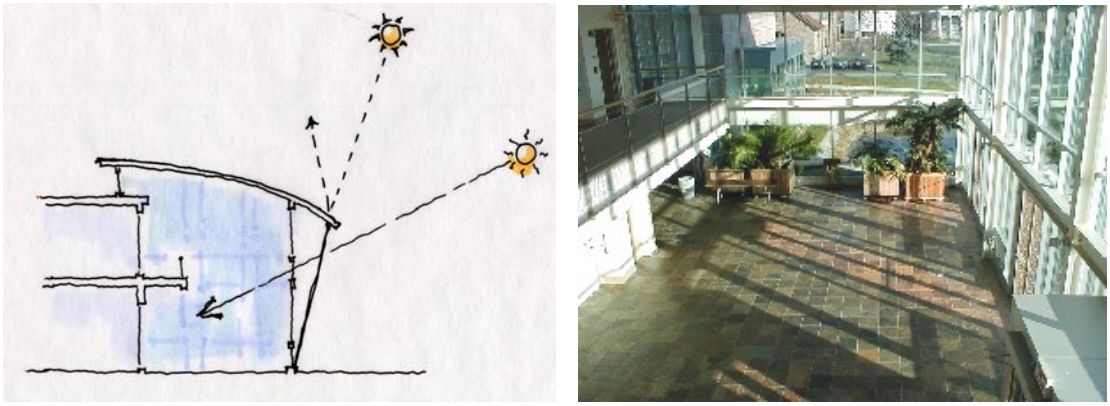

Figure 39 Section through the atrium and the view of atrium[5]. The east and south facing windows bring ample natural light into the generous two-story space. South facing glass wall has the overhang designed to prevent the harsh summer sun, yet allow the winter sun.

The surrounding landscape features various constructed ecosystem, such as wetland which was a dominant nature form of northern Ohio area[6], orchard which produces apples and pears, permaculture garden which is part of edible landscape, deciduous trees and lawns as well as plaza where students can gather.

Figure 40 Constructed Wetland and Permaculture Garden[7]

Materials used for the center were recycled or reused, low embedded energy, and locally harvested, produced and/or distributed. Energy to run the center is generated by photovoltaic panel installed on to the roof. Building's wastewater is treated through the "Living Machine." Constructed wetland filters storm water runoff. The edible garden around the building produces fresh products. Every event mentioned above is analyzed, monitored, and studied by students and faculties who use the building. The building shows the proof that "it is possible to design buildings so well and so carefully that they do not cast a long ecological shadow over the future that our students - future generation - will inherit. Buildings can be designed to give more than they take."[8]

Sustainability as an Idea 02:

- The Philip Merrill Environmental Center

Location: Annapolis, Maryland

Architect: Smith Group

The Philip Merrill Environmental Center is the headquarters for the Chesapeake Bay Foundation, the non-profit regional environmental organization. It is considered the "greenest" building in the USA, and the first project to receive the Platinum LEED rating from US Green Building Council.

Figure 41 The Philip Merrill Environmental Center. View from southeast.

The building footprint was deliberately chosen within a 33-acre site. The building sits on top of the area where buildings had been built previously, leaving 85% of the site undisturbed. The building's elongated mass along with east-west axis allows maximum southern exposure for natural lighting. The building is also oriented to take advantage of breezes coming off the bay. The building's long, thin shape and open plan enhances natural ventilation.

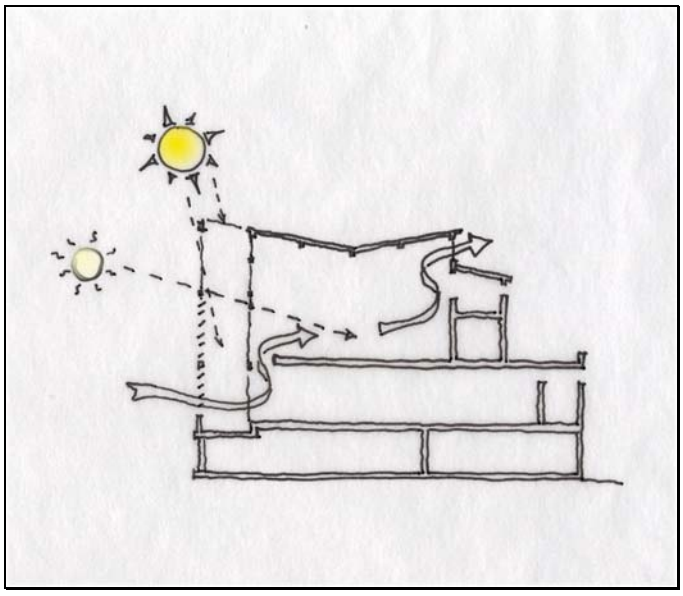

Figure 42 Section

All materials used in the building are made of recycled materials or created through processes that don't damage the environment. Local materials are used wherever possible so that depletion of fossil fuels from transporting materials could be minimized. Easily renewable materials are used, such as cork, bamboo and Parallam. The building conserved resources simply using less material. The structure is remained exposed, and there are no fancy interior finishes. Wherever possible, materials were left in their raw state enabling future recycling.

Figure 43 Interior of Chesapeake Bay Foundation showing exposed structure and free plan office space

Single pitched and standing seam metal roof is designed for collecting rainwater, channeled into continuous gutter and stored in three cisterns. The collected rainwater is used for a fire suppression system, irrigation, or is filtered for use in hand-wash and laundry. By using stored rainwater and composting toilets instead of flush, the building uses 90% less potable water than normal buildings.

Figure 44 The building reuses rainwater captured off the roof in three large cisterns.

The Phillip Merrill Environmental Center incorporates many features of green architecture. Overall, the building uses 50% less energy than a typical office building, gains 34 % of its energy from renewable sources and reduces 90% of waste[9]. Despite aggressive sustainable strategies applied to the building, the Center doesn't look much different than a typical building. It was the goal behind the main design idea that such building can be accomplished by anyone. Mary Winchester, the vice president of Chesapeake Bay Foundation, said, "rather than create a one-of-a-kind structure that is so specialized no one can emulate it, we are setting an example that anyone can accomplish. The idea is to get people to do what we're doing, because that is what is going to make the difference."[10]

Laboratory Building with Sustainable Landscape

- Water Pollution Control Laboratory

Location: Portland, Oregon

Architect: Miller/Hull Partnership

The Water Pollution Control Laboratory (WPCL) located along a ten-mile-long riverside park at Portland houses 15,000 square feet of laboratory with 25,000 square feet of administrative and support spaces. The building and the site demonstrate the collection, cleaning, and discharge of storm water. Especially, oversized scuppers and exaggerated roof planes of the building accentuate storm-water runoff mostly originated from roofs in urban area. When it rains the roof demonstrates an urban runoff as oversized scuppers pouring rainwater into a landscaped treatment pond.

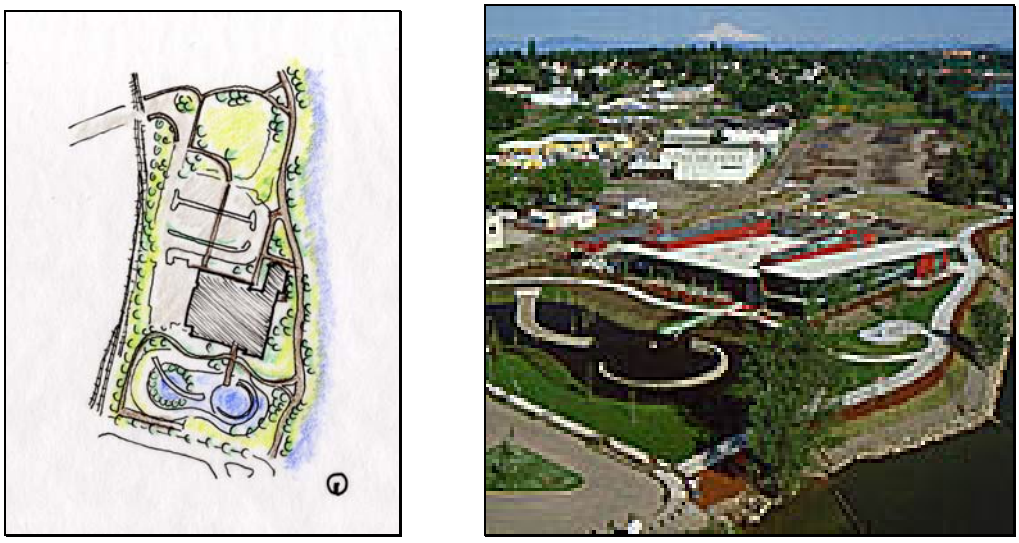

Figure 45 Site Plan and Aerial View[11]

Figure 46 Demonstration Water Treatment Ponds. Rain on the roof is routed into this pond. The process of storm water treatment became clearly visible to public.[12]

The occupants of the building are environmentalists who are interested in sustainable issues including sustainable architecture. However, laboratories often require controlled environment, which makes natural light and ventilation impossible. The plan is organized in a way that natural light and ventilation can be utilized wherever possible. Main entry is located between administrative periphery and central laboratory block. Open plan offices are located on west side of building where large glazing with operable windows is installed. At the center, the loft like space is subdivided into six individual laboratories that look like large nooks off the wide circulation. Overhead skylights bring daylight into the laboratory area.

Public spaces, such as main lobby, multipurpose/conference rooms, a cafeteria, are clustered in one side of building that building can be open to public activities even after the lab portion is closed.

Figure 47 Ground Floor Plan

Figure 48 View of open plan office space [13](left) and Laboratory[14] (right). Office is placed where natural light can be used. In addition to the skylights, glazed doorway separating public corridor and laboratory space brings natural lighting into laboratory area.

Laboratory Building 02

- Center for Industrial Innovation, Rensselaer Polytechnic Institute

Location: Troy, New York

Architect: Mitchell/ Giurgoia Architects

The Center for Industrial Innovation (CII) building sits at the front edge of Rensselaer Polytechnic Institute's academic precinct. The Institute established the engineering school as an important intellectual center of technological research. The building's prime location in the campus shows the institution's conviction that "research is a basic ingredient of scientific scholarship.[15]"

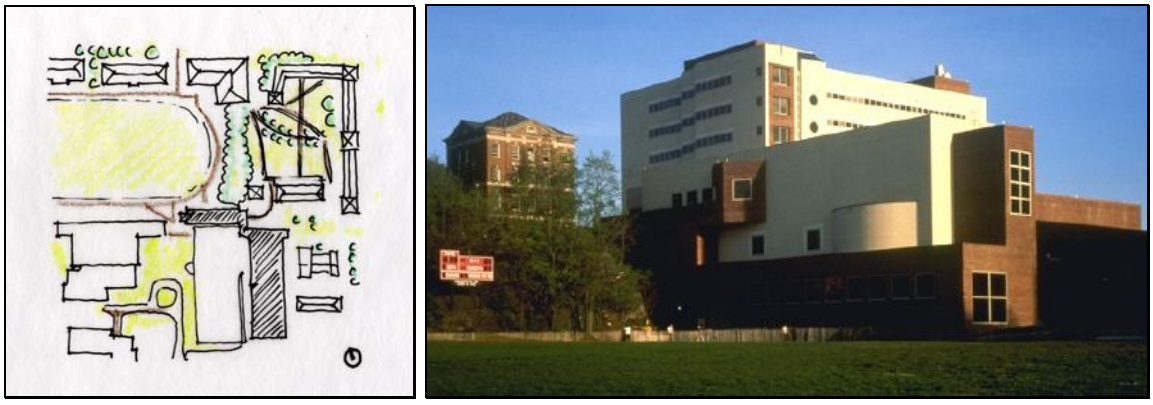

Figure 49 Site Plan and View from north[16]

The CII includes four independent areas: a microelectronics lab (clean room, second floor); a tower with conventional labs; a wing for conferences separated from main building by a walkway; and a high-bay lab at grade below conference facilities. Enormous mechanical spaces are located top and bottom of the clean room which

demands the most amount of HVAC. Office spaces are incorporated within laboratory areas. Classrooms and conference, however, is separated from main body of building. Considering the cutting-edge researches studied in the CII, security could be a main concern for the Institution as well as researchers. The auditorium and seminar space are for outsiders asking for the result of center's researches. The conference wing is connected with the main building only by a second-story bridge.

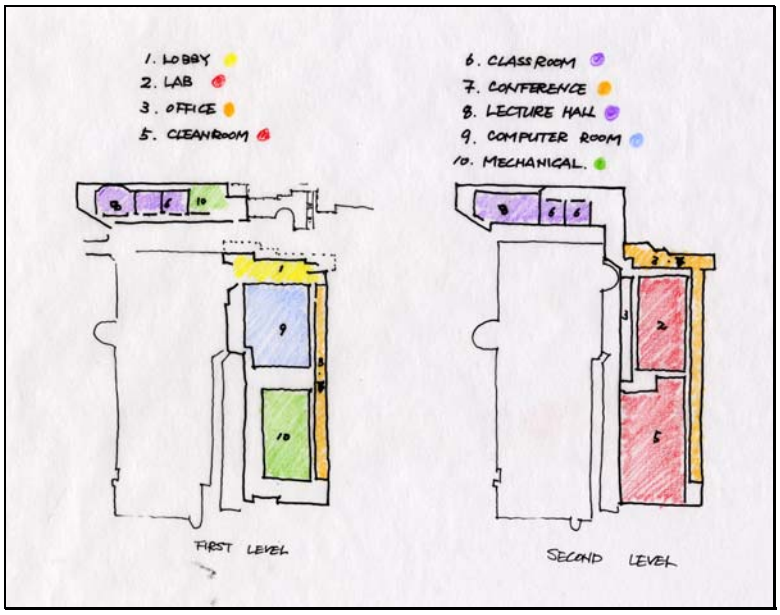

Figure 50 Plan

Laboratory Building 03

- Ortho Research Center

Location: Richmond, California

Architect: Stone, Marraccini and Patterson Architects

Ortho Research Center houses two major fields of research: chemistry dealing with ways of eliminating pestiferous weeds, fungi, and other agricultural undesirables, and biology devising plants with resistance. Despite the interdependent research necessity, a chemistry lab and a biology lab need to be isolated from each other.

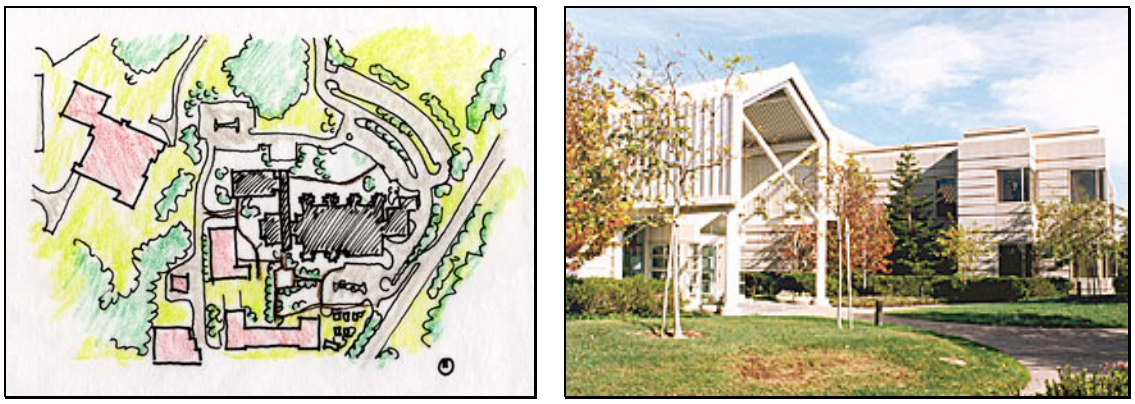

Figure 51 Site Plan and View from south[17]

The Ortho Research Center includes administrative offices, a library in addition to the laboratories. Each function is housed in separate building, yet connected by two-story gallery.

Administrative offices are clustered in northwest building next to the main entry. The two-story gallery serves not only security needs to control the access of lab area but also connecting functions physically as well as scientists who work in different labs. A library and lunchroom are attached to the gallery. In the laboratory building, biology labs and chemistry labs are separated by central service core area. The air handling system for laboratory building is designed to avoid mixing air from two different types of labs. All air coming into the building is divided for separate delivery and exhaust. Scientists' offices are incorporated in laboratory building. Research offices are located the protruded niches around periphery of the laboratory building. Each niche has four offices with a shared foyer as well as informal lounge in the widened corridor where scientists can have informal meetings and exchange their thoughts.

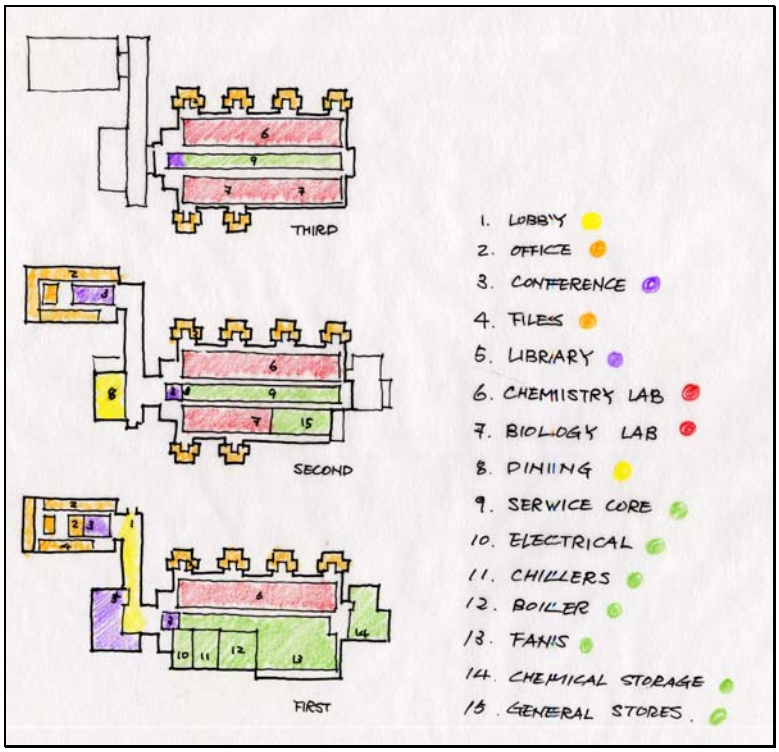

Figure 52 Plan

[1] *Architectural Review*

[2] <www.agcohio.com> Associated General Contractors of Ohio

[3] Truppin, Andrea, Interiors, January, 1999

[4] Orr, David W., "Better Angels of Our Nature: Ecological Design and Organizational Learning," *Harvard Design Magazine*, Sp.-Win., n. 18, 2003

[5] <www.oberlin.edu> Adam Joseph Lewis Center for Environmental Studies web site, Virtual Tour

[6] Ibid.

[7] Ibid.

[8] Orr, David W., Ibid.

[9] "Chesapeake Bay Foundation HQ: the "Greenest" Office Building," *Architect & Builder*, vol. 53, issue 1, January/February 2002

[10] Gunts, Ed, "Bay Keepers," *Inform*, no. 3, 2002

[11] Hinshaw, Mark, "Water works," *Architecture*, July 1997

[12] Olson, Sheri, *Miller Hull, Architects of the Pacific Northwest*, Monograph, Princeton Architectural Press, 2001

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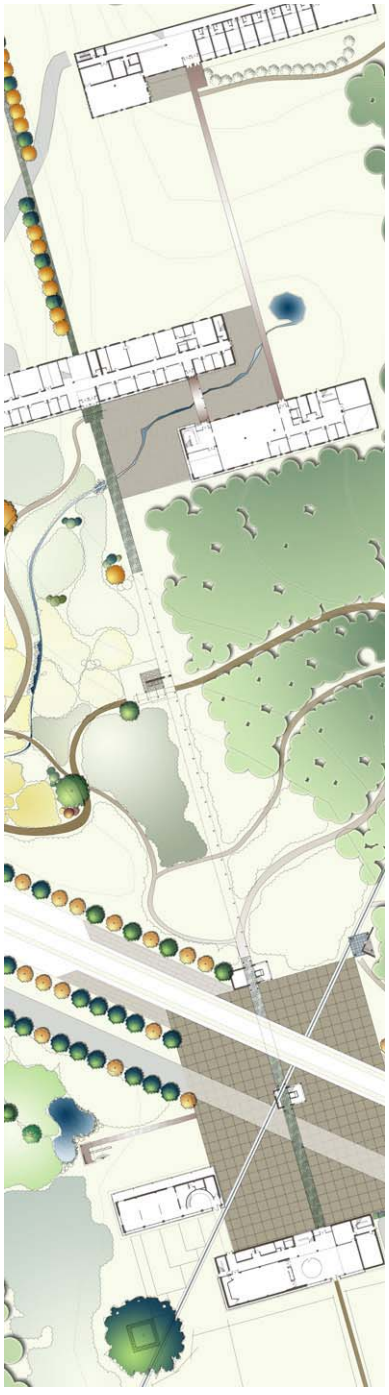
[14] Olson, Sheri, *Miller Hull, Architects of the Pacific Northwest*, Monograph, Princeton Architectural Press, 2001

[15] Anderson, Grace, *Architectural Record*, July 1987

[16] Ibid.

[17] Ibid.



Design Objectives and Program Analysis

Design Objectives

The DMZ area has special meaning in several different aspects. To create an overall master plan that can address issues of peace, life, and cooperation is the first goal of the thesis. The master plan is a response of the special condition of specific site area as well as a symbolic place representing the unified Korea as a whole.

Considering current condition between North and South Korea, the program of building should to be chosen carefully to conduct both countries participation without political, ideological pressure. The program, a center for environmental research and sustainability, is dealing with the common issue of the present as well as the future. This thesis explores the ways of creating space where the common goal is freely discussed and developed. Therefore, architecture is considered as a major element bridging the gap.

The idea of sustainability is explored in many different aspects. Cultural sustainability is considered in terms of adapting the traditional ways of situating building in Korea. At the same time, main characteristics of Korean architecture are addressed in various levels, such as site plan, landscape, and architecture itself. Main elements of sustainability are employed into built form in landscape development. Green building aspects are tested and integrated in various level starting from structural system to building skin and material. Renewable energy sources and energy efficiency are considered to create building system. Overall water cycle is also incorporated into building system as well as landscape development.

Program Description:

The Center for Environmental Research and Sustainability

The overall program contains three parts: (1) the public function which includes the conference center, the gallery, and the administrative office, (2) the research function which includes laboratories, research offices, a library, and the staff office, and (3) the residence for the visiting scholars. The first part is considered as the most public function, and the second and the third parts are considered as the private function. The research function can be open to the public in some occasions.

The conference center and the gallery

Building Entry

The building entry is the place where the public can experience the overview of the facility. A flexible open space is desired for different uses such as a reception area, an information center, a departure point for guided tour and so on. The living machine can be displaced as a functional sculpture showcasing the sustainable idea.

Lecture Hall and Conference rooms

In ordinary occasion, a large lecture hall can be used for an orientation lecture for the public visiting the facility. In case of conference, a main lecture can be placed in the large lecture hall, while small sessions are held in small conference rooms.

Gallery

The gallery is for displaying the ideas of sustainability as well as the meaning and the memory of the DMZ. For the location of the gallery, the solar orientation and the sequence are important elements to consider.

In addition to these programs, a café and an administrative office are located in the conference center.

The research center

Building Entry

The building entry for the research center welcomes the researchers. The security check and information desk is located at the main entryway. The entry hall can be used for the display of academic achievement, the newest technology, and so on.

Laboratory

The field of environmental research can be subdivided into numerous subjects. However, main concerns of the environment are represented by the following subjects; air, water, earth (soil), fire (sun/ renewable energy). Special needs per each occasion should be considered, such as an outdoor field lab, a big supporting space, open or closed to the natural light and air and so on. Some outdoor lab can be incorporated with landscape design.

For the researchers, co-working is the most important ingredient for success. Some lab space can be designed in a way that active discussion and co-working is encouraged. Break out space or other social space can be utilized not only for their original function, but also a space for brainstorming. Creating a community for scientists is the main goal of designing lab facility.

Research Offices

The close proximity to the laboratory is the main consideration to place the research office. The research offices are located near the laboratory in order to create convenient environment for the researchers. Different from the laboratory, the research offices want to be placed on south side of the building to utilize the natural light.

Library

Library has both traditional spaces, such as a reading room and stack area, and new spaces, such as multimedia station, digital stack, and so on. Library is place in close distance from the research offices. Outdoor space can be utilized as an outdoor reading room, and the small discussion area can be placed within the library.

In addition, the laboratory supporting spaces and the staff offices are located in the research center.

The residence for visiting scholars

Considering the remote location, it is necessary to have residential units within the center. In addition, though the nearest city from the site is located less then 10 km, the current condition of the DMZ prefers limited access rather than frequent, daily based commute. Also, certain research needs more intense focus on the subject, thus scientists may choose to stay in the facility.

Two options can be considered by locating the residential area. First, to make some break between work place, which is lab, and living place, the residential unit can be detached from lab building. Second, residential unit can be totally incorporated into the research area.

In addition to the apartment, common spaces are required, such as a dining hall, meeting space, a gym facility, and so on.

Program Space Tabulation:

The Center for Environmental Research and Sustainability

The conference center and the gallery

Program space		**SF**
Lobby		2000
Lecture Hall		2000
Café/Shop		1000
Conference Rooms	500/ea	2000
Gallery		3000
Restrooms		500
Administrative Office		1500
Storage		500
Sub Total		**12500**

The research center

Program space		**SF**
Laboratory		
Laboratory	600/ea	12000
Computer Lab		1000
Control Space		2000
Shop etc		1000
Sub Total		**16000**
Research Area		
Research Office		6000
Meeting Rooms	300/ea	3000

Staff Office		3000
Sub Total		**12000**
Library		
Reading/Stack		1000
Multimedia		1500
(Computer stations etc.)		
Custodial Space		500
Sub Total		**3000**
Sub Total		**31000**

The residence for visiting scholars

Program space		**SF**
Apartment	600/ea	9000
Dinning		1500
Kitchen		1000
Common		1000
Gym Facility		1000
Meeting Space		1000
Sub Total		**14500**
Mechanical (~10% of Net)		5800
	Sub Total	**63800 sf**
	Gross Factor (0.4)	**25520 sf**
	Grand Total	**89320 sf**

Design Approach:

01 Site intervention / 02 Site alternatives / 03 Schematic Design

To achieve an overall master plan of DMZ, it is necessary to look at the DMZ within the bigger context. Following diagrams are the location of DMZ in the Korean Peninsular, the park system of Korea, and the proposal of North-South connection and the possible development of the DMZ.

The idea of reclaiming the DMZ started from dividing the overall zone into three different zones of development. The first zone, which is located in the center of the overall area, is the core area that is put on reserve for the future use. Only the research and monitoring station can be located within that zone, and the limitation of human access will be maintained as the same level as current. The second zone, which is the boundary of the core area, is the buffer zone. This area is for low impact development, such as an educational facility, a research facility, and/or an eco-tourism. The third zone is transition area where different types of settlement are existed under the security regulations. The density and land use will be adjusted to meet the need of neighborhood within the boundary of sustainable development.

Three possible developments are proposed based on the possible connection route, the ecological significances, the historical significances and the economical aspect. The east region is a good candidate to develop for recreational purposes. The middle region has great potential in terms of historical, archaeological researches. The west region, which is the site of this thesis, is a symbolic place. In that area, the armistice agreement had been signed to cease the war and enter the history of two Koreas. It will be an interesting adventure if the experiment for unification is started at the very same place.

Figure 53 Map of Korea showing major North-South connections. Dotted line in the middle indicates the Military Demarcation Line.

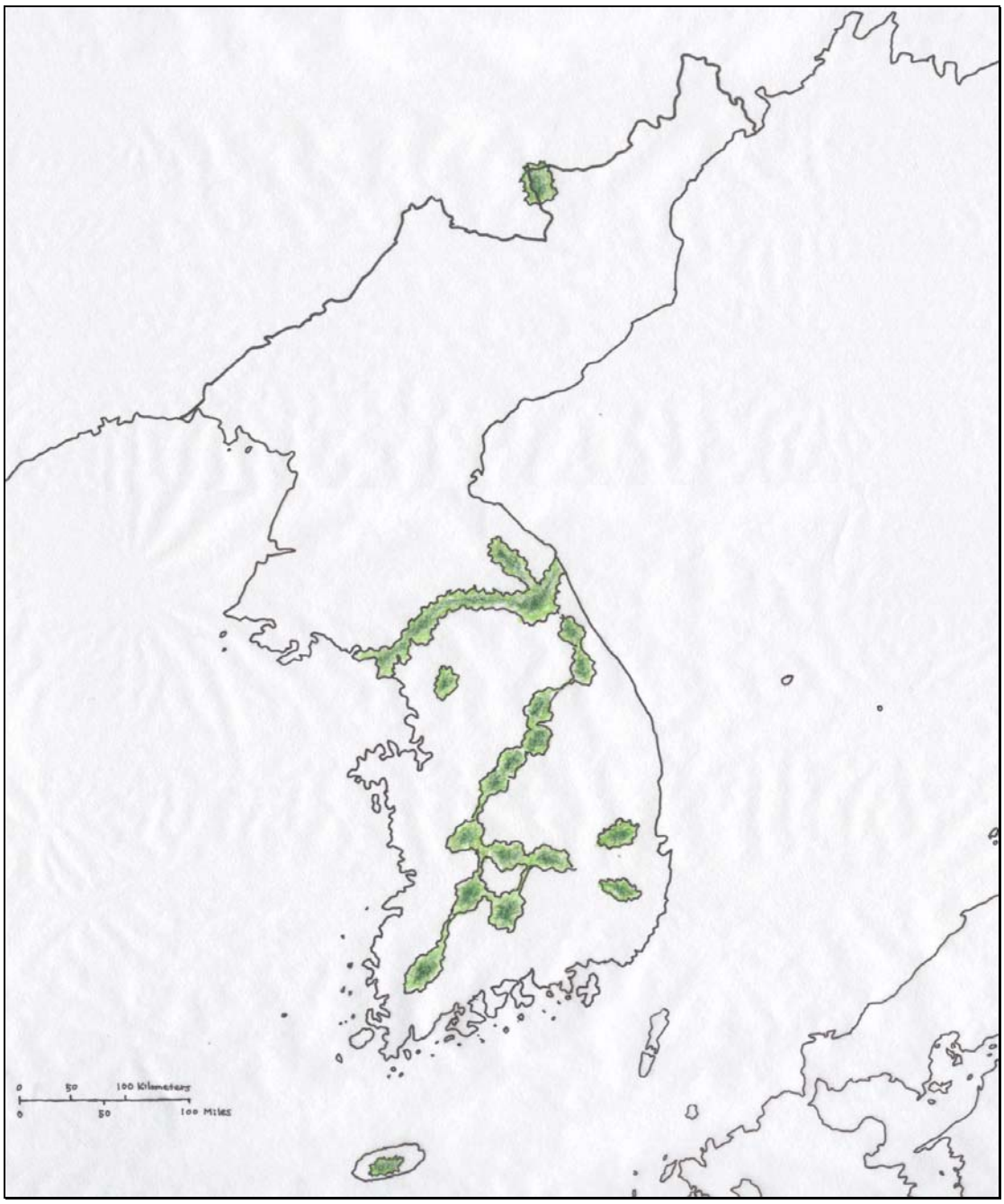


Figure 54 Green Connection: Location of the National Parks. Following the ridgeline, the national parks create green corridor. Currently, the information about national park in North Korean territory is not available.

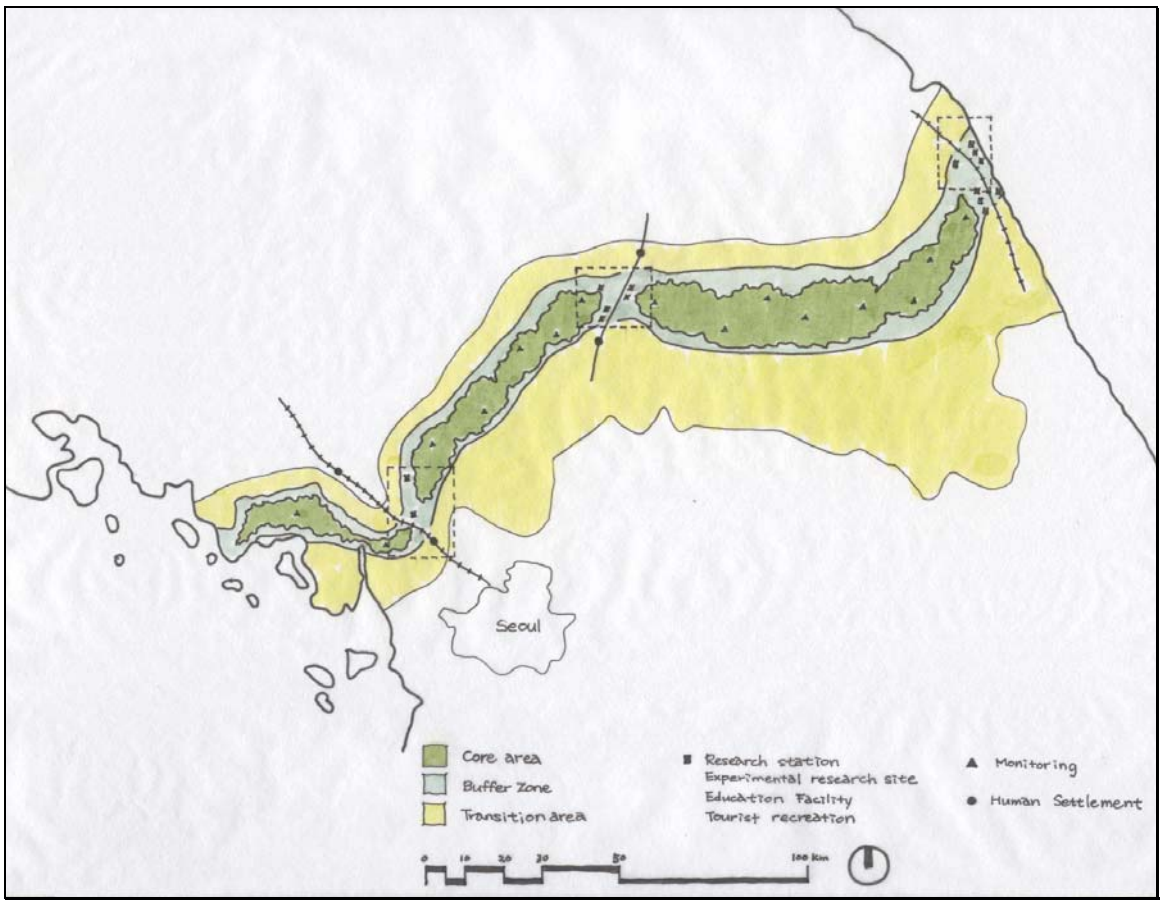


Figure 55 The DMZ Master Plan. This diagram indicates three different zones of development as well as three areas of North-South connection and possible development.

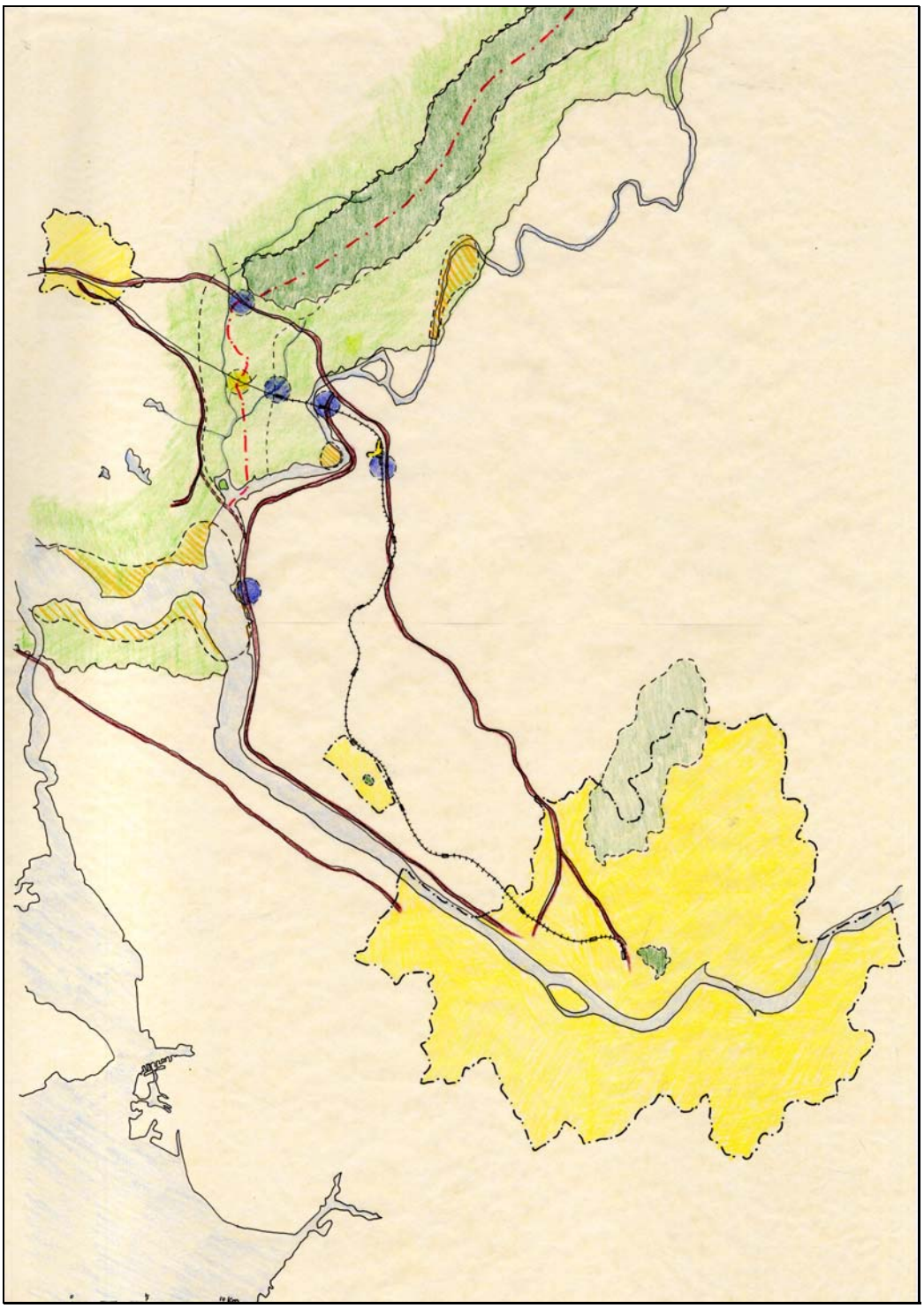


Figure 56 Context map around the site showing the zoning idea of the site based on the overall DMZ master plan. The highway connecting Seoul to Kaesung creates the boundary of development.

Following diagrams shows three site intervention ideas. The first site intervention is the minimum development plan. An iconic building marks only the place where the train passes, and other area becomes a reserve. The building itself becomes a bridge over the train track creating the gateway. Two showcase villages located across the military demarcation line are connected by road branched from the main North-South connection highway.

The second site intervention is creating low impact settlement across the military demarcation line, and the building becomes a center of the neighborhood. In this idea, the program spaces are subdivided into several buildings, and the future growth is considered as creating a research campus. As the type of settlement, a low impact permaculture village is proposed. This new village is connected with the existing showcase villages by the field and service roads.

The third site intervention is a city scheme. This idea is the futuristic idea looking forward to seeing the united Korea which needs neutral place for its new capital. The military demarcation line which used to be a divider of North and South Korea become a major movement system. As the first building of the future capital, the center for environmental research and sustainability becomes an example of future building practice. Sustainable building technologies as well as other aspects of sustainability need to be actively engaged to the process of design development.

Site Intervention 01

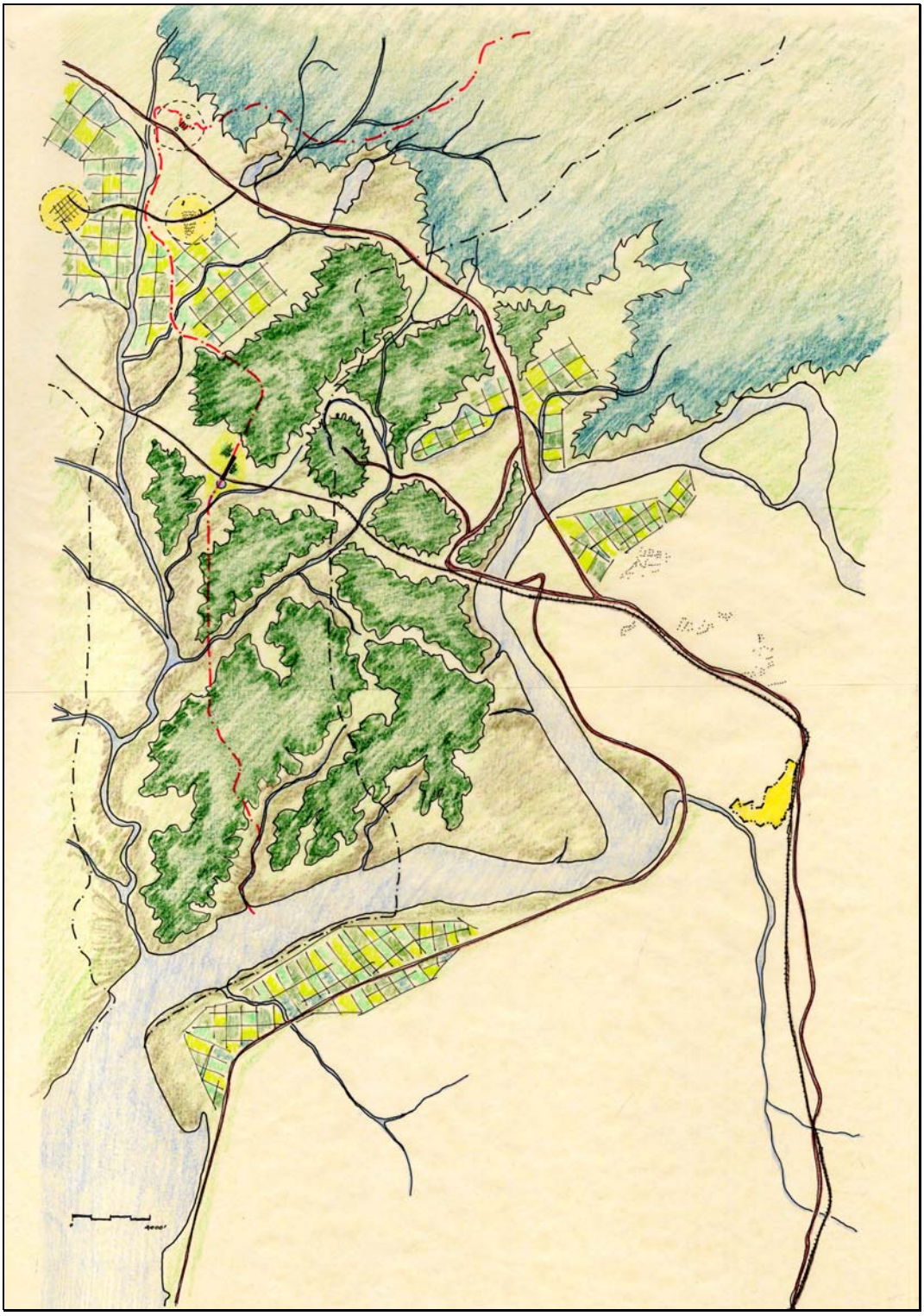


Figure 57 Building as an icon: the minimum development scheme.

Site Intervention 02

Figure 58 Building centering the low impact settlement: the medium development scheme.

Site Intervention 03

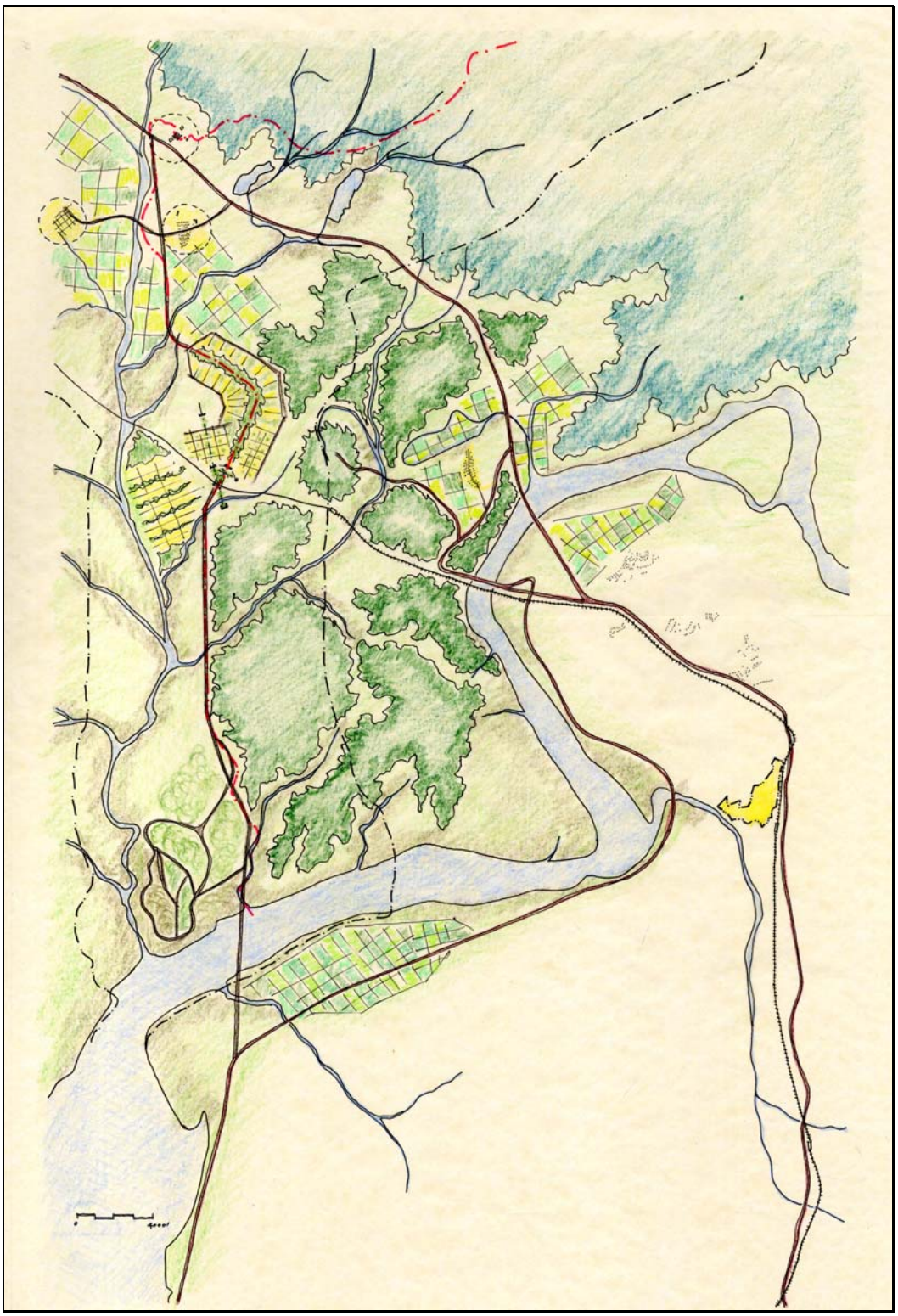


Figure 59 Building as the center of the future capital of Korea: the city scheme.

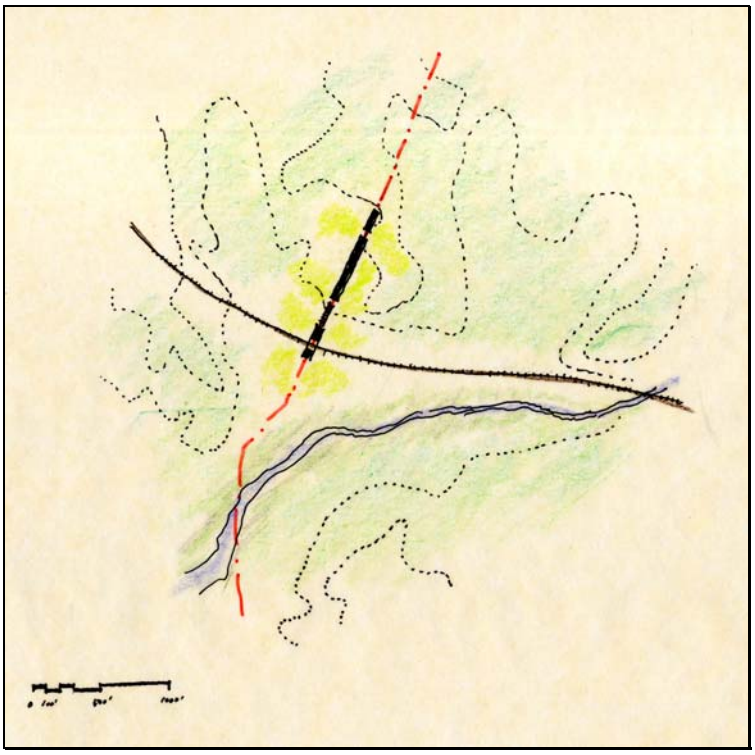
Figure 60 Site Alternatives

Area 1) the program driven site: this is the site where the laboratory components can take advantage of the natural environment, for example, the water research lab will take advantage of the river running between the Dora mountain and the site, and the air research lab will have the easies access to the CO_2 monitoring station which will be set on top of the Dora Mountain.

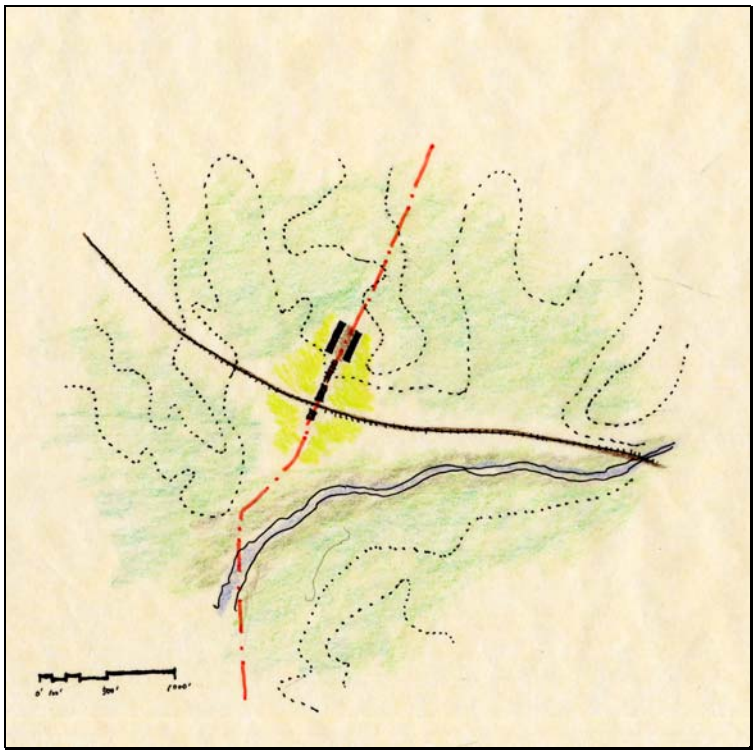
Area 2) the solar orientation driven site: this is the high land area The land is sloping down gradually toward southeast direction allowing best solar orientation.

Area 3) the most symbolic site: the site is literally on top of the military demarcation line, hovering both North and South Korean territory. The destroyed old train station can be revitalized and utilized as a main transportation method.

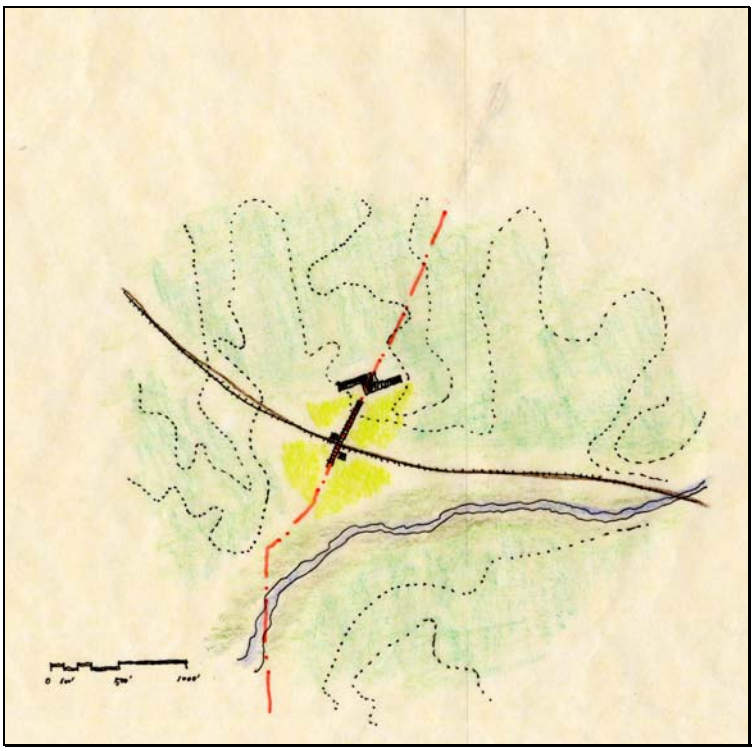
Before further consideration of the building parti, the placement of the building in relation with the Military Demarcation Line is examined.



(a)



(b)



(c)

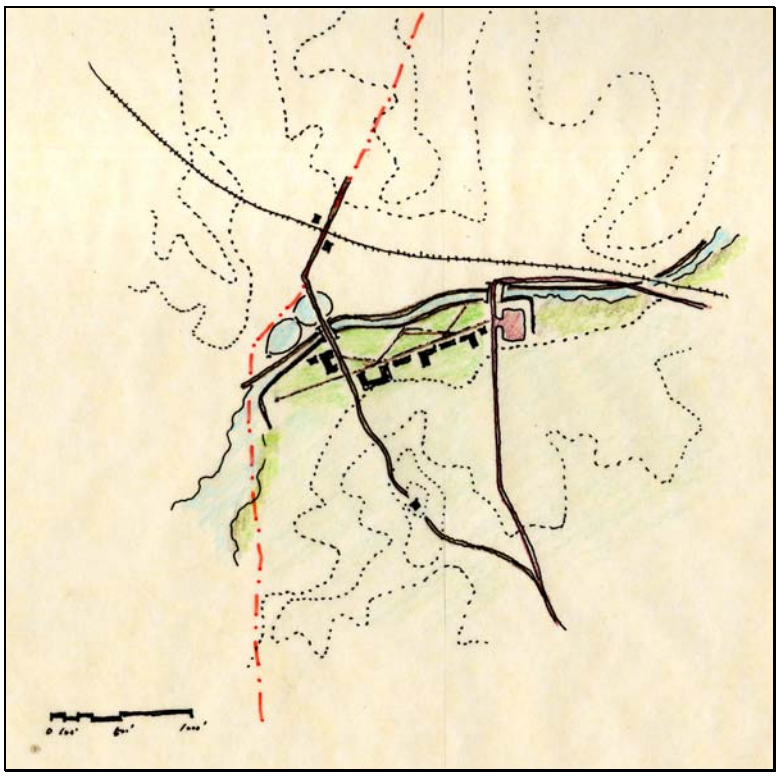
Figure 61 Relationship between the building and the line.

These series of diagram examines different relationships between the building and the Military Demarcation Line.

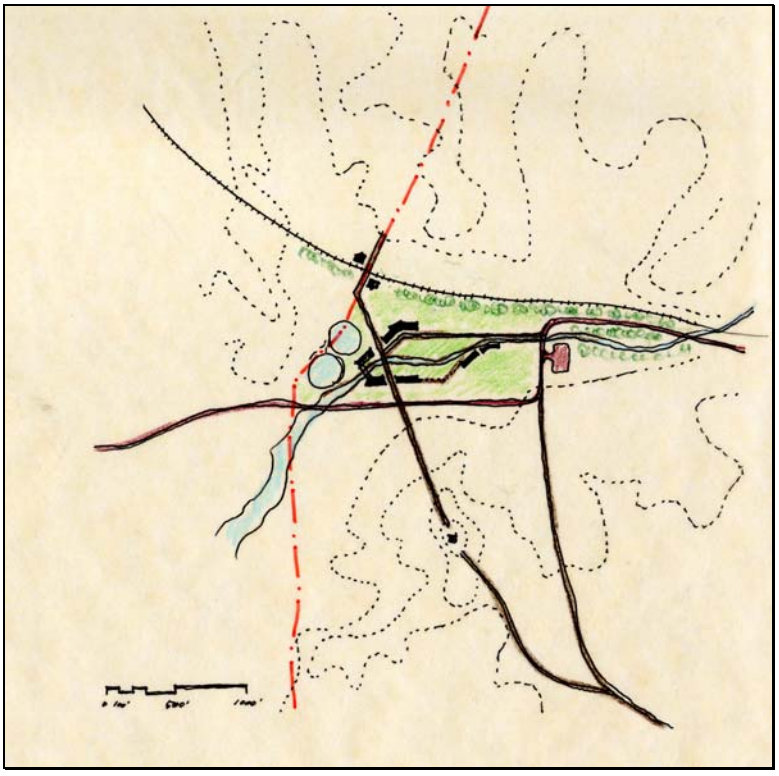
(a) The building is located on top of the line. The idea of this placement is that the line is transformed into the building, which is habitable space. Linear buildings become strong memory of the line.

(b) Two main buildings are located parallel to the line, creating space in between. The idea of this placement is that a place where no one could occupy or pass through becomes a space where people can gather and exchange their ideas.

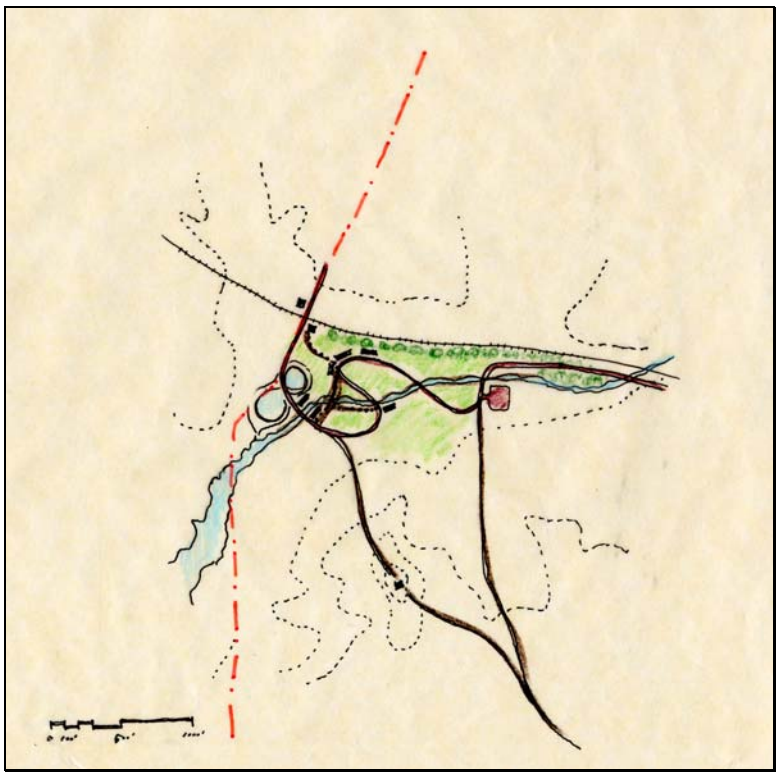
(c) The program components are separated into two or more buildings, and main buildings are located on both side of the line. In this case, the buildings are tilted in order to achieve the best solar orientation. Two buildings are sharing main entryway, which is the place where the line runs between two buildings.



(a)



(b)



(c)

Figure 62 Diagrams of Campus scheme

These diagrams explores different configuration of campus scheme. (a) The river forms an edge of one side of campus, and buildings are oriented for the best solar orientation. (b) The river becomes a center of the campus. (c) The buildings are located along with the organic path.

As the parti being developed, the program is separated into three parts: (1) the public function which includes the conference center, the gallery, and the administrative office, (2) the research function which includes laboratories, research offices, a library, and the staff office, and (3) the residence for the visiting scholars.

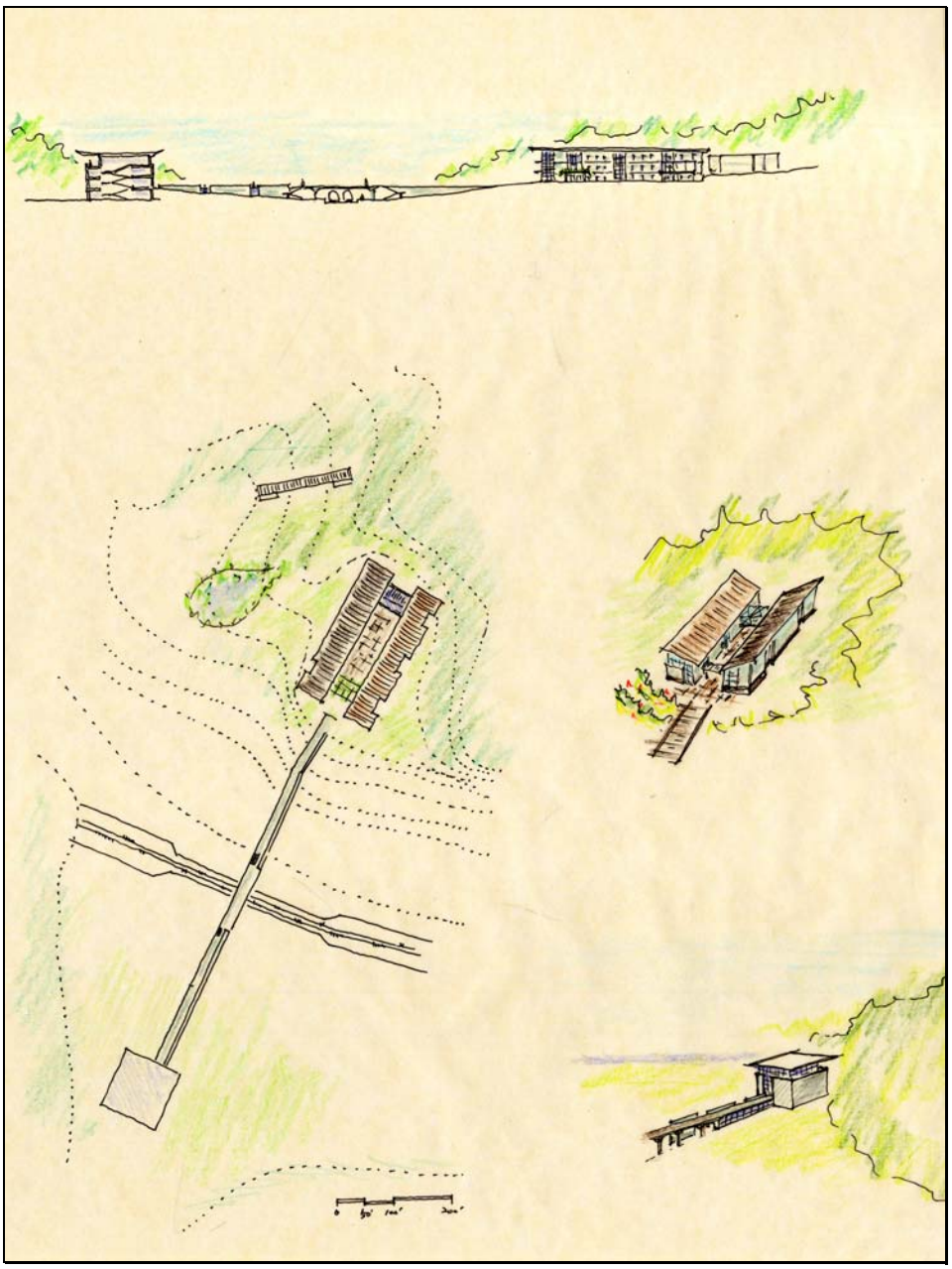


Figure 63 Parti 1: the DMZ as a gathering space

In this parti, the public function and the private function, which includes research function and residential component, are located on either side of the train track. In addition, the research buildings are located on both side of the line creating gathering place in between. Therefore, the line becomes an active space to occupy.

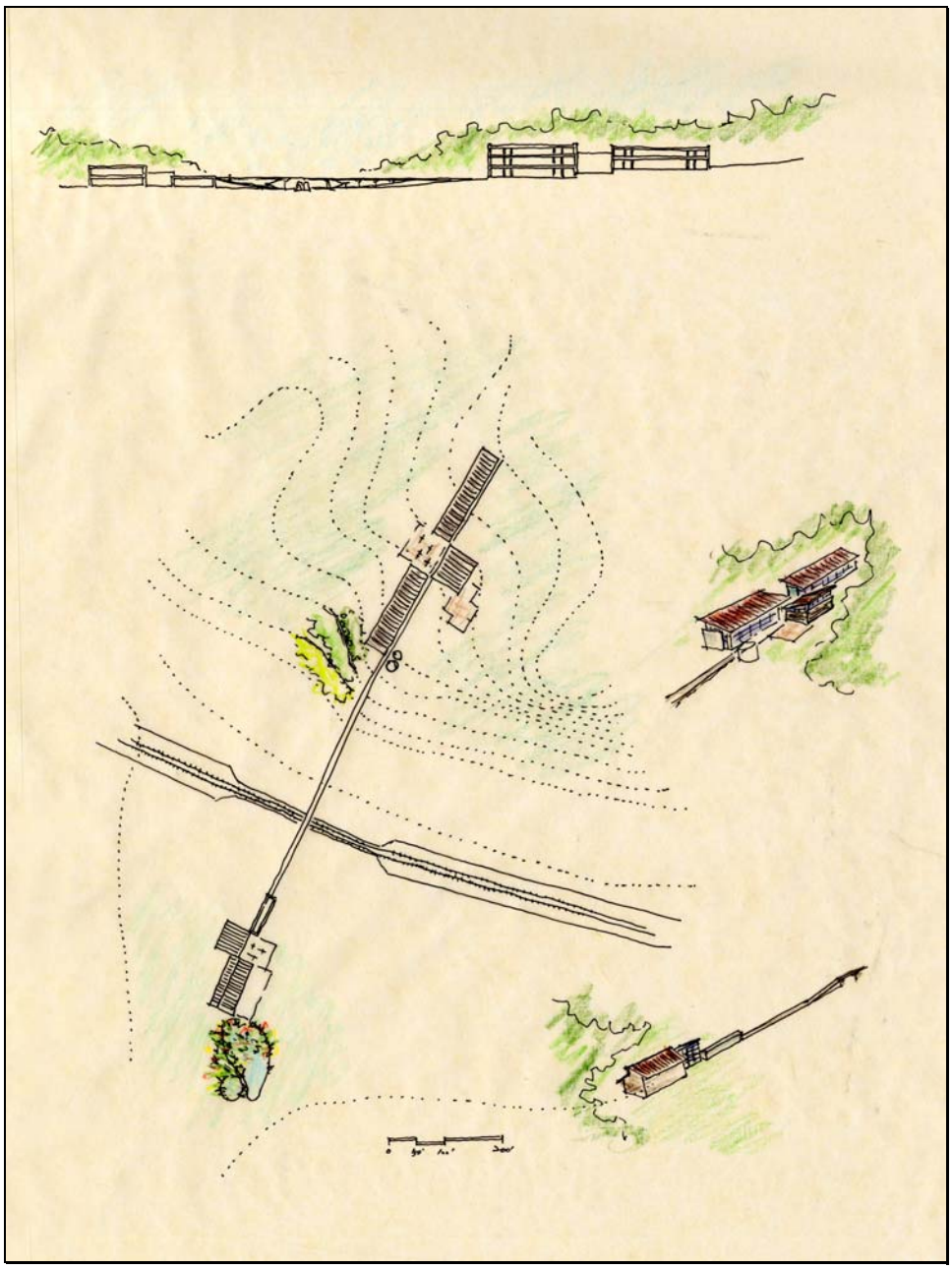


Figure 64 Parti 2: the DMZ as a datum

In this parti, the line becomes a datum organizing program spaces on either side. The public function and the private function are separated by the train track. However, the bridge over the train track offers the connection between these functions.

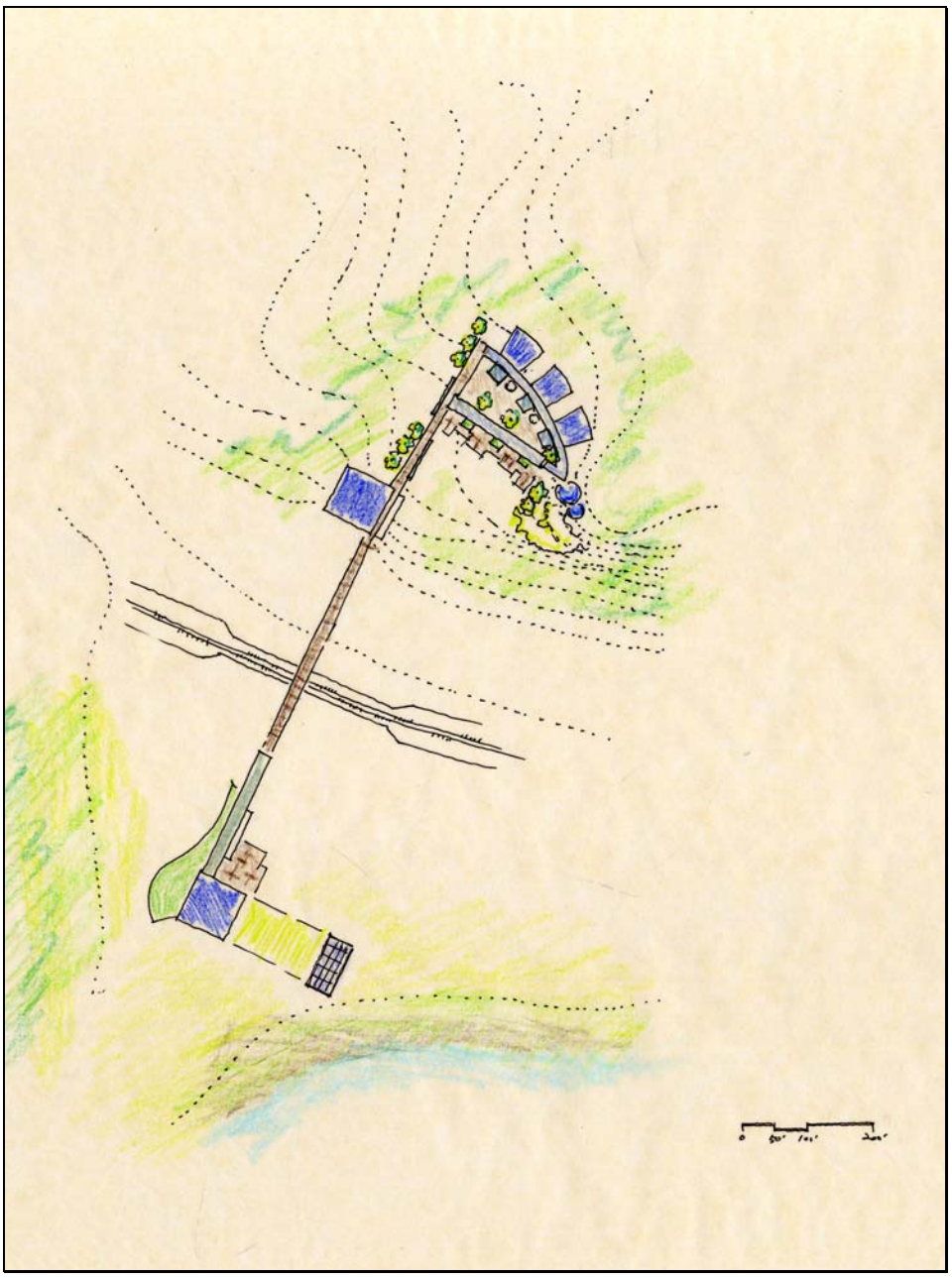


Figure 65 Parti 3: the building as a series of pavilions

In this parti, the program components are subdivided into smaller pieces, which allow creating a series of pavilions. Following diagrams explain the functions of individual pavilions.

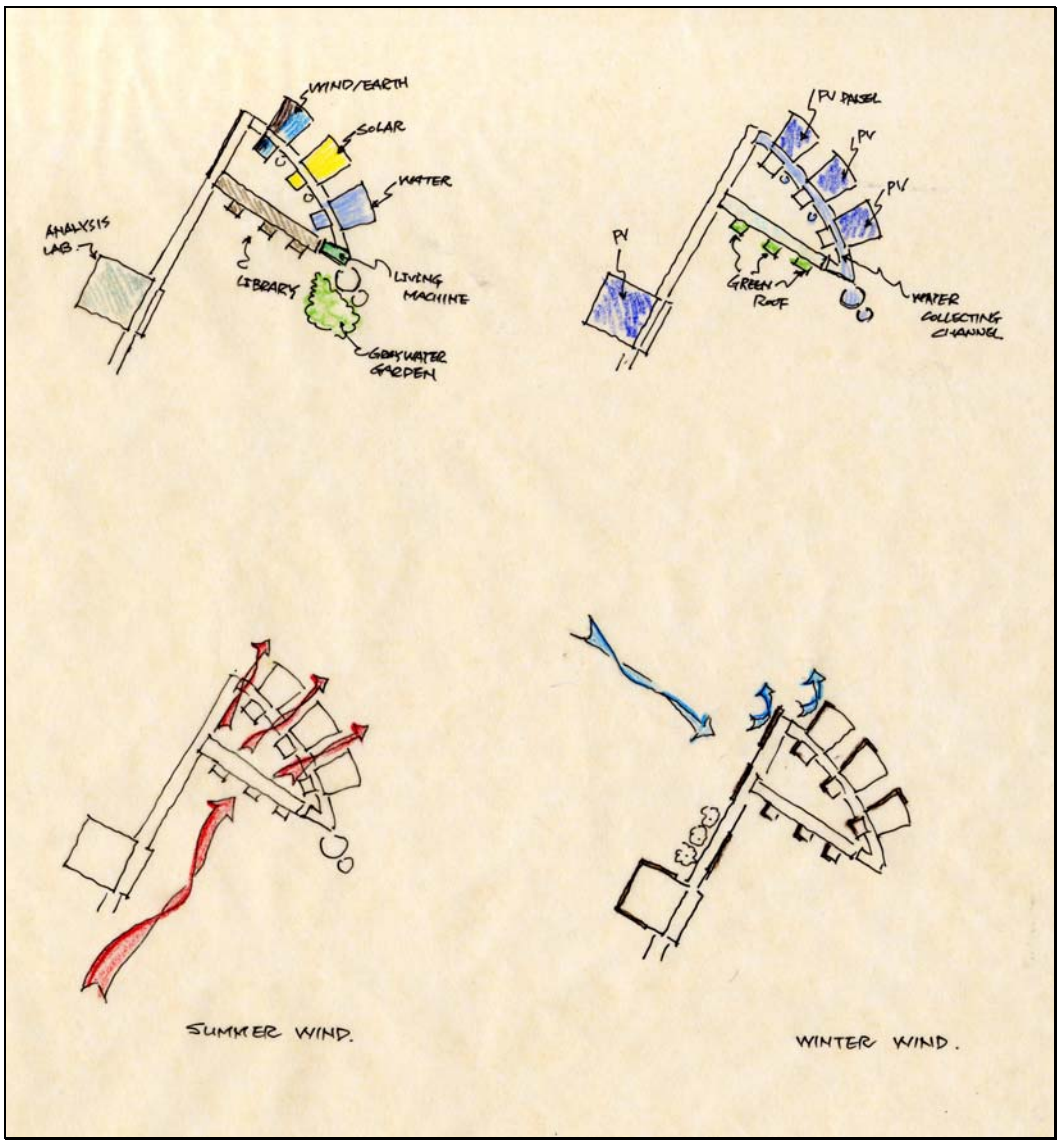
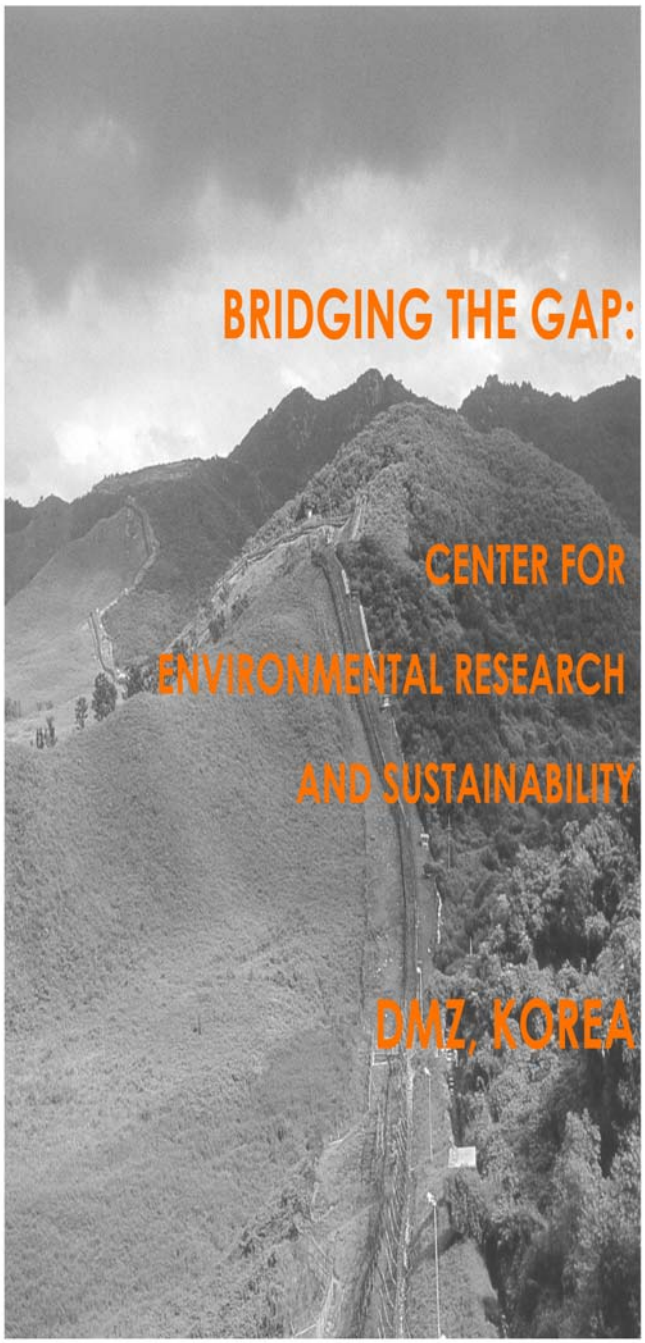


Figure 66 Diagrams for the ideas of sustainability in parti 3.


BRIDGING THE GAP:
CENTER FOR
ENVIRONMENTAL RESEARCH
AND SUSTAINABILITY
DMZ, KOREA

Conclusion

Overall site is organized based on the three major axes: the railroad, the Military Demarcation Line and the view connecting two mountains. In addition, the solar orientation and the wind direction are considered to decide the program space as well as the building massing. The idea of sustainability is explored many different layers starting from the cultural sustainability to the sustainable technology.

Applying one of the main characteristics of Korean architecture and space making, the buildings are designed to become a background of the nature as suppose to be an object in the landscape.

Main elements of sustainability are actively engaged into the overall design, for example the photovoltaic panels are used to generate electricity; the rainwater collection system is installed under the plaza; the gray water treatment garden is integrated into the ecological park; the green roof is used for thermal insulation as well as rainwater management purposes; considering the climate, double skin façade is incorporated.

Even though the main intention of the building design is creating backdrop of the landscape, the overall building massing could have been developed further to create more intricate dialog between the surrounding nature and the building itself.

Followings are the final design drawings and diagrams.

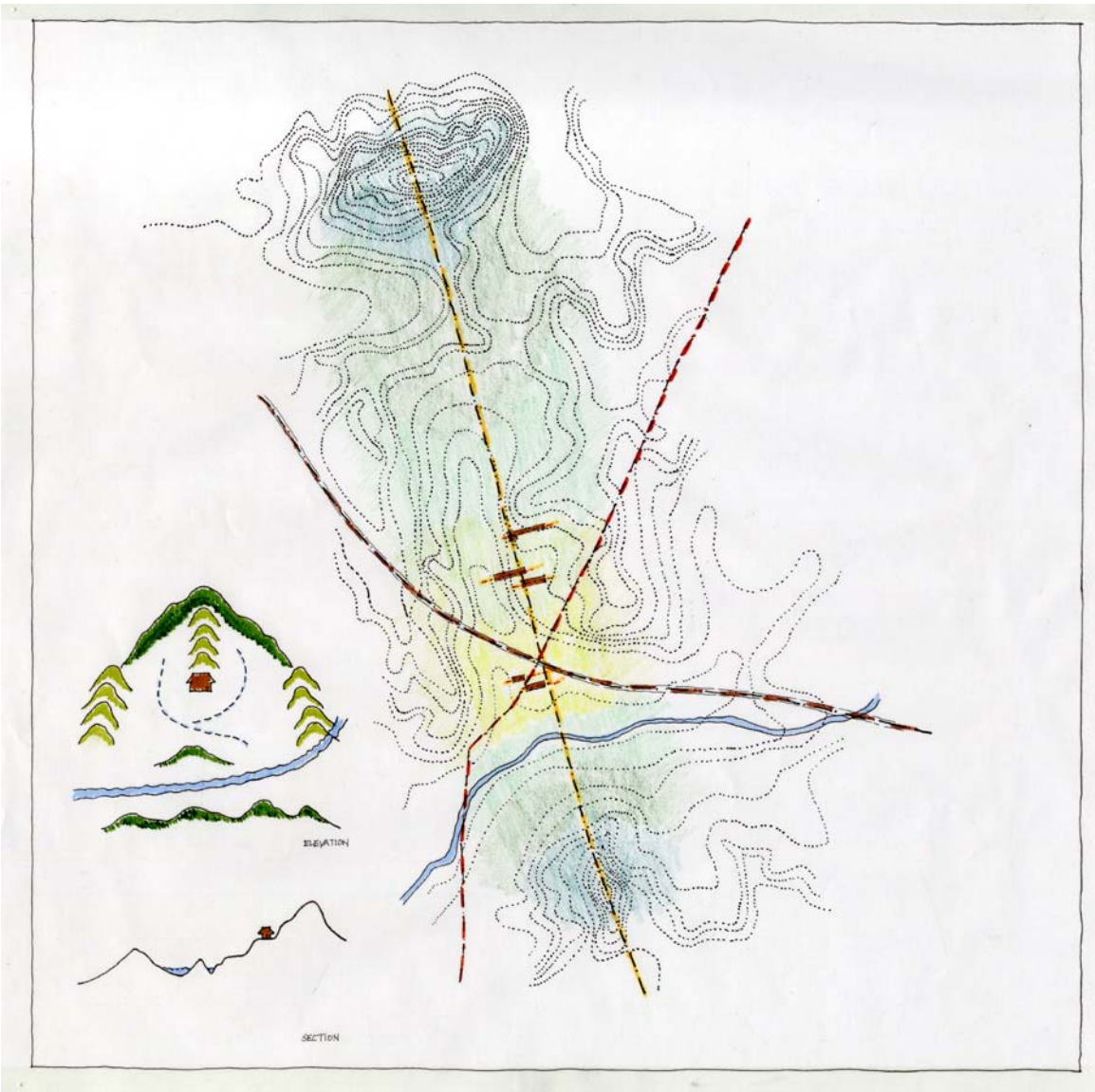


Figure 67 Site Concept Diagram.

Figure 68 Area use diagram

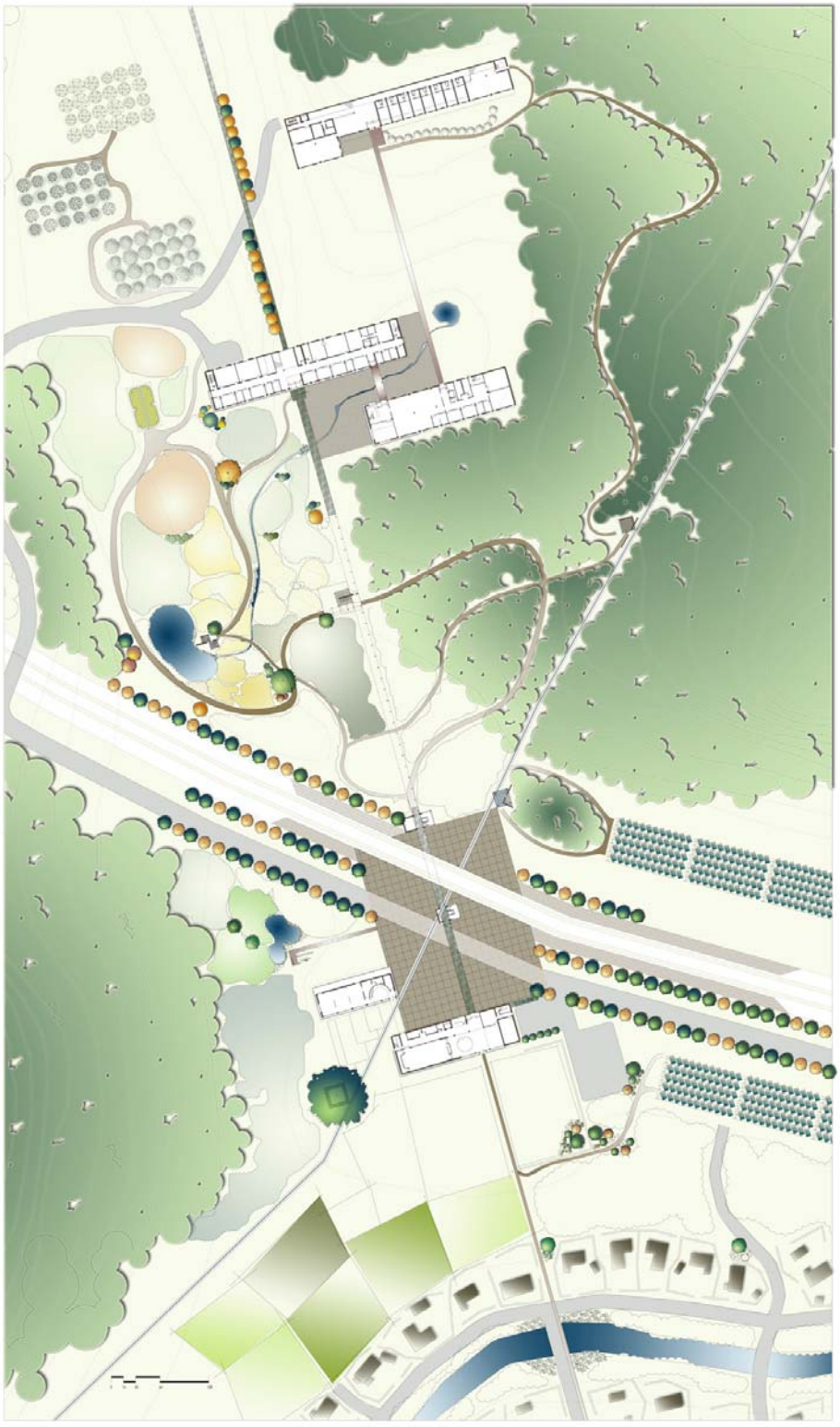


Figure 69 Site Plan

Figure 70 Zoning diagram: the overall site is subdivided into three different areas. The area between the conference center and the research center is developed as an ecological park.

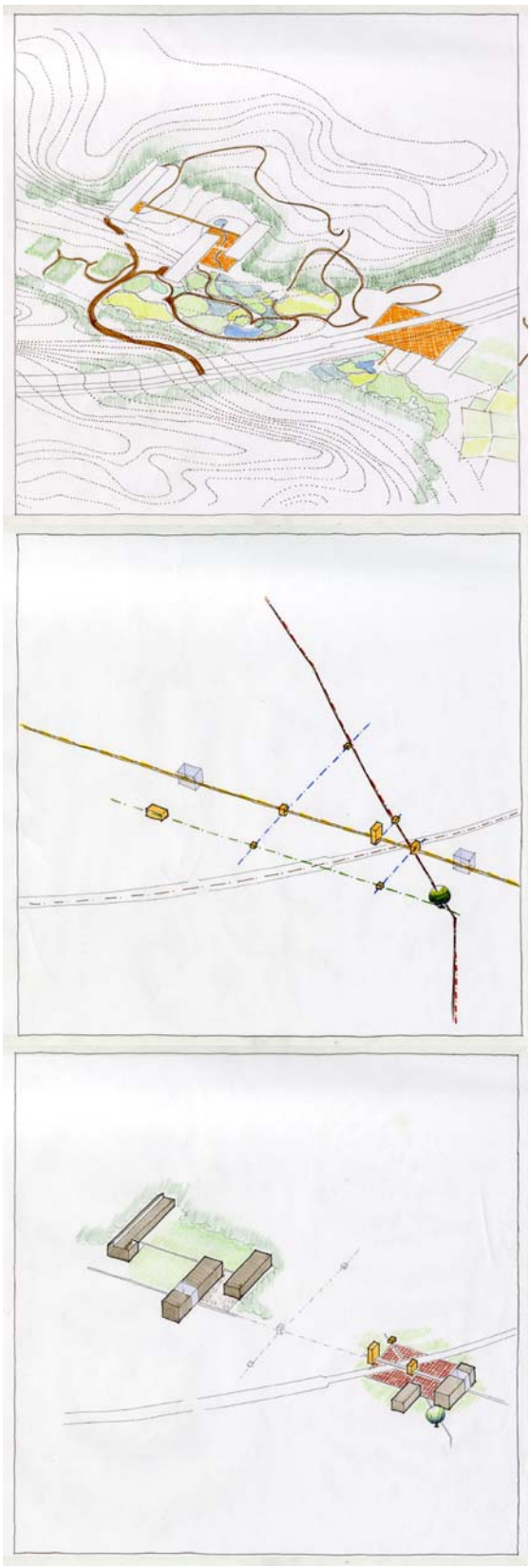


Figure 71 Diagram: organizing elements - surface, grid and the cluster

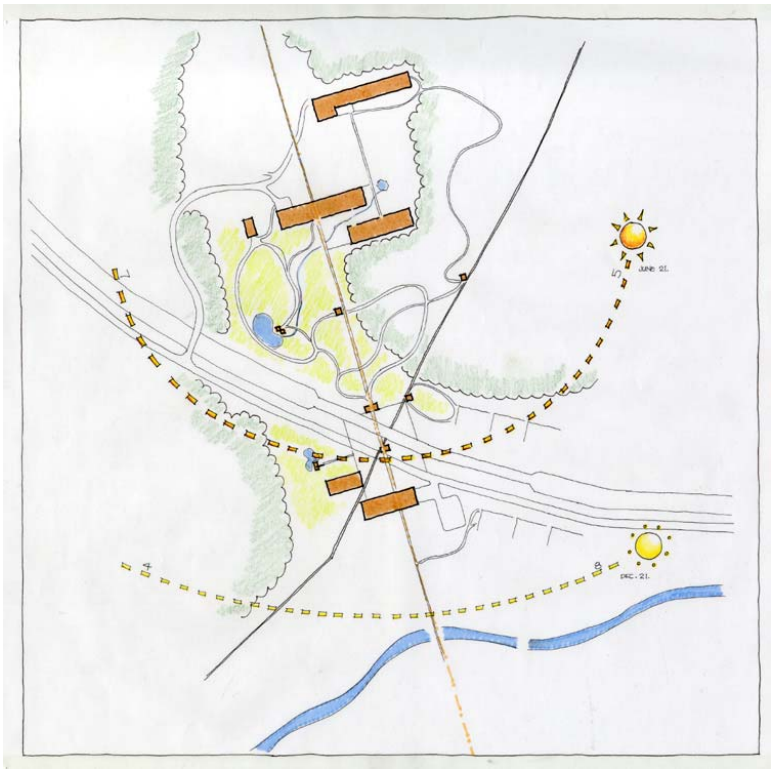


Figure 72 Solar Diagram

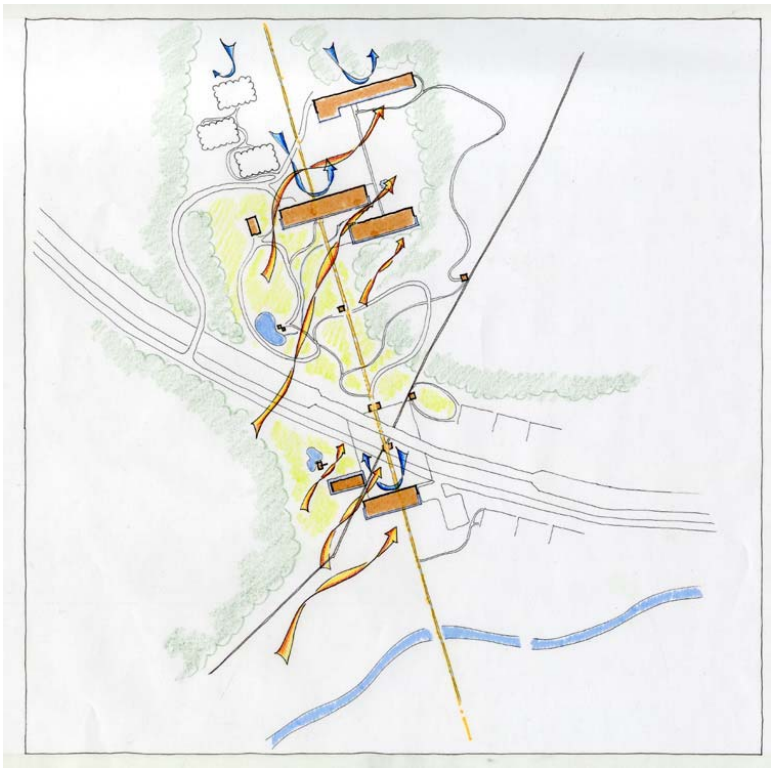


Figure 73 Wind Diagram: Prevailing wind directions during summer and winter

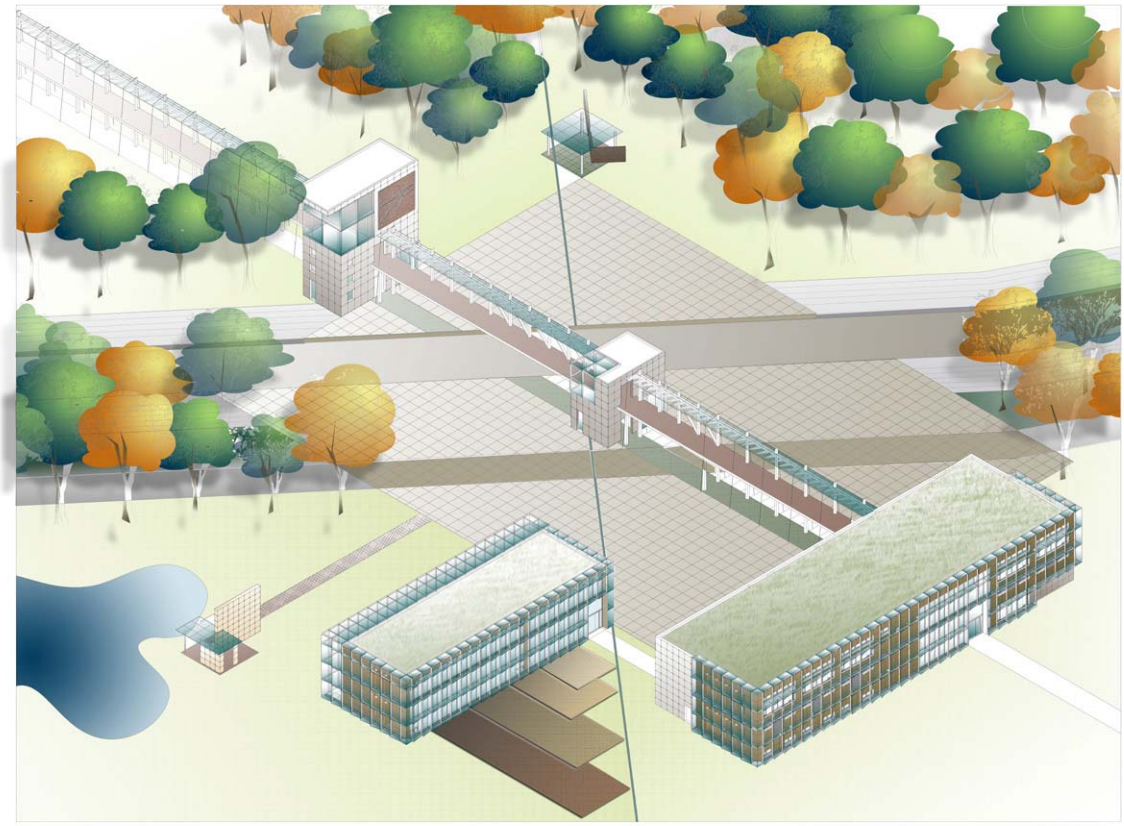


Figure 74 Isometric view of the station and the conference center

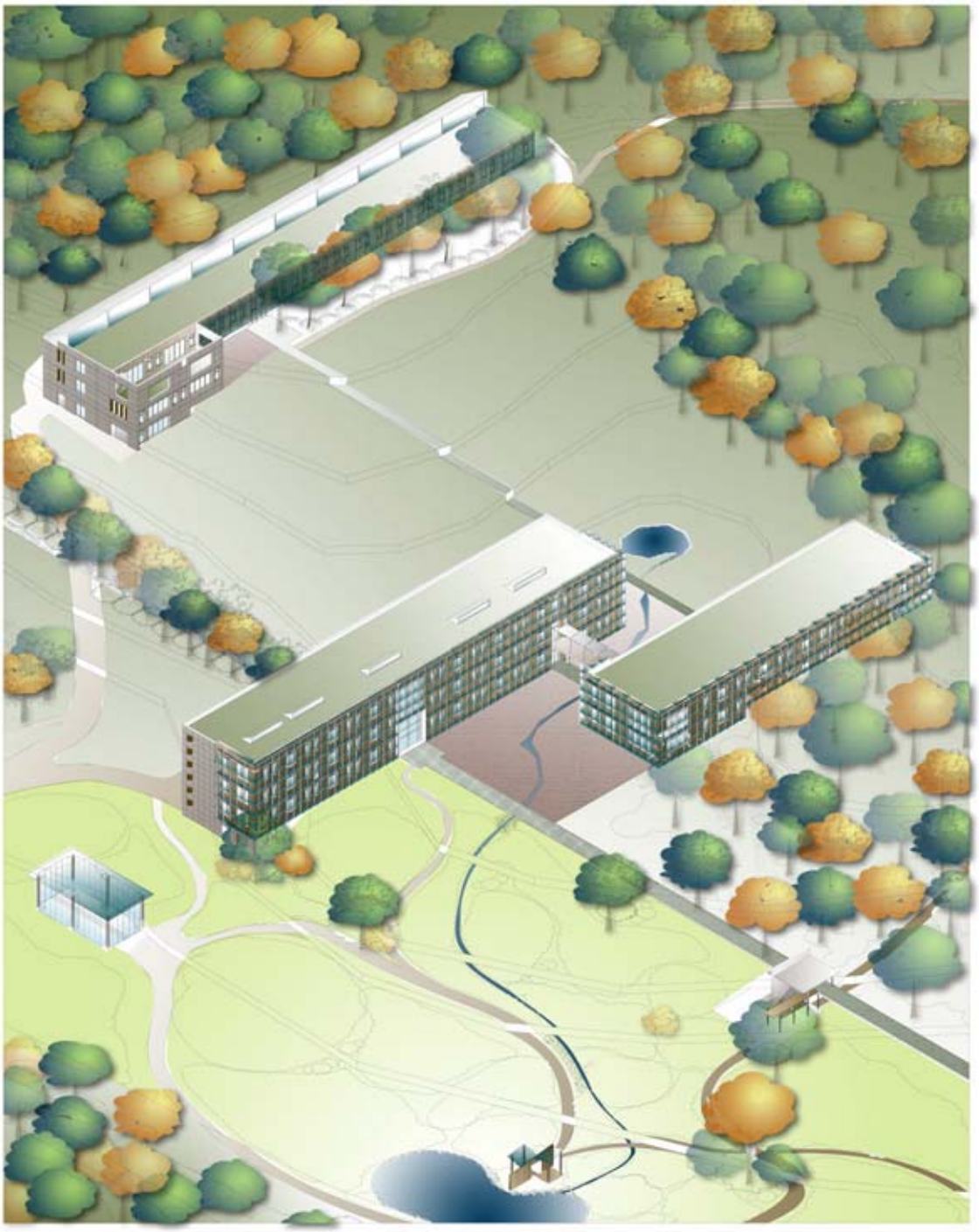


Figure 75 Isometric view of the research center and the residence

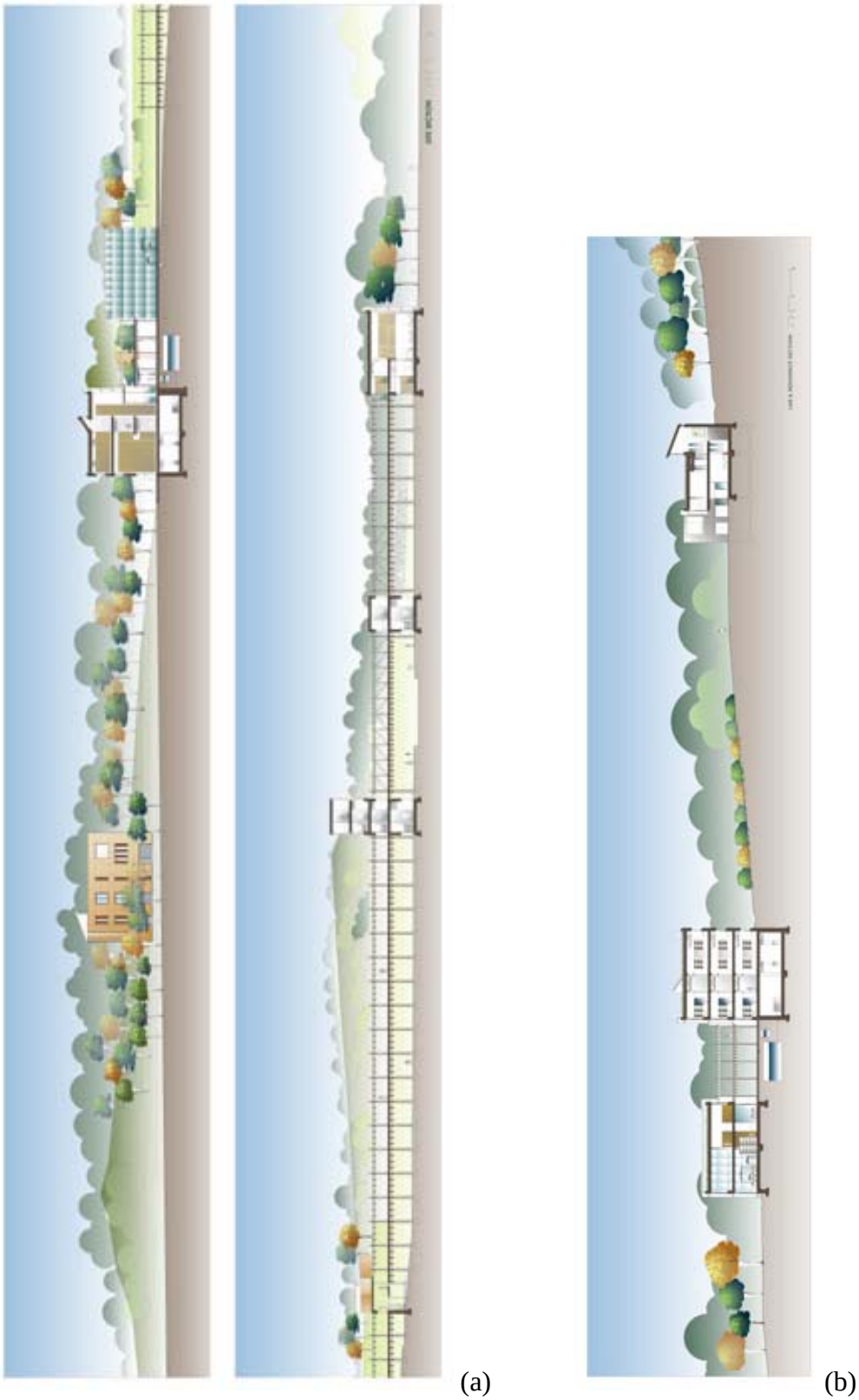


Figure 76 (a) Site Section and (b) section of the laboratory building and the residence

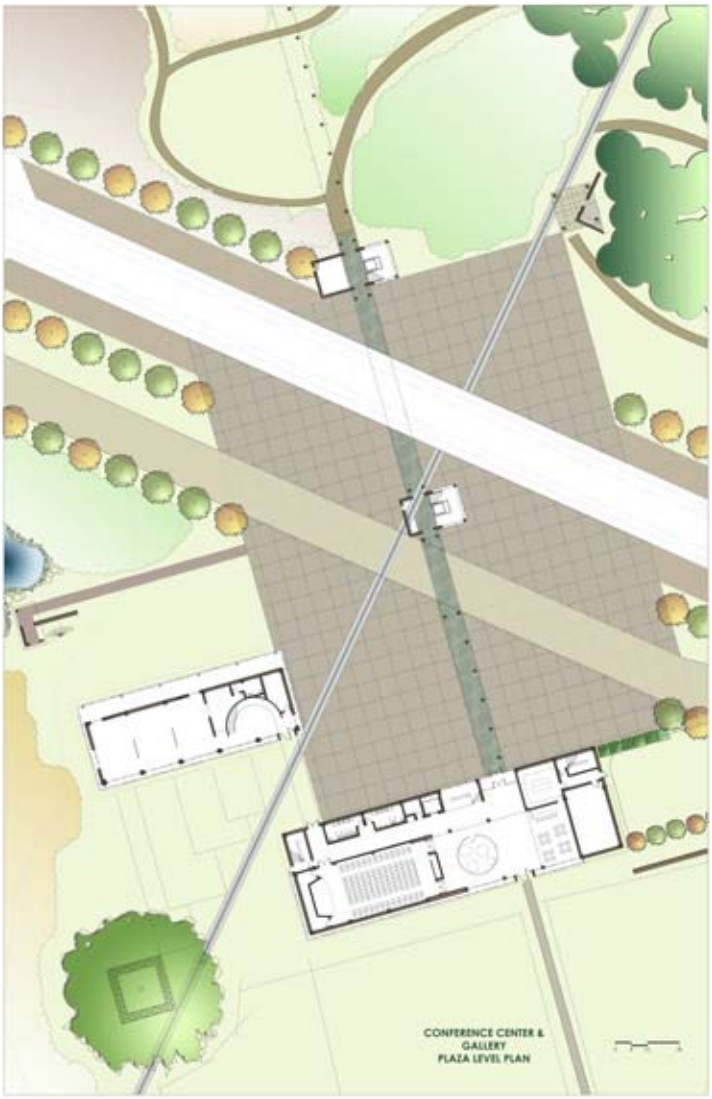


Figure 77 The conference center plaza level plan

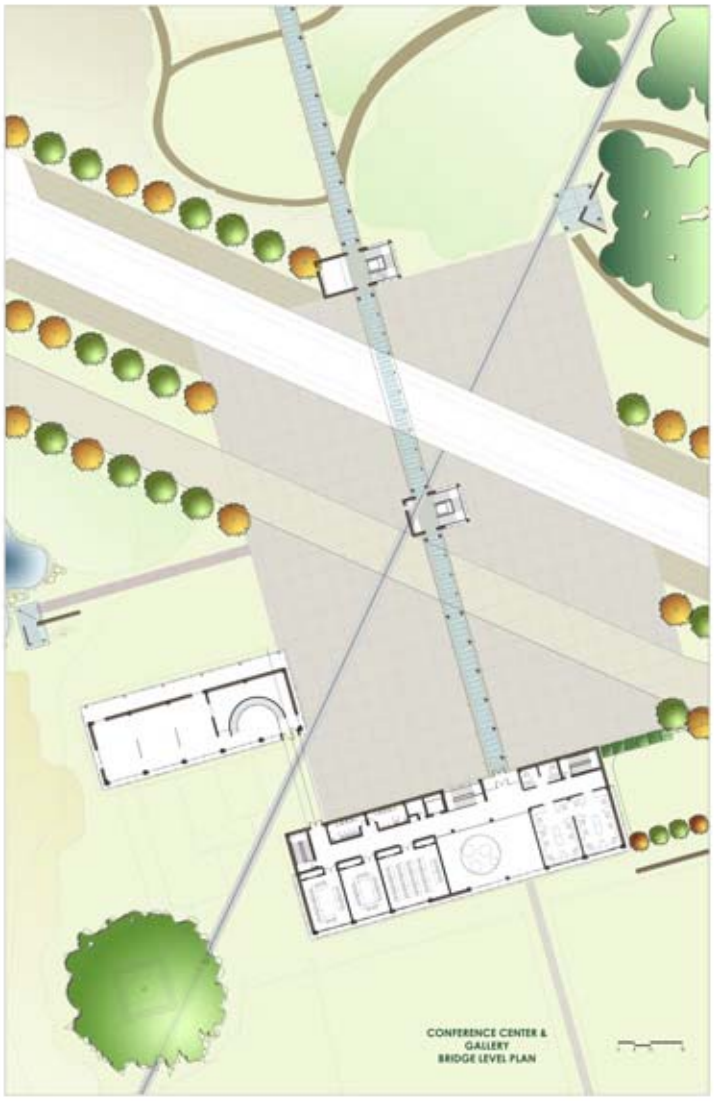


Figure 78 The conference center bridge level plan

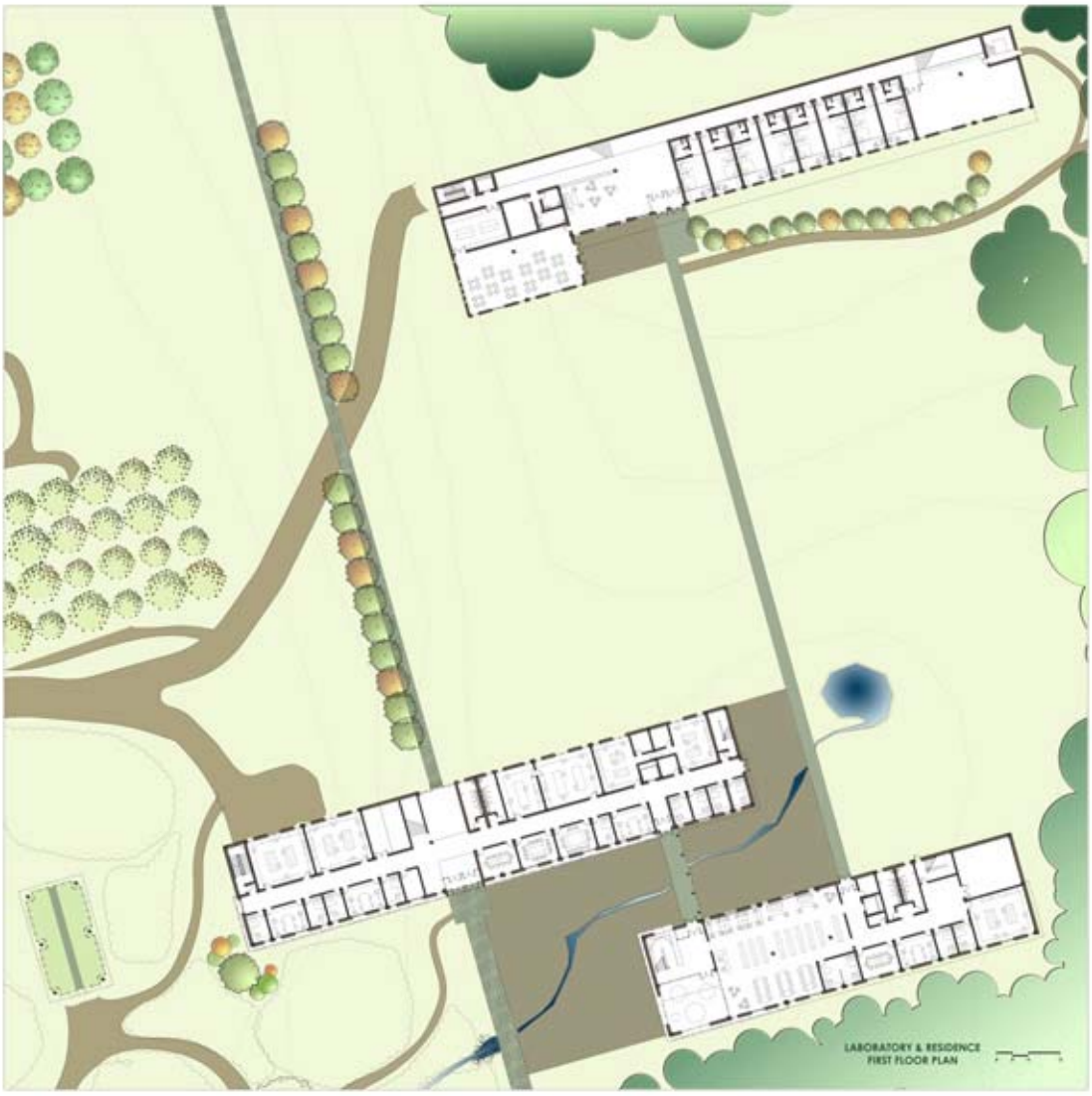


Figure 79 The research center and the residence first floor plan

Figure 80 The research center and the residence second floor plan

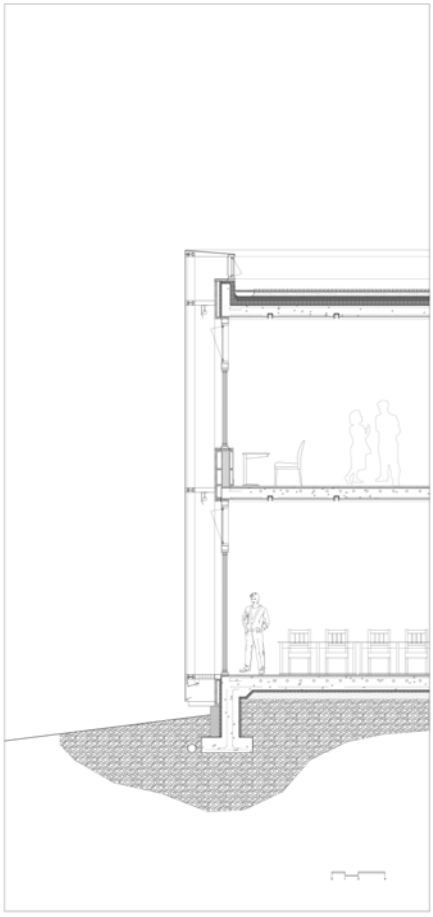


Figure 81 Wall section

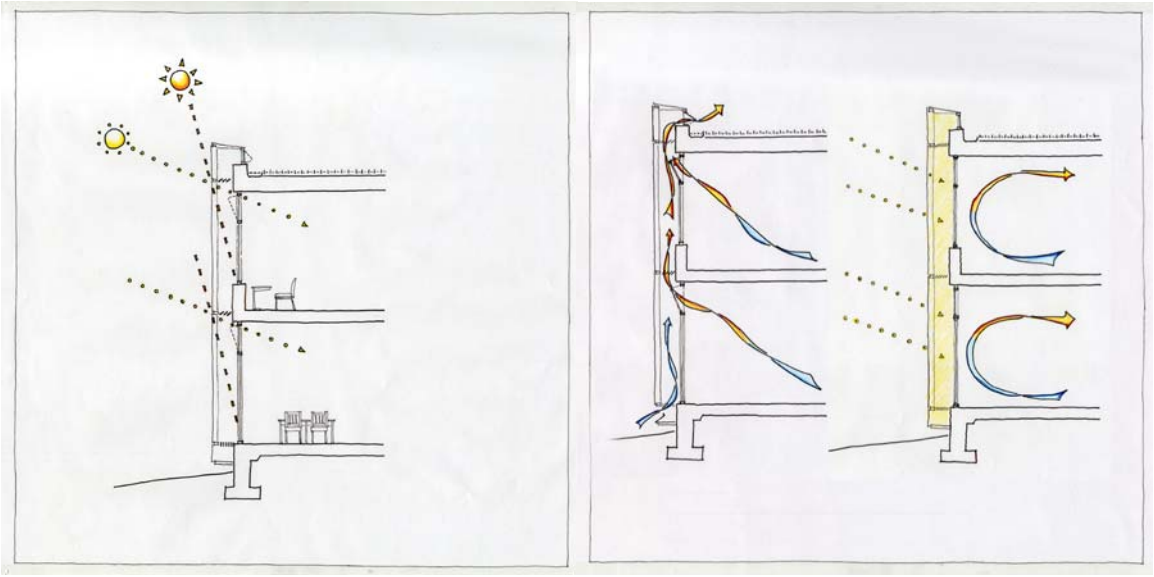


Figure 82 Wall Section Diagram: Cooling and heating mode of Double Skin

Figure 83 Aerial perspective

Figure 84 Perspective: the DMZ view from the pavilion to the conference center

Figure 85 Perspective view of the earth pavilion

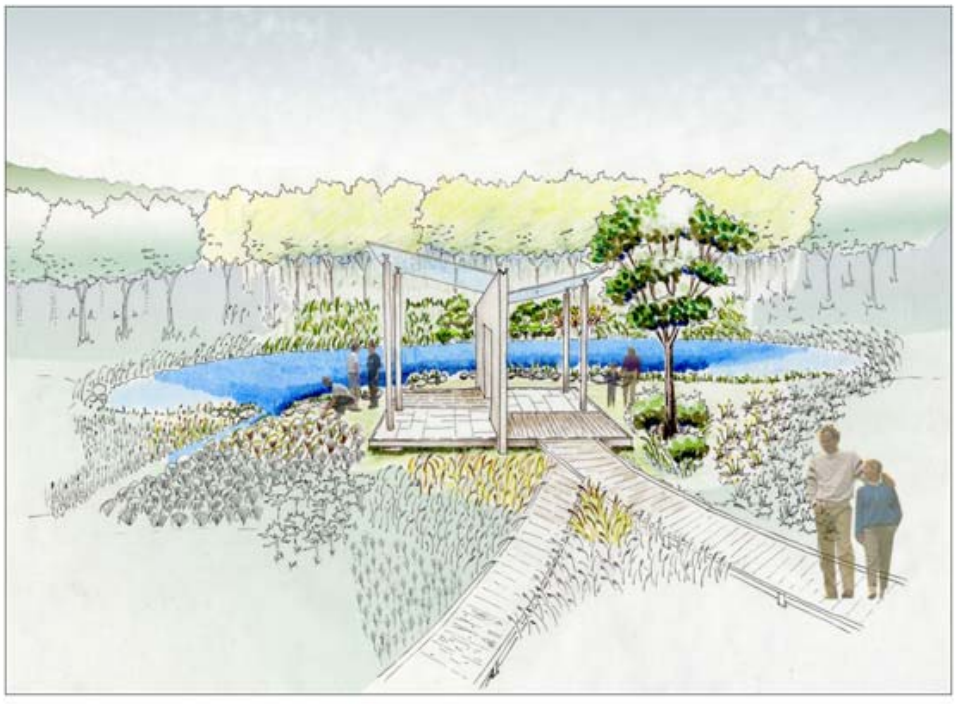


Figure 86 Perspective view of the water pavilion

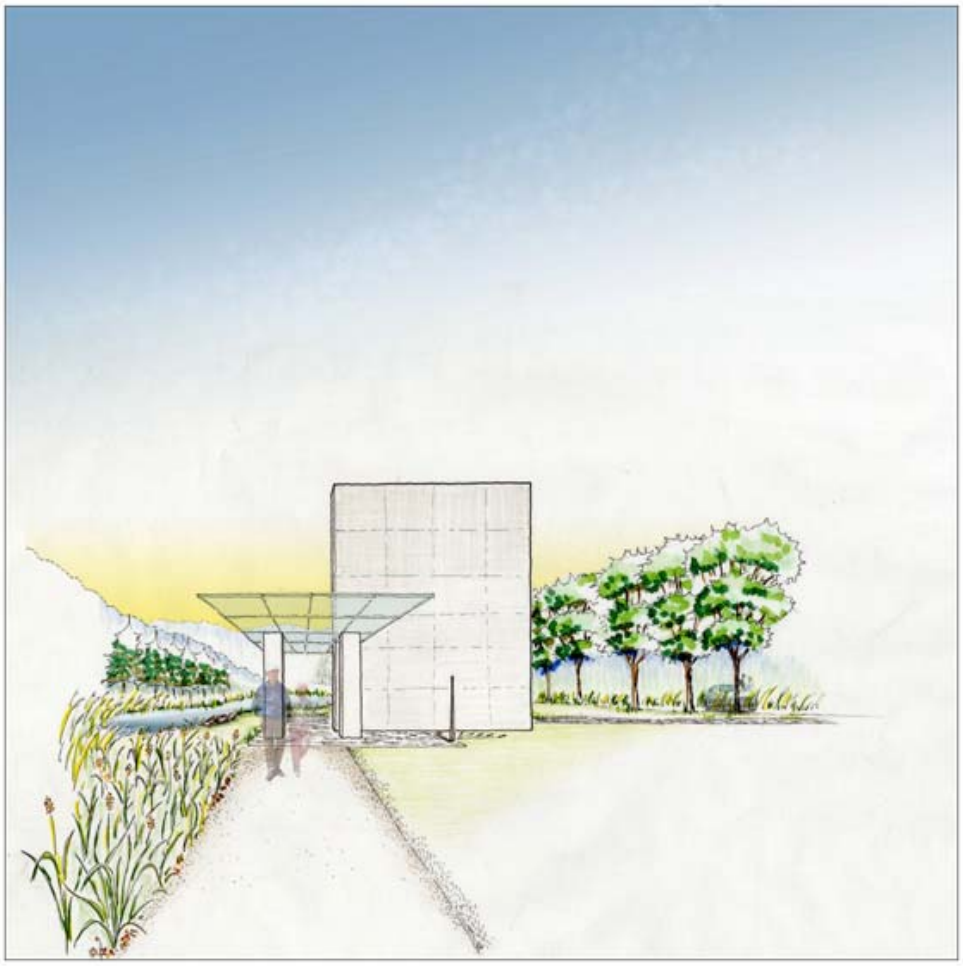


Figure 87 Perspective view of the solar pavilion

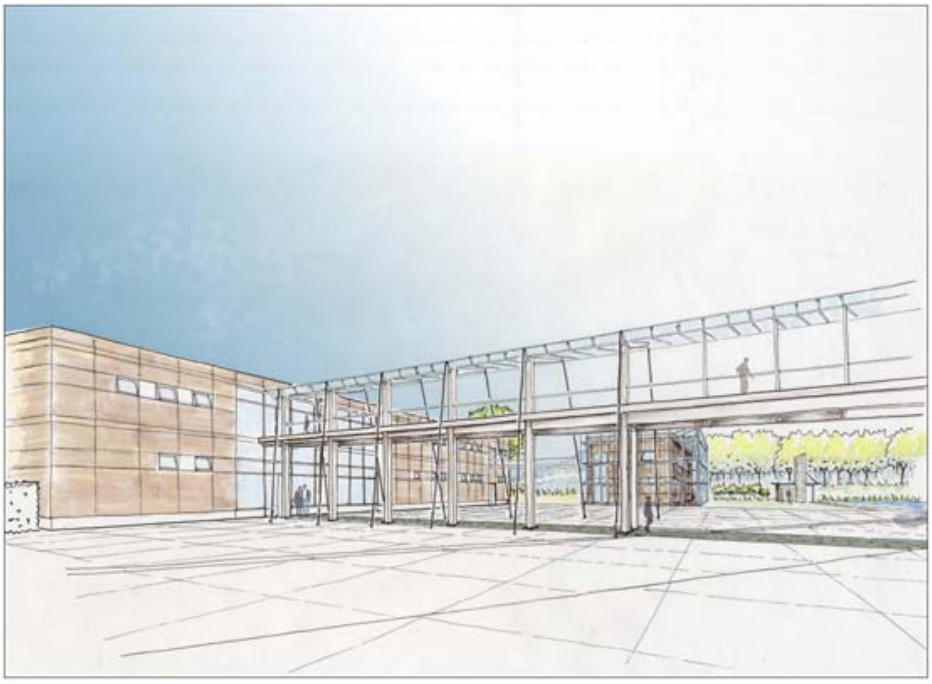


Figure 88 Perspective view from the station to the conference center

Figure 89 Perspective view from the station tower to the research center

Figure 90 Perspective: the lobby view of the conference center

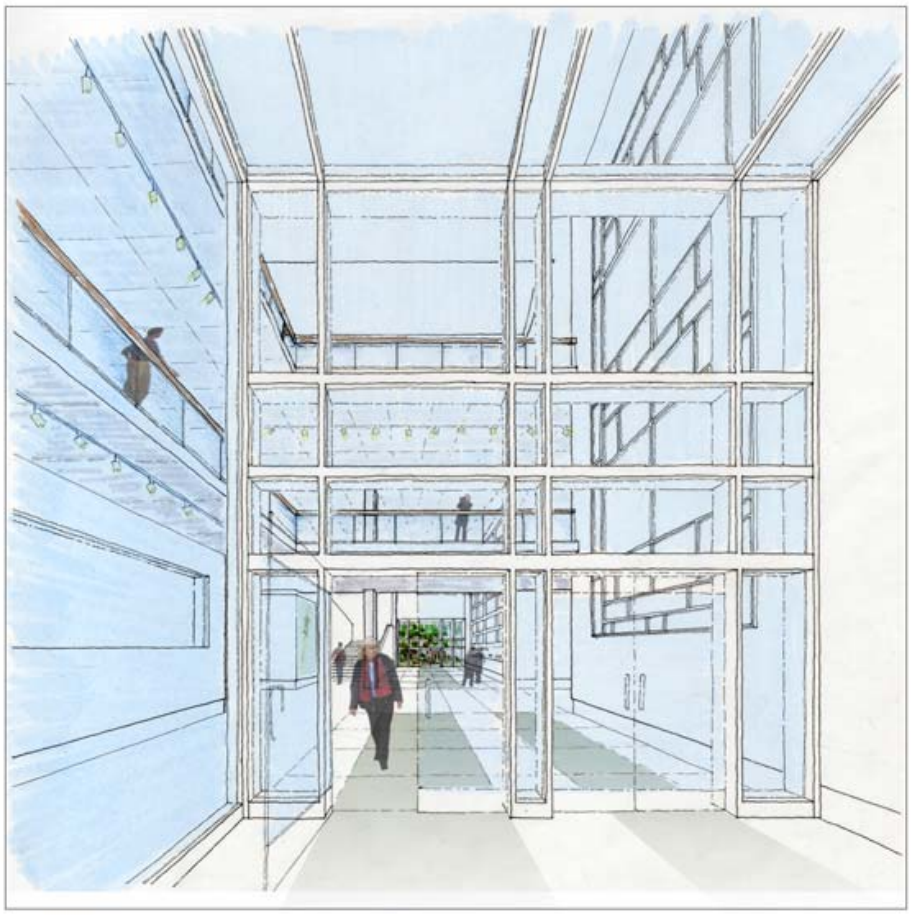


Figure 91 Perspective: the lobby view of the research center

Figure 92 Perspective: the station view to the conference center

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