1 Basic Porject Construction Information

Project Name	European Investment Bank Loan—Sustainable Management Project of Rare Forest in Hubei Province				
Construction unit	Forestry Department of Hubei Province, China				
Legal representative	Liu Xinchi		Contact person	Xiao Jibin	
Address	No. 335 Chuxiong Street, Hongshan district, Wuhan, Hubei province				
Contact number	02751796013	Fax	51796053	Postcode	430079
Construction site	11 counties, six cities (autonomous prefectures) including Xianning City Hubei Province (Xian'an District, Chibi City, Tongcheng County, Tongshan County), Xiaogan City (Xiaonan Distrcit, Dawu County), Huanggang City (Yingshan County), Xiangyang City (Xiangcheng District, Zaoyang City), Yichang City (Changyang County), Enshi autonomous prefecture (Badong County)				
Project approval department	Development and Reform Commission of Hubei Province		Approval number	No. 541, Economic correspondence [2014], Foreign Investment Office, Development and Reform Commission of Hubei Province	
Type of construction	Newly-built √ ; Conversion or expansion; Technological innovation √		Industry category and code	Forestry A02	
Floor area (Ha)	6206.45		Green coverage	100%	
Total investment (10 thousand RMB yuan)	39000	Where: environmental protection investment (10 thousand RMB yuan)		proportion of environmental protection investment among total investment	
Evaluation expenditure (10 thousand RMB yuan)	9	Expected commissioning time		2019	

1.1 Project Background

The goal is to accelerate the development of sustainable management of rare forest in Hubei Province, strengthen tending management of young and middle aged rare forests, fully improve forest management standards and quality, speed up the development and enhance the efficiency of rare tree species in Hubei province. Establish national strategic timber reserve bases of multiple tree species and timber species so as to lay the foundation of realizing the "Double Growth" objective. In August 2014, Forestry Bureau of Hubei Province submitted Request of Including the Sustainable Development of Rare Forestry in Hubei Province into Projects in the Pipeline of European Investment Bank Loan (No. 360, economic correspondence [2014], foreign investment office, Forestry Bureau of Hubei province) to Development and Reform Commission of Hubei Province.

National Development and Reform Commission issued *Notice on Plan Adjustment and Balance Arrangement about Making Use of Alternative Projects in the First Period of European Investment Bank Frame Loan on Climate Changes* (No. 2833, economic correspondence [2014], foreign investment office, Development and Reform Commission of Hubei Province) on December 15, 2014. *Forward the Notice on Plan Adjustment and Balance Arrangement about Making Use of Alternative Projects in the First Period of European Investment Bank Frame Loan on Climate Changes* (No. 541, economic correspondence [2014], foreign investment office, Development and Reform Commission of Hubei Province) issued by the Development and Reform Committee of Hubei Province on December 24, 2014 approved to include the project proposed by Forestry Bureau of Hubei Province in the alternative project plan (Appendix 2). Subsequently, the forestry of Hubei province held the pre-preparation meeting of the forestry project of European Investment Bank Loan of Hubei Province in Wuhan, fully deploying the pre-preparations of the project, explaining the establishment of the database, participatory consultation and other technical requirements. Meanwhile, it also authorized the State Forestry Bureau to prepare and design the feasibility study report and other documents.

In accordance with relevant provisions of Decree No. 253 of the State Council State Council Regulations on Environmental Protection of Construction Projects, Forestry Bureau

of Hubei Province authorized China University of Geosciences (Wuhan) to carry out the environmental impact assessment (EIA) work of the project. After accepting the assignment (Appendix 1), EIA units collected data and did analysis to prepare the EIA report in accordance with relevant technical standards and regulations.

1.2 Preparation Basis

- *Environmental Protection Law of the People's Republic of China*, amended on April 24, 2014
- *Law of the People's Republic of China on Environmental Impact Assessment*, Oct 28, 2002
- *Forest Law of the People's Republic of China*, amended on April 29, 1998
- *Law of the People's Republic of China on Prevention and Control of Water Pollution*, amended on February 28, 2008
- *Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution*, amended on April 29, 2004
- *Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste*, amended on December 29, 2004
- *Law of the People's Republic of China on Prevention and Control of Pollution From Environmental Noise*, October 29, 1996
- *Law of the People's Republic of China on Water and Soil Conservation*, amended on December 25, 2010
- *Law of the People's Republic of China on the Protection of Wildlife*, amended on August 28, 2004
- *Regulations of the People's Republic of China on Wild Plants Protection*, amended on September 30, 1996
- *Regulations of the People's Republic of China on Nature Reserve*, amended on October 9, 1994
- *Measures for the Management of Forest and Wildlife Type Nature Reserve*, approved by the State Council on Jun 21, 1985
- *Regulations on the Administration of Construction Project Environmental Protection*,

November 29, 1998

- *Regulations of the People's Republic of China on the Protection of Basic Farmland*, December 27, 1998
- *Decision on Accelerating the Development of Forestry*, No. 9 [2003], the State Council, Central Committee of the Communist Party of China, June 25, 2003
- *Key Points of Forestry Industry Policy*, State Forestry Bureau, National Development and Reform Commission, Ministry of Finance, Ministry of Commerce, State Administration of Taxation, China Banking Regulatory Commission, China Securities Regulatory Commission, No 173, Forestry Plan and Development [2007], August 10, 2007
- *Plan for the Construction of National Timber Strategic Reserve Production Bases* (2013--2020), State Forestry Bureau, January, 2013
- *Regulations on Forest Land of Hubei Province,* August 5, 1997
- *Regulations on Environmental Protection of Hubei Province*, amended on December 3, 1997
- *Regulations on the Protection of Ancient and Famous Trees of Hubei Province*, NO. 336 Decree, the People's Government of Hubei Province, May 31, 2010
- *Measures for the Management of Forest and Wildlife Type Nature Reserve*, NO. 249 Decree, the People's Government of Hubei Province, June 23, 2003
- *Directory of Classified Management of Project Environmental Impact Assessment*, NO.2 Decree, Ministry of Environmental Protection, September 2, 2008
- *Technical Guidelines for Environmental Impact Assessment General Principles* (HJ/T 2.1-2011)
- *Technical Guidelines for Environmental Impact AssessmentAtmospheric Environment* (HJ/T 2.2-2008)
- *Technical Guidelines for Environmental Impact AssessmentSurface Water Environment* (HJ/T 2.3-93)
- *Technical Guidelines for Environmental Impact Assessment Acoustic Environment* (HJ/T 2.4-2009)

- *Technical Guidelines for Environmental Impact Assessment Ecological Impact* (HJ 19-2011)
- *Technical Guidelines for Environmental Impact Assessment Afforestation Project (Exposure Draft)*, NO. 222, Correspondence of Environmental Protection Office [2006], Ministry of Environmental Protection
- *Regulations on Forestation Overall Design* (GB/T 15782)
- *Non—commercial Forest Construction Technical Regulation* (GB/T 18337-2001)
- *Regulations for Tending of Forest* (GB/T 15781-2009)
- *Design Code for Afforestation Operation* (LY/T 1607)
- *Technical Regulations on Improvement of Low Yield Timber Forest* (LY/T 1560-1999)
- *Technical Regulations on Reconstruction of Low-function Forest* (LY/T 1690-2007)
- *Code of Forest Harvesting* (LY/T 1646)
- *Technological Guidelines for Cultivation of Fast-growing and High-yielding Timber Plantation* (LY/T 1706-2007)
- Operational Regulation of Harvesting of Short-rotation and Fast-growing Plantation (LY/T 1724-2008)
- Evaluation Criteria on Artificial Afforestation Quality (LY/T 1844-2009)
- Operational Regulation of Harvesting of Plantation for Industrial Raw Materials (LY/T 1724)
- Regulation of Ecological Management of Industrial Plantation (LY/T 1836-2009)
- *60-Article Feasibility Study Report of Sustainable Management Project of Rare Forest in Hubei Province of European Investment Bank Loan*, Academy of Forest Inventory and Planning, State Forestry Bureau, January 2015

1.3 Project Overview

1.3.1 Project Construction Site

The project covers 11 counties (cities, districts) in six prefectural-level divisions, namely Xian'an District in Xianning City, Chibi City, Tongcheng County, Tongshan County, Yingshan County in Huanggang City, Xiaonan District in Xiaogan City, Dawu County, Xiangcheng

District in Xiangyang City, Zaoyang City, Changyang County in Yichang City, and Badong County in Enshi Prefecture.

Please refer to attached figure for sketches for distribution areas of the project.

1.3.2 Project Investment

(1) The Investment Scale

The total project investment is 390 million RMB yuan (equivalent to 50 million Euros), in which the construction investment is 380.1703 million RMB yuan (equivalent to 48.7398 million Euros), accounting for 97.5% of the total investment; while the interest during the construction is 9.8297 million RMB yuan (equivalent to 1.2602 million Euros), accounting for 2.5% of the total investment.

(2) Capital Source

The total project investment is 390 million RMB yuan, in which 25 million Euros are invested by European Investment Bank, equivalent to 195 million RMB yuan, accounting for 50% of the total investment; while 195 million RMB yuan comes from domestic funds, accounting for 50% of the total investment. Regarding the domestic funds, 39 million RMB yuan comes from provincial finance, accounting for 10% of the total investment, 39 million RMB yuan comes from local finance, accounting for 10% of the total investment, and 117 million RMB yuan comes from beneficiaries, accounting for 30% of the total investment.

1.3.3 Construction Content and Scale

Considering the site conditions and present situations of land use of the project area and relying on the advantage of abundant tree species, 6,206.45 HAs of demonstration base of rare forest protection and development will be established, among which 3,876.44 HAs is new afforestation while 2,330.01 HAs are tending forest. 11 nurseries are converted or expanded, with an area of 36.7 HAs. Necessary subsidiary facilities will also be built.

(1) Afforestation Project

During the construction period, the total planned scale of afforestation and tending forest is 6206.45 HAs. Where:

1) New Afforestation

Select non-standing tree land, open forest land and suitable land for forest suitable for

rare tree species afforestation. The total afforestation area achieves 3876.45HAs. Where 198.11 HAs are for liquidambar formosana, 104.74 HAs are for osmanthus fragrans, 381.46 HAs are for zelkova serrata, 323.08 HAs are for toxicodendron vernicifluum, 189.36 HAs are for cunninghamia lanceolata, 397.93 HAs are for ginkgo biloba, 202.43 HAs are for choerospondias axillaris, 139.73 HAs are for liriodendron chinese, 271.26 HAs are for cinnamomum camphora, 389.67 HAs are for koelreuteria paniculata, 458.75 HAs are for camellia oleifera, 82.75 HAs are for torreya grandis, 85.03 HAs are for taxus mairei, 53.01 HAs are for phyllostachys heterocycla, 332 HAs are for pinus elliottii and 267.13 HAs are for mangnolia officinalis.

2) Forest Tending

Select promising forest stands among existing young and middle aged forests. Tending management measures help to improve forest stand structure and growth environment which speeds up the growth of forest stands, improves forest productivity, realizes healthy forest management, and advances ecological functions so as to bring multiple benefits. There're 2330.01 HAs tending area of young and middle aged forests, with 5.41 HAs of liquidambar formosana, 999.4 HAs of phyllostachys heterocycla, 535.81 HAs of pinus taiwanensis, 91.55 HAs of masson pine, 482.81 HAs of cunninghamia lanceolata, 14.45 HAs of pinus elliottii, and 200.58 HAs of larix kaempferi.

(2) Construction of Nursery Stock Production Base

11 nurseries are converted or expanded in the 11 counties (cities) of the project, with an area of 36.7 HAs. Necessary subsidiary facilities are also built.

(3) Construction of Infrastructure and Supporting Facilities

An area of 4,000 ㎡ of simple management and maintenance room will be built. The length of newly-built forest road will achieve 1,020 km while the length of forest road getting maintained will be 1,841 km. 11 km of water supply and drainage engineering and 596 km of fire lane will get maintained. 81 sets of forest fire protection equipment, 29 sets of forest pest control equipment, one set of management information system and 121 sets of production instrument and equipment will be developed.

(4) Construction of Sustainable Forest Management Capacity

The construction includes the domestic and overseas training of forest managers and staff involved in the project, technical consultation, project promotion, and works related to providing necessary office equipment for forest management, software and promotion equipment, as well as forest certification. To be more specific: carry out 3900 work days of domestic training, 900 work days of overseas training and 110 work days of project technical consultation, set 76 boards for project promotion, prepare 11 sets of promotion equipment and 1250 copies of promotion materials, purchase 22 vehicles for work and 200 sets of office equipment.

1.3.4 Construction Period and Schedule

The project construction period is 5 years, that is, 2015-2019. Specific arrangements are as follows:

(1) Afforestation. Will be carried out in 3 years (2015-2017). 1,301.04 HAs area of new afforestation in the 1st year, 1,279.89 HAs area of new afforestation in the 2nd year, 1295.51 HAs area of new afforestation in the 3rd year. Carry out tending management for 3 consecutive years after the afforestation (the current year inclusively).

(2) Forest Tending. Will be carried out in 2 years (2018--2019). 1,176.86 HAs of tending area in the 4th year, 1,153.15 HAs for tending area in the 5th year.

(3) Construction of Nursery Stock Production Base. Complete the conversion and expansion of 11 nurseries and start the tending work in 2015.

(4) Construction of Infrastructure and Supporting Facilities. The construction will be conducted in 4 years (2015-2018). The construction of infrastructure and supporting facilities includes simple management and maintenance room, forest road building and maintenance, which will be carried out together with the afforestation project.

Regarding the construction demands, prioritize construction such as office equipment and promotion in the 1st year (2015). Project training, technical consultation and promotion will be completed in 3 years (2015-2018). Young forest tending, completion acceptance and evaluation will be finished in the 4th and 5th year (2018-2019).

1.3.5 Technical Measures of Afforestation

(1) Selection of Tree Species

1) Native tree species should be prioritized in order to enhance biodiversity protection. It helps to improve the ability of afforestation against plant diseases and insect pests as well as reduces the risk of afforestation from being affected by pests and diseases to select superior provenance of good native tree species, familial species and clonal species. Only when the growth and resistance of exotic tree species are higher than native species can exotic tree species be selected.

Each compartment of the new afforestation usually should not exceed 35 HAs within this project. The maximum dimension of each parcel with mono-cultured tree species should not exceed 10 HAs. During the design and arrangement of plantations, measures such as making use of wildlife's corridors, retaining native tree species, taking advantage of river to protect corridor and using associated native tree species should be applied to imitate the structure of natural forest so as to facilitate the protection, recovery and retention of natural plant communities. There should be an isolation strip, ranging from 50 meters to 100 meters, as the bio channel between each piece of woodland.

According to above two principles, there're 16 species selected: liquidambar formosana, osmanthus fragrans, zelkova serrata, toxicodendron vernicifluum, cunninghamia lanceolata, ginkgo biloba, choerospondias axillaris, liriodendron chinense, cinnamomum camphora, koelreuteria paniculata, camellia oleifera, torreya grandis, taxus mairei, phyllostachys heterocycla, pinus elliottii and mangnolia officinalis. Please refer to table 1-1 for major biological characteristics and afforestation area of each tree species.

Table 1-1 Major Biological Characteristics of Model Tree Species

Tree species	Botanical features	Suitable afforestation area
Liquidambar formosana	It belongs to hamamelidaceae and liquidambar. It's a kind of deciduous tree, with the height of 30 m and the max DBH (diameter at breast height) up to 1 m. The bark is taupe. It grows well in warm and humid climate with sufficient light and has strong resistance against drought and barrenness. It's originated in Qinling Mountains and other provinces in the south area of Huai River in China. The timber texture is slightly solid and suitable for furniture and packing of precious commodities.	198.11
Osmanthus	It belongs to oleaceae and osmanthus. The osmanthus fragrans	104.74

Tree species	Botanical features	Suitable afforestation area
fragrans	grows well in warm climate and has strong resistance against stress, high temperature and cold condition. So it can survive in open-field in winter of Qinling Mountains and other provinces in the south area of Huai River in China. The osmanthus fragrans is a kind of photophilous but cold-resistant plant. Its branches and leaves flourish in full sunlight.	
Zelkova serrata	It belongs to ulmaceae and zelkova. As one tree species among the second grade of national key protective hard broad-leaved timber species, the zelkova serrata heliophilous is a heliophilous species and grows well in warm environment. It's vertically distributed in mountains and plains with the altitude of 500m. Its location can even reach the altitude of 1000m in Yunnan province. The zelkova serrata can be used for buildings, bridges, cars and first-class furniture.	381.46
Cunninghamia lanceolata	It belongs to taxodiaceae and cunninghamia. It's a kind of subtropical tree and photophilous.	189.36
Toxicodendron vernicifluum	It belongs to anacardiaceae and rhus. The toxicodendron vernicifluum is one of the oldest economic tree species in China, which belongs to the alpine species. It's photophilous and cold-resistant. The seed can be used for oil manufacture. The timber texture is solid so as to make toxicodendron vernicifluum a dual-purpose tree species of natural paint, oil plant and wood. The lacquer is natural resin paint but cannot survive in dry wind and cold conditions. Sunny and sheltered slopes and valleys are better choices.	323.08
Ginkgo biloba	It belongs to ginkgoaceae and ginkgo. The ginkgo bilobatree is photophilous and one of the oldest relic plant among the existing spermatophyte species. It's first-grade state protection plant.	397.93
Choerospondias axillaris	It belongs to rhamnaceae and zizyphus. It's a kind of tall deciduous tree.	202.43
Liriodendron chinese	It belongs to magnoliaceae and liriodendron chinense. It's a kind of second-grade state protection plant and Chinese-specific rare plant. It's a kind of large deciduous tree. It's photophilous but fails to grow well in arid land or humid and waterlogging land. Usually it grows in the mountain forest or at forest edge with the altitude of 900-1000 meters above sea level, scattering far and wide or growing together as a small pure forest.	139.73
Cinnamomum camphora	It belongs to lauraceae and cinnamomum. The cinnamomum camphora is a kind of second-grade state protection plant. It's photophilous an tall. It is shade-tolerant during its young age and grows better under shade than in full light. 5 or 6 years later, it needs	271.26

Tree species	Botanical features	Suitable afforestation area
	more light. It needs strong light in its prime age.	
Koelreuteria paniculata	It belongs to sapindaceae and koelreuteria. It usually appears as deciduous tree or shrubs. It's a photophilous and slightly half-shade-tolerant plant, with strong resistance against cold condition but poor resistance to waterlogging. Attention should be drawn to the selection of the land. It has the characteristics of deep-rooted, strong tillers sprouting ability, medium growth rate and strong ability to resist dust. It grows slowly during its young age and gradually grows faster.	389.67
Camellia oleifera	It belongs to camellia and theaceae. It's a small evergreen dungarunga. Tea oil is high quality cooking oil and can also be used as lubricants and anti-rust oil in industry. Tea cake is a pesticide and fertilizer which can increase the water storage capacity of the farmland and control insect pests in the paddy field. Its peel can be used as the raw material of tanning extracts.	458.75
Torreya grandis	It belongs to taxus mairei. It's a native tree species in China and a rare economic tree species in the world. The torreya grandis is a hardy subtropical species. It's dioecious, shallow-rooted and half-sheltered evergreen megaphanerophyte.	82.75
Taxus mairei	It belongs to taxuceae and taxus. It's a kind of first-grade State protection plant. It's shallow-rooted and evergreen tree. It's shade-tolerant and can grow under dense forest. As a perennial and shade-tolerant species, it prefers humid condition but not waterlogging condition.	85.03
Phyllostachys heterocycla	It belongs to gramineae and phyllostachys. It's a kind of scattered tree with single axle as well as an evergreen bamboo plant. It's an important timber and economic plant.	
Pinus elliottii	It belongs to pinaceae and pine. It's a fast-growing evergreen tree and enjoys growing in moist soil with the height of 150 m to 500 m above sea level. It's drought-resistant and barrenness-resistant with good adaptability and resilience.	332.00
Magnolia officinalis	It belongs to magnoliaceae and magnolia. It's a kind of first-grade state protection plant. It's a deciduous, photophilous and mesophytic tree which grows in mountains and woodlands with the height of 300m to 1500m above the sea level. Young forest needs shelter. It often grows in deciduous broad-leaved forest or in the edge of evergreen broad-leaved forest.	267.13

(2) The Selection of Afforestation

The preferential sequence for woodland which is used for forest culture and management

is: First, waste hills and unreclaimed lands suitable for afforestation; second, old cutover lands as well as low-quality and low-benefit plantations; then, forest returning from farmland; lastly, degenerated plantations with bare land and exotic grass species.

(3) Land Preparation

1) Land preparation should decided by the gradient of the slope so as to choose the right mode—hole cultivation, band cultivation or full cultivation. Groundbreaking dimension should be within 20% to 25%. Please refer to table 1-2 for the relationship between modes of land preparation and plantation slopes.

Table 1-2 Relationship between Modes of Land Preparation and Plantation Slopes

Plantation Slope	Modes of Land Preparation
<15°	full cultivation
16°-25°	hole cultivation, band cultivation alongside the contour line or cascade land preparation
>26°	hole cultivation land preparation arranging in the structure of character "品"character, set catch water alongside the contour line

(2) There should be a 10-meter-wide vegetation protection strip between parcel edge of the plantation and the farmland, and a 3-meter-wide sward protection strip every 100 meters on long slopes which applies full cultivation for land preparation.

(3) To construct economic forest on slopes above 15°, cascade cultivation (anti-corner terrace) should be applied so that the surface runoff water can be transferred to the stable ground or into streams that can receive extra water.

(4) Afforestation Standard Parameters and Time

It's suitable to plant trees in spring (February to March) in Hubei province. March and April are suitable for planting trees in areas of high altitude. Please refer to table 1-3 for afforestation standards.

Table 1-3 Afforestation Standard Parameters

Afforestation species	Initial planting density		Forestland clearance	Land preparation		Rotation and Preliminary period (year)
	planting space (m×m)	Number of plantings **(number/Ha)**		Method	Specification (cm)	
Liquidambar formosana	2×3	1667	All-round clearance	Hole	50×50×40	21
Osmanthus fragrans	2×3	1667	All-round clearance	Hole	40×40×30	4
Zelkova serrata	2×3	1667	All-round	Hole	40×40×30	41

			clearance			
Toxicodendron vernicifluum	2×3	1111	All-round clearance	Hole	40×40×30	8
Cunninghamia lanceolata	2×1.5	3333	All-round clearance	Hole	40×40×30	21
Ginkgo biloba	3×4	833	All-round clearance	Hole	40×40×30	6
Choerospondias axillaris	2×3	1667	All-round clearance	Hole	60×60×50	21
Liriodendron chinese	3×4	833	All-round clearance	Hole	40×40×30	21
Cinnamomum camphora	2×3	1667	All-round clearance	Hole	40×40×30	41
Koelreuteria paniculata	3×3	1111	All-round clearance	Hole	40×40×30	16
Camellia oleifera	3×3	1111	All-round clearance	Hole	50×50×40	4
Torreya grandis	2×3	1667	All-round clearance	Hole	40×40×30	5
Taxus mairei	2×3	1667	All-round clearance	Hole	40×40×30	61
Phyllostachys heterocycla	4×5	500	All-round clearance	Hole	100×60×50	8
Pinus elliottii	2×3	1667	All-round clearance	Hole	50×50×40	21
Magnolia officinalis	2×3	1667	All-round clearance	Hole	50×50×40	10

(5) Young Forest Tending

1) Intercropping: interbreed among plantations on slopes should be carried out in a horizontal direction and should not be carried out on slopes above 25°. Intercropping is not allowed for hole cultivation on slopes between 15°and 25°. It shall be carried out during band cultivation alongside the contour line or cascade land preparation. Roots and tuber crops are not allowed for intercropping under such condition. Leguminous plants are preferred as they're good for soil improvement.

2) Weeding and Ripping: Prohibit the use of herbicides. It's better to use partial tending modes for the tending of young growth. To protect the natural vegetation of young growth as much as possible by expanding holes, ripping and weeding around saplings. After weeding,

the vegetation residues should be left in the land as mulch. Prohibit wood chopping of dry branches and fallen leaves in plantations so as to improve the capacity of water conservation and maintain soil fertility.

(6) Fertilization

To facilitate the growth of forest and gain economic and ecological benefit, try to use organic fertilizers. Fertilizer utilization should strictly follow the afforestation models. The time, frequency, amount and mode should be in strict accordance with characteristics and requirements of fertilizers. To determine the fertilization schedule should be based on appropriate research or proper soil and plant testing results. Hole fertilization or band fertilization but not broadcast fertilization must be applied. The fertilizer should be used in the uphill direction of the hole and covered with soil in order to prevent nutrient loss and pollution of surface water.

(7) Harvesting and Logging

Carry out thinning and regeneration felling for new afforestation and renovating lands to protect environmental function.

1) Harvesting

①Harvesting should strictly enforce the "Forest Law of The People's Republic of China Forest Law" and "Code of Forest Harvesting"

②For harvesting focusing on tending and regeneration, selective cutting should be applied to maintain permanent vegetation and forest protection.

③Pay attention to the protection of understory vegetation, which must be updated in the following year after harvest.

2) Logging

①Maximize the use of log-length logging and minimize the use of tree-length logging in order to reduce the damage to the vegetation and topsoil.

②Take advantage of existing paths through the woods as much as possible. Open up forest-road with width less than 1 m when necessary.

1.3.6 Forest Land Management

(1) Seedling Supply

All seedlings used by Hubei province must be high quality provenance. Seedlings used by timber and economic forest must meet the standard stated in Seedling Quality Grading of Major Afforestation Tree Species (GB 6000-1999) and be selected according to the requirement of class A seedling of relevant local standard.

(2) Forest Pest Control

For afforestation seedling: select strong seedling that has resistance against diseases and pests, strengthen inspection and quarantine of forest seedling to completely eradicate the transport and planting of seedlings with diseases and pests, take effective control measures for forest culture and management to improve the ability of trees against diseases and pests, keeping forest healthy, emphasize on strengthening monitoring and prediction of diseases and pests in order to provide basis for the prevention and treatment decisions, integrate quarantine, silvicultural, physical and mechanical, biological and chemical methods to control and treat diseases and pests. When carrying out disease and pest control, physical and biological control measures should be prioritized. Only when other control methods fail and the monitoring results show that the harm of disease and pest exceeds economic thresholds, can pesticides be used. It's important to use non-polluted pesticide to reduce disease and pest resistance and avoid environmental pollution.

(3) Forest Fire Management

Forest fire prevention must be incorporated into all levels of local forest fire management system. Each afforestation unit must be prepared for forest fire prevention plan and establish fire management organizations, developing detailed plan for fire prevention, public education, patrol, law enforcement and fire emergency.

Any woodland with the dimension over 100 HAs has no firebreak should build one. The woodland can be divided into several compartments less than 35 HAs. The width of the firebreak should be 10 meters to 20 meters, making the best use of rivers and local natural pyrophytes.

(4) Natural Disaster Control

It's recommended that county project office shall establish network links with meteorological departments at all levels and keep abreast of local weather conditions and the

occurrence and development trend of disastrous weather which has serious effects on the growth of trees such as drought, freezing injury, and sustained thunderstorms. Actively take preventive measures, especially work for protecting seedlings of new economic forest tree species, anti-drought, anti-frost and preventing crushing by snow.

1.3.7 Afforestation Model Decomposition

This project has designed 23 afforestation models. Please refer to table 1-4 for the detailed information of the summary and decomposition of each county (city, district) of Hubei province.

Table 4-1 Statistical Table of the Investment of Afforestation Model per County (City, District)

Unit: HA, RMB yuan, ten thousand RMB yuan

Unit	Model name	Tree Species	Afforestation model name	Area	Unit Price	Investment
Hubei Province	Hubei Province	*Total*		6206.45		19500
	Model 1	*Liquidambar formosana*	Newly-planted liquidambar formosana in the timber forest	198.11	44451	880.60
	Model 2	*Osmanthus fragrans*	Newly-planted osmanthus fragrans in the economic forest	104.74	46285	484.80
	Model 3	*red beech*	Newly-planted red beech in the timber forest	381.46	47203	1800.58
	Model 4	*Toxicodendron vernicifluum*	Newly-planted toxicodendron vernicifluum in the economic forest	323.08	41059	1326.56
	Model 5	*Cunninghamia lanceolata*	Newly-planted cunninghamia lanceolata in the timber forest	189.36	48948	926.92
	Model 6	*Ginkgo biloba*	Newly-planted gingkos in the economic forest	397.93	42319	1684.00
	Model 7	*Choerospondias axillaris*	Newly-planted choerospondias axillaris in the timber forest	202.43	48119	974.09
	Model 8	*Liriodendron chinese*	Newly-planted liriodendron chinese in the timber forest	139.73	40487	565.75
	Model 9	*Cinnamomum camphora*	Newly-planted camphor trees in the timber forest	271.26	45369	1230.63
	Model 10	*Koelreuteria paniculata*	Newly-planted koelreuteria paniculata in the timber	389.67	40449	1576.16

Unit	Model name	Tree Species	Afforestation model name	Area	Unit Price	Investment
			forest			
	Model 11	*Camellia oleifera*	Newly-planted tea-oil trees in the economic forest	458.75	44173	2026.44
	Model 12	*Torreya grandis*	Newly-planted torreya grandis in the economic forest	82.75	51787	428.48
	Model 13	*Taxus mairei*	Newly-planted Taxus mairei in the economic forest	85.03	51787	440.36
	Model 14	*Phyllostachys heterocycla*	Newly-planted phyllostachys heterocycla in the timber forest	53.01	46140	244.68
	Model 15	*Pinus elliottii*	Newly-planted pinus elliottii in the timber forest	332.00	43535	1445.37
	Model 16	*Magnolia officinalis*	Newly-planted magnolia officinalis in the economic forest	267.13	48119	1285.40
	Model 17	*Liquidambar formosana*	Tending liquidambar formosana in the timber forest	5.41	6850	3.71
	Model 18	*Phyllostachys heterocycla*	Tending phyllostachys heterocycla in the timber forest	999.40	10100	1009.39
	Model 19	*Pius taiwanensis*	Tending pinus taiwanensis in the timber forest	535.81	8800	471.51
	Model 20	*Pinus massoniana*	Tending pinus massoniana in the timber forest	91.55	8800	80.56
	Model 21	*Cunninghamia lanceolata*	Tending cunninghamia lanceolata in the timber forest	482.81	8800	424.88
	Model 22	*Pinus elliottii*	Tending pinus elliottii in the timber forest	14.45	8800	12.72
	Model 23	*Larix kaempferi*	Tending larix kaempferi in the timber forest	200.58	8800	176.51
Chibi City	Chibi City	*SUM*		623.66		1838.00
	Model 3	*red beech*	Newly-planted red beech in the timber forest	36.66	47203	173.06
	Model 6	*Ginkgo biloba*	Newly-planted gingkos in the economic forest	17.85	42319	75.52
	Model 9	*Cinnamomum camphora*	Newly-planted camphor trees in the timber forest	195.14	45369	885.30
	Model 10	*Koelreuteria paniculata*	Newly-planted koelreuteria paniculata in the timber forest	57.06	40449	230.83

Unit	Model name	Tree Species	Afforestation model name	Area	Unit Price	Investment
	Model 11	*Camellia oleifera*	Newly-planted tea-oil trees in the economic forest	44.95	44176	198.57
	Model 18	*Phyllostachys heterocycla*	Tending phyllostachys heterocycla in the timber forest	272.00	10100	274.72
Unit	Model name	*Tree Species*	Afforestation model name	Area	Unit Price	Investment
Tongcheng County	Tongcheng County	*SUM*		718.18		1560.00
	Model 11	*Camellia oleifera*	Newly-planted tea-oil trees in the economic forest	257.15	44173	1135.91
	Model 18	*Phyllostachys heterocycla*	Tending phyllostachys heterocycla in the timber forest	141.42	10100	142.83
	Model 21	*Cunninghamia lanceolata*	Tending cunninghamia lanceolata in the timber forest	319.61	8800	281.26
Tongshan County	Tongshan County	*SUM*		745.28		2340.00
	Model 7	*Choerospondias axillaris*	Newly-planted choerospondias axillaris in the timber forest	202.43	48119	974.07
	Model 8	*Liriodendron chinese*	Newly-planted liriodendron chinese in the timber forest	18.76	40487	75.97
	Model 11	*Camellia oleifera*	Newly-planted tea-oil trees in the economic forest	110.35	44176	487.48
	Model 12	*Torreya grandis*	Newly-planted torreya grandis in the economic forest	82.75	51787	428.48
	Model 14	*Phyllostachys heterocycla*	Newly-planted phyllostachys heterocycla in the timber forest	11.01	46140	50.82
	Model 18	*Phyllostachys heterocycla*	Tending phyllostachys heterocycla in the timber forest	319.98	10100	323.18
Xian'an District	Xian'an District	*SUM*		626.25		1950.00
	Model 2	*Osmanthus fragrans*	Newly-planted osmanthus fragrans in the economic forest	60.00	46285	277.70
	Model 5	*Cunninghamia lanceolata*	Newly-planted cunninghamia lanceolata in the timber forest	82.80	48948	405.34
	Model 8	*Liriodendron chinese*	Newly-planted liriodendron chinese in the timber forest	84.00	40487	339.98

Unit	Model name	Tree Species	Afforestation model name	Area	Unit Price	Investment
	Model 11	*Camellia oleifera*	Newly-planted tea-oil trees in the economic forest	12.00	44175	53.01
	Model 13	*Taxus mairei*	Newly-planted Taxus mairei in the economic forest	79.45	51787	411.45
	Model 14	*Phyllostachys heterocycla*	Newly-planted phyllostachys heterocycla in the timber forest	42.00	46140	193.86
	Model 18	*Phyllostachys heterocycla*	Tending phyllostachys heterocycla in the timber forest	266.00	10100	268.66
Yingshan County	Yingshan County	*SUM*		802.51		1092.00
	Model 1	*Liquidambar formosana*	Newly-planted liquidambar formosana in the timber forest	108.51	44451	482.33
	Model 17	*Liquidambar formosana*	Tending liquidambar formosana in the timber forest	5.41	6850	3.71
	Model 19	*Pinus taiwanensis*	Tending pinus taiwanensis in the timber forest	535.81	8800	471.51
	Model 21	*Cunninghamia lanceolata*	Tending cunninghamia lanceolata in the timber forest	152.78	8800	134.45
Xiaonan County	Xiaonan County	*SUM*		495.85		2183.97
	Model 3	*red beech*	Newly-planted red beech in the timber forest	248.07	47203	1170.94
	Model 6	*Ginkgo biloba*	Newly-planted gingkos in the economic forest	57.81	42319	244.62
	Model 10	*Koelreuteria paniculata*	Newly-planted koelreuteria paniculata in the timber forest	189.97	40449	768.41
Dawu County	Dawu County	*SUM*		423.70		1892.00
	Model 1	*Liquidambar formosana*	Newly-planted liquidambar formosana in the timber forest	89.60	44451	398.28
	Model 2	*Osmanthus fragrans*	Newly-planted osmanthus fragrans in the economic forest	44.74	46285	207.10
	Model 3	*red beech*	Newly-planted red beech in the timber forest	96.73	47203	456.56
	Model 6	*Ginkgo biloba*	Newly-planted gingkos in the economic forest	70.36	42319	297.75

Unit	Model name	Tree Species	Afforestation model name	Area	Unit Price	Investment
	Model 15	*Pinus elliottii*	Newly-planted pinus elliottii in the timber forest	122.27	43535	532.31
Xiangcheng District	Xiangcheng	*SUM*		370.04		1582.00
	Model 6	*Ginkgo biloba*	Newly-planted gingkos in the economic forest	46.80	42319	198.10
	Model 9	*Cinnamomum camphora*	Newly-planted camphor trees in the timber forest	74.78	45369	339.29
	Model 10	*Koelreuteria paniculata*	Newly-planted koelreuteria paniculata in the timber forest	119.88	40449	484.91
	Model 15	*Pinus elliottii*	Newly-planted pinus elliottii in the timber forest	128.58	43535	559.70
Zaoyang County	Zaoyang County	*SUM*		335.94		1163.00
	Model 5	*Cunninghamia lanceolata*	Newly-planted cunninghamia lanceolata in the timber forest	106.56	48948	521.61
	Model 11	*Camellia oleifera*	Newly-planted tea-oil trees in the economic forest	26.33	44159	116.27
	Model 13	*Taxus mairei*	Newly-planted Taxus mairei in the economic forest	5.58	51787	28.91
	Model 15	*Pinus elliottii*	Newly-planted pinus elliottii in the timber forest	81.15	43535	353.29
	Model 16	*Magnolia officinalis*	Newly-planted magnolia officinalis in the economic forest	10.32	48119	49.64
	Model 20	*Pinus massoniana*	Tending pinus massoniana in the timber forest	91.55	8800	80.56
	Model 22	*Pinus elliottii*	Tending pinus elliottii in the timber forest	14.45	8800	12.72
Changyang County	Changyang County	*SUM*		539.58		1716.00
	Model 6	*Ginkgo biloba*	Newly-planted gingkos in the economic forest	2.73	42319	11.55
	Model 8	*Liriodendron chinese*	Newly-planted liriodendron chinese in the timber forest	36.97	40487	149.73
	Model 9	*Cinnamomum camphora*	Newly-planted camphor trees in the timber forest	1.34	45369	6.05
	Model 10	*Koelreuteria paniculata*	Newly-planted koelreuteria paniculata in the timber forest	22.76	40449	92.01
	Model 11	*Camellia oleifera*	Newly-planted tea-oil trees in the economic forest	7.97	44191	35.22

Unit	Model name	Tree Species	Afforestation model name	Area	Unit Price	Investment
	Model 16	*Magnolia officinalis*	Newly-planted magnolia officinalis in the economic forest	256.81	48119	1235.76
	Model 21	*Cunninghamia lanceolata*	Tending cunninghamia lanceolata in the timber forest	10.42	8800	9.17
	Model 23	*Larix kaempferi*	Tending larix kaempferi in the timber forest	200.58	8800	176.51
Badong County	Badong County	*SUM*		525.46		2183.00
	Model 4	*Toxicodendron vernicifluum*	Newly-planted toxicodendron vernicifluum in the economic forest	323.08	41059	1326.54
	Model 6	*Ginkgo biloba*	Newly-planted gingkos in the economic forest	202.38	42319	856.46

1.4 The Original Pollution Associated with This Project and Main Environmental Problems

This project is a new and technical renovation project. The construction area is mainly engaged in agriculture and forestry production, with no obvious sources of pollution within the project area and nearby area. The environmental quality of the project implementation area preserves original characteristics of the area, largely unaffected by pollution. The implementation areas of this project are basically agricultural and forest areas with fewer industrial activities, small scale, less environmental pollution.

The project area is facing serious soil and water loss. Only through planting trees and grass, ecological measures such as increasing land cover, can fundamentally solve the erosion problem.

2 Natural and Social Environmental Profile of the Project Site

2.1 Natural Environment Profile (topography, geomorphology, geology, climate, meteorology, hydrology, vegetation, biodiversity, etc.)

2.1.1 Geographical Location

Hubei province crosses 108°21' 42' east longitude to 116°07' 50' east longitude, 29°01' 53' north latitude to 33°6' 47' north latitude. The project area covers 11 counties (cities, distrcits), namely Xian'an District in Xianning City, Chibi City, Tongcheng County, Tongshan County, Yingshan County in Huanggang City, Xiaonan District in Xiaogan City, Dawu County, Xiangcheng District in Xiangyang City, Zaoyang City, Changyang County in Yichang City, and Badong County in Enshi Prefecture. Please refer to Attached Figure 1 for sketches for distribution areas of the project.

2.1.2 Geology, Topography and Geomorphology

Hubei province locates in the transition zone from the second step to the third step, with the three sides risen, flat middle part, south part open and north part of incomplete basin. There's a line from Danjiangkou to Gucheng, Nanzhang to the west part of Jingmen, Yichang and Zhicheng, with Wuling Mountain, Wu Mountain, Jing Mountain and Daba Mountain lie in the west. The terrain is high with overlapping mountains. Most mountains are above 1000m. The basic landscape is the western Hubei mountainous region. Tongbai Mountain, Dabie Mountain, Jiugong Mountain and Mufu Mountain lie in the east of the line, forming low mountains and hills surrounding Jianghan Plain. Only a few mountains are above 1000m while the average height of most mountains is below 800m. The basic landscape is eastern Hubei low mountains and hills. Suburb of Xiangfan city, Xiangyang District, Zaoyang, Yicheng city and five counties (cities, districts) of Laohekou in the north part of the line is located in the southern margin of Nanyang basin in Henan province. Both sides of Han River are covered by hilly lands and downlands with the average altitude below 300m, which belongs to the north Hubei downland. Its north-central part is Dahong Mountain, with hilly areas extending both east and west. The altitude of the main peak of Dahongshan is 1055m,

with the average altitude below 500m, which is central Hubei hilly area. South-central part is a strip of land from west to west, with an average altitude below 200m, which is known as the downland alongside the Yangtze River. The central part is the vast area of Jianghan Plain.

2.1.3 Climate and Meteorology

Hubei is located in the subtropical zone. There're sufficient light, with the average annual sunshine duration ranging from 1,150 hours to 2,245 hours. Total solar radiation in most area of the province is 87~122 kcal/cm. The annual average temperature of the province is 15~17℃, with the extremely high temperature of 38~43℃ and the extremely low temperature of -19~-8℃. The accumulated temperature of average daily temperature above 10℃ is 4800~5700℃. The frost-free season has 230 days to 290 days. There's abundant rainfall with unequally geographical distribution. The average annual rainfall is 800mm to 1400mm and can reach 1800mm to 2200mm at high mountain areas. The rainfall of southwest and southwest area is the most while that of the northwest and north area are the least. There are significant seasonal changes in precipitation distribution, abundant in summer and rare in winter. Rainstorms often occur at the end of spring and summer. Sometimes there're even downpours and extraordinary rainstorms.

2.1.4 Hydrology

Apart from mainstreams Yangtze River and Han River, Hubei province have 4,228 rivers with the length above 5 km and 1,193 small and medium rivers. The total length of all rivers is 59,200 km, with 41 rivers above 100 km. The Yangtze River flows through 26 cities and counties from the west to the east in Hubei province. It starts from the river mouth of Bianyu Creek in Badong County in the west and flows out the province at Huangbin River in the east. The total flow length is 1,041 km. Branches of Yangtze River within its territory include Han River, Ju River, Zhang River, Qing River, Dongjing River, Lu River, She River, Dao River, Ju River, Ba River, Xi River, Fu River etc. Among which Han River is the largest reach of the Yangtze River, flowing from northwest to southeast in Hubei province and crossing 13 cities and counties. It enters Yunxi County of Hubei province from Jiangjun River of Baihe county of Shaanxi Province and flows into the Yangtze River from Wuhan, with the flow path of 858 km. The overall length of Han River is 1,532 km while the drainage area is 62,400 k㎡.

Hubei province is well known as "Province with Hundreds of Lakes". Lakes are mainly distributed in the Jianghan Plain. There're over 800 lakes with the area of more than one hundred acre. The total area of lakes in Hubei province is 2983.5 km^2. Lakes with the area more than 100 km^2 are Hong Lake, Chang Lake, Liangzi Lake and Futou Lake.

2.1.5 Soil Situation

The project area is vast with complex natural conditions. Various types of soil and unique geographical distribution patterns have been formed due to both natural and human factors. Zonal soil of low mountains and hills in southeastern of Hubei province is mainly red soil. The soil texture of red soil is heavy and solid, with poor structure and permeability. Yellow-brown soil locates in zonal soil in the northeast of Hubei province, with medium organic content. The formation condition of yellow-brown soil: subtropical humid monsoon climate and rock weathering of parent material. The northern and southern shores of the Yangtze River are covered by brown-red soil and yellow-brown soil, indicating the transition from mid-subtropical climate to the northern subtropical climate.

Limestone soil mainly concentrates in the mountain area of southern Hubei province. It locates in cracks of karst valleys with good vegetation coverage or undulating valleys and cracks of limestone. Limestone soil is always inlaid with yellow-brown soil and acid brown soil, with loose soil texture and high organic content is high. Purple soil is sporadically distributed in various areas of the project area.

2.1.6 Vegetation and Biodiversity

Hubei province belongs to subtropical evergreen broadleaved forest region, which is the transition zone from the southeastern hills to high hills and plateaus in northwest and southwest of China. The forest vegetation changes from north subtropical evergreen and deciduous mixed forest to the mid-subtropical evergreen broad-leaved forest. Due to specific geological history Hubei Province especially west Hubei mountainous wasn't affected by the quaternary glacier too much. It has not only become the "refuge" of flora during the tertiary period in China, but also the "cradle" of flora in the temperate zone and the subtropical zone in China. The relict species of the tertiary period or more ancient tropical plants have concentrated here. There're abundant unique plants so as to be well known as one of the

endemism distribution centers of spermatophyte in China.

The biodiversity of Hubei Province has the characteristics of rich species, ancient flora, unique and rare and endangered species, complex spatial patterns and concentrated distribution of species.

According to preliminary statistics, Hubei Province has 6359 species of 1581 categories of 296 families of higher plants, accounting for about 18.26% of the national total number. Among which there're 216 species of 114 categories of 51 families of bryophyte (bryophyte species of Shennongjia area as an example). There're 533 species of 112 categories of 45 families of pteridophyte. There're 5650 species of 1355 categories of 200 families of spermatophyte (100 species 31 categories of 9 families of gymnosperm and 5550 species of 1324 categories of 191 families of angiosperm). The floristic composition dominates by tropical, subtropical and temperate flora, with the characteristic of the transition zone of both north and south flora.

50 species of national key protected wild plants natural distribute in Hubei Province, accounting for 18.18% of the total amount of China, with 8 Class I species and 42 class Ⅱ species. For example, the well-known "Living Fossil" *Metasequoia glyptostroboides* was first discovered in Lichuan city, Hubei Province, in the 1940s. In addition, *Taxus wallichiana* var. *chinensis*, *Taiwania cryptomerioides*, *Davidia involucrate*, *Pinus fenzeliana* var. *dabeshanensis*, *Bretschneidera sinensis*, *Tetracentron sinense*, *Cercidiphyllum japonicum* and *Emmenopterys henryi* are also found in Hubei province.

According to recent statistics, Hubei Province has 1008 wild vertebrate species (including subspecies), accounting for about 15.76% of the total amount in China. There're 202 fish species, 68 species of amphibians, 82 species of reptiles, 531 species of birds and 125 species of mammals. Wildlife of Hubei province belongs to the oriental realm, Chindia territories and central China district on the geographical division of China. The composition of the fauna is characterized by: dominated by oriental realm species, accounting for about 70%; fewer palearctic realm species, accounting for about 30%.

There're 131 species of wild animals of national priority protection in Hubei Province, accounts for 33.76% of the nationwide amount. Among them 26 species belong to Class I

while 105 species belong to Class II. Among wild animals of national priority protection, there're 128 species of vertebrates, 25 species of mammals (10 species of Class I and 15 species of Class II), 96 species of birds (13 species of Class I and 83 species of Class II), 3 species of amphibious (both belong to Class II), 4 species of fishes (3 species of Class I, 1 species of Class II) and 3 species of invertebrates, that is insects (all belong to Class II). Famous animals are *Rhinopithecus roxellana*, *Lipotes vexillifer*, *Acipenser sinensis*, *Neophocaena asiaorientalis*, *Panthera pardus*, *Grus monacha*, *Ciconia nigra*, *Syrmaticus ellioti*, etc.

2.1.7 Ecologically Sensitive Areas (Nature Reserve)

At the end of June 2013, 64 nature reserves have been established in Hubei Province, with a total area of 976,851 ha, accounting for 5.25% total provincial land area. Classified by the level of nature reserve, there're 14 national nature reserves, with an area of 370,156.3 ha; 25 provincial nature reserves, with an area of 427,671 ha; 18 municipal nature reserves, with an area of 133,604 ha; 7 county-level nature reserves, with an area of 45,419 ha. According to the types of nature reserves, 27 nature reserves are forest ecosystem types, with an area of 559,036.4 ha; 18 nature reserves are wetland ecosystem types, with an area of 288,039 ha; 7 nature reserves are wild plant types, with an area of 52,389.7 ha; 8 nature reserves are wildlife types, with an area of 64,262.6 ha; 1 nature reserve is wild fauna and flora type, with an area of 11,617.8 ha; 2 nature reserves are paleontology relics types, with an area of 505.3 ha; and 1 nature reserve is geological relics type, with an area of 1,000 ha.

2.2 Social Environment Profile (social-economic structure, education, culture and cultural relic protection)

2.2.1 Administrative Division and Area

There're 12 municipalities, one autonomous prefecture, one forest area, three municipalities directly under the provincial central government, 24 county-level cities, 39 counties, 37 municipal districts, 279 subdistrict offices, 210 township governments, 734 town governments, 26,045 village committee and 208,716 groups of villagers. The land area is 185,900 km^2.

The project involves 11 counties (cities, districts) of six prefectural-level divisions. The total area of demonstration bases of rare forest protection and development is 6,206.45 ha including 3,876.44 ha of new afforestation, 2,330.01 ha of forest tending, 36.7 ha of 11 converted or expanded nurseries.

2.2.2 Population and Population Structure

According to statistics, the current population of Hubei province is 60.7 million, with permanent resident population of 57.11 million and employed population of 35.64 million. Among which: agricultural population is 43.8 million, accounting for 71.16% of the total population non-agricultural population is 16.9 million, accounting for 28.84%; rural population is 40.1679 million while the number of rural households is 10.3836 million; the number of employed people in rural areas is 20.3016 million, including 17.8168 million of rural labor people. The rural family per capita annual net income is 2,352.16 RMB yuan. There're 38 poor counties and 19 million of poverty-stricken people. The average population density is 321 persons/km^2.

The project will help to increase farmers' employment and income within the project area. It's expected to achieve revenue of 1.956 billion RMB yuan, which will benefit 3,474 households with 13,895 famers. The average annual income of forest workers will increase 1,500 RMB yuan.

3 Environment Quality

3.1 The Present Environment Quality and Major Environment Problems within the Project Area (surface water, ambient air, acoustic environment, ecological environment, etc.)

3.1.1 The Present Ambient Air Quality within the Project Area

13 cities of ambient air quality monitoring network of Hubei Province carried out air quality monitoring in 2013. According to Ambient Air Quality Standard (GB 3095-2012), Wuhan failed to meet national Class II standard, with 43.8% days up to the air quality index (AQI). Other 16 key cities are comprehensively evaluated according to the annual average value of Class II of Ambient Air Quality Standard (GB 3085-1996): ten key cities among 16 key cities reached national Class II standard, with the proportion cities up to standard of 62.5%. The average percentage of days of air pollution index (API) of 16 cities reaching the fine standard is 86.2%.

According to Ambient Air Quality Standard (GB 3085-1996) and the annual average value of sulfur dioxide, nitrogen dioxide and inhalable particle of Class II in the modification list, among 16 key cities, the proportion of cities up to the standard is 62.5%. Shennongjia reached Class I standard, accounting for 6.25%; nine cities including Shiyan, Xiangyang, Jingmen, Xiaogan, Xianning, Suizhou, Enshi, Qianjiang and Tianmen reached Class II standard, accounting for 56.25%; six cities including Huangshi, Yichang, Ezhou, Jingzhou, Huanggang and Xiantao exceeds Class II standard, accounting for 37.5%.

In the proposed project areas, Xiangyang city, Xiaogan city, Xianning city and Enshi autonomous prefecture reached Class II standard, with relatively good ambient air quality. Yichang city and Huanggang city are not as good as above cities.

3.1.2 The Present Environment Quantity of Surface Water within the Project Area

In 2013, environmental monitor stations at all levels of water environment monitoring network of Hubei Province conducted monitoring to 154 monitoring sections of 56 major rivers in Hubei province, 16 lakes, 12 reservoirs, eight municipal lakes and six pollutant

collection canals. 87% of the water quality of monitoring sections of major rivers meets the standard of Class I to Class III, with the year-on-year growth of 3.2%. The water quality of 5.2% of all sections is inferior Class V, with the year-on-year decrease of 1.3%. The overall water quality is good. The overall water quality of Han River is excellent. The overall water quality of the mainstream and branches of Yangtze River and branches of the Han River is good. The proportion of main lakes and reservoirs with the water quality that is in line with or better than Class III is 78.1%, with the year-on-year decrease of 3.2%. The water quality of 6.3% of water area is inferior Class V, with no year-on-year change. The overall water quality keeps good.

3.1.3 The Present Acoustic Environment Quality within the Project Area

In 2013, the total number of effective ambient noise monitoring grid of Hubei province is 2,117, covering an area of 762.4 km^2. The average value of equivalent sound level of ambient noise of 16 cities is 53.9 dbs. The average value of equivalent sound level of the 16 cities ranges from 50.6 dbs to 55.9 dbs, with Huanggang the lowest, Enshi the highest. Within the project area, the acoustic environment quality of Enshi, Yichang and Xiangyang is in general, while that of Xiaogan, Huanggang and Xianning is good.

3.1.4 Present Eco-environment Quality within the Project Area

(Due to limited time for data collection of relevant sectors, the eco-environment quality evaluation delays a year compared with other environmental factors), the provincial environment index (EI) is 66.18 in 2012, with good ecological environment. Seen from each area, the ecological environment of Shennongjia is the best, with the index of 82.28, followed by Enshi autonomous prefecture (79.51), Xianning city (79.17), Yichang city (78.36), Shiyan city (75.75), Huangshi city (71.06) and Huanggang city (67.59). The ecological environment of above seven areas is above provincial ecological environment index value. The condition of five ecological environment areas is excellent. Areas with the lowest ecological environment index are respectively Xiaogan city (53.46), Tianmen city (53.58) and Qianjiang city (54.46). The ecological environment condition is general. The ecological environment condition of rest areas is good.

In the proposed project area, the ecological environment quality of Enshi prefecture, Xianning city and Yichang city is excellent, while the ecological environment quality of Xiangyang city and Huanggang city is good. The ecological environment quality of Xiaogan city is general.

The project is located in four physical geographical units including northeastern Hubei (Yingshan county of Huanggang city, Xiaonan district of Xiaogan city and Dawu county), southeastern Hubei (Xian'an district of Xianning city, Chibi city, Tongcheng county, Tongshan county), northwest Hubei (Xiangcheng district of Xiangyang city, Zaoyang city) and southwest Hubei (Badong county of Enshi prefecture, Changyang county of Yichang city).

Northeast of Hubei province is located in hilly land of the southern foot of Tongbai Mountain and low mountains and hilly land of the southern slope of Dabie Mountain, which is the north part of the transition zone from the northern subtropical region to warm temperate zone. The base-band vegetation is evergreen and deciduous broad-leaved mixed forest. The vegetation includes quercus variabilis, quercus acutissima and castanea seguinii that belong to fagaceae, broad-leaved forest such as liquidambar formosana that belongs to hamamelidaceae, coniferous forest such as pinus massoniana and pinus quercus, and coniferous and broad-leaved mixed forest of pinus elliottii and liquidambar formosana. Economic tree species mainly include Chinese chestnut, persimmon, jujube, pear and tea. National key protected wild plants mainly include *Pinus fenzeliana* var. *dabeshanensis*, *Pseudolarix amabilis*, *Torreya fargesii*, *Houpoëa officinalis*, *Liriodendron chinense*, *Cercidiphyllum japonicum*, *Cinnamomum camphora*, *Phoebe zhennan*, *Zelkova serrate*, *Fagopyrum dibotrys*, *Glycine soja*, *Phellodendron chinense*, *Camptotheca acuminate*, *Emmenopterys henryi*, etc. National key protected wildlife mainly include *Panthera pardus*, *Moschus fuscus*, *Manis pentadactyla*, *Cuon alpinus*, *Lutra lutra*, *Viverricula indica*, *Anser albifrons*, *Milvus migrans*, *Accipiter soloensis*, *Buteo buteo*, *Hieraaetus fasciatus*，*Aegypius monachus*，*Circus cyaneus*，*Circus melanoleucos*，*Falco columbarius*, *Falco tinnunculus*, *Syrmaticus reevesii*, *Pucrasia macrolopha*, *Glaucidium cuculoides*, etc.

The forest vegetation of southeast of Hubei province is subtropical forest vegetation,

forming of broad-leaved mixed evergreen and deciduous forest containing fagaceae, lauraceae, aquifoliaceae and hamamelidaceae. Evergreen broad-leaved forest often distributes in low mountains and valleys. Low mountains and hills in the southeast of Hubei Province are the major production area of wood, bamboo and tea. Phyllostachys heterocycla shows sheet distribution in the area. National key wild plants mainly are *Taxus wallichiana var. mairei, Bretschneidera sinensis, Cibotium barometz, Pseudolarix amabilis, Cephalotaxus oliveri, Torreya fargesii var. fargesii, Torreya grandis, Monimopetalum chinense, Houpoëa officinalis, Tetracentron sinense, Cercidiphyllum japonicum, cinnamomum camphora, Phoebe zhennan, Ormosia henryi, Glycine soja, Fagopyrum cymosum, Zelkova serrata, Toona ciliate, Camptotheca acuminate, Eemmenopterys henryi*, etc. National key protected wildlife mainly include *Panthera pardus, Neofelis nebulosa, Aquila chrysaetos, Syrmaticus ellioti, Manis pentadactyla, Cuon alpinus, Lutra lutra, Martes flavigula, Viverricula indica, Hydropotes inermis, Capricornis milneedwardsii, Pernis ptilorhynchus, Milvus migrans, Haliastur indus, Accipiter gentilis, Accipiter soloensis, Accipiter nisus, Accipiter virgatus, Hieraaetus fasciatus, Falco peregrinus, Falco subbuteo, Falco tinnunculus, Lophura nycthemera, Pucrasia macrolopha, Coturnicops exquisitus, Centropus sinensis, Tyto capensis, Otus sunia, Otus bakkamoena, Bubo bubo, Glaucidium brodiei, Glaucidium cuculoides, Asio otus, Pitta brachyuran*, etc.

Northwest Hubei is covered by plains, hills, and middle mountains and subalpine. The terrain gradually descends from southwest to northeast. The south and north ascend highly. The central part is the river basin of upper reaches of the Han River. Wilde plants and animals are abundant in Shennongjia forest area of Qinba Mountain of northwest of Hubei Province and Shiyan city. But the project area (Zaoyang city and Xiangcheng district of Xiangyang city) has relatively fewer fauna and flora resources, but has more orchids and ginkgo biloba distributed. There’re diverse forest vegetation types in the northwest, dominated by deciduous broad-leaved forest forming by fagaceae, betulaceae and juglandaceae. There’s also a small area of subtropical evergreen broad-leaved forest.

Evergreen and deciduous broad-leaved mixed forests formed by quercus, cinnamomum and betula are the main vegetation in the southwest of Hubei province. This region has

abundant species resources, such as the "Living Fossil" *Metasequoia glyptostroboides*, the "Chinese Dove Tree" *Davidia involucrata* and *Taxus wallichiana* var. *chinensis*, *Emmenopterys henryi* and other rare and endangered wild plants. The region also has rare and endangered wildlife such as *Rhinopithecus roxellanae* and *Panthera pardus*, which is the largest and most concentrated area of wild fauna and flora in Hubei province.

3.1.5 Ecologically Sensitive Areas (Nature Reserve)

According to the analysis of afforestation site provided by the project feasibility report, the ecologically sensitive areas involved in the project area (nature reserve) is relatively small. There's no nature reserve in other project sites excluding Huangpao Forest Farm in Tongcheng county, Yaogushan Forest Farm and surrounding afforestation sites, and provincial nature reserve of Yaogushan in Hubei Province, Wujiashan Forest Farm in Yingshan county relating to national nature reserve of Dabie Mountain in Hubei province, afforestation sites of Xiongji town in Zaoyang city that may be involved in the county-level nature reserve of Xiong River System and county-level nature reserve of Orchid Resources in Zaoyang city.

3.2 Major Environment Protection Objectives (list and the protection level)

3.2.1 Environment Quality Objectives

According to emission characteristics and the external environment of the project, below environment quality objectives are confirmed:

1. Ambient air protection: the ambient air quality of construction projects before 2016 should comply with the Class II standards of the Ambient Air Quality Standards (GB 3095-1996). Construction projects after 2016 should carry out the Class II standards of the Ambient Air Quality Standards (GB 3095-2012).

2. Protection of water environment: the surface water of the project follows the Class III water standards of Surface Water Environment Quality Standards (GB 3838-2002); the underground water follows the Class III standards of Underground Water Quality Standards (GB/T 14848-93).

3. Acoustic environment protection: regional environment quality should meet the Class II standards of Acoustic Environment Noise Standards (GB 3096-2008). Ecologically sensitive areas follows the Class I standards.

4. Soil environment protection: forestland soil follows the Class III standards of the Soil Environment Quality Standards (GB 15618-1995). Other soil follows the corresponding provisions.

3.2.2 Environmentally Sensitive Targets

①the protection of land resources and basic farmland: save land resources and reduce the land occupation of subsidiary projects; reclaim land or restore the topsoil for the land after temporary occupation in a timely manner; strictly prohibit project construction in the farmland.

②the protection of ecologically sensitive area: Special and major ecologically sensitive areas need strict protection. Special ecologically sensitive areas include nature reserves, places of world cultural and natural heritage; important ecologically sensitive areas include scenic spots, forest parks, geological parks, important wetlands, primeval forests, natural concentrated distribution areas of rare and endangered species of wild fauna and flora, significant aquatic natural spawning grounds and feeding grounds, over-wintering grounds and migration pathway, natural fishing grounds, etc. Projects in these regions must be carried out in accordance with relevant requirements. Special ecologically sensitive areas (nature reserves) of the project area include national nature reserve of Dabie Mountain, Yaogu Mountain provincial natural reserve, county-level natural reserve of Xiong River system and county-level nature reserve of orchid plant resources in Zaoyang city.

③the protection of biodiversity: strictly protect native vegetation, rare vegetation and special vegetation; focus on protecting national and provincial key protected wild plants and animals and native species, local unique species and ancient and precious trees that has important economic value required in Directory of National Key Protected Wild Animals, Directory of Key Protected Terrestrial Animals of Hubei Province, Directory of Key Protected Aquatic Animals of Hubei Province and Directory of National Key Protected Wild Plants (the 1st batch).

④ecological security: strictly control alien invasive species to ensure the ecological security of the project area, particularly ecologically sensitive areas (nature reserves).

⑤water and soil conservation: strengthen the management of construction activities and

prevent unnecessary destruction of vegetation and soil erosion during the construction period. Ensure that the project implementation will not have large adverse effects on eco-environment in the project area. Try to keep the utilization of waste soil for faming above 90%, the vegetation recovery rate above 85%, the management rate of soil erosion within the construction area above 95% and the erosion control rate of 95%. Make the soil and water loss intensity of the project area lower than that of the native soil and water loss within in the project area, with the control rate of 1:1.2.

⑥acoustic environment: control noise emissions during construction period of the project, making the noise environment within the project area in accordance with the Class II standards of Acoustic Environment Quality Standards (GB 3096-2008).

⑦water and soil environment: strengthen the management of afforestation project and forest tending and appropriately use pesticides and fertilizers to ensure that the project management will not cause pollution to the soil and groundwater within the area and within surrounding areas.

⑧the protection of water resources and water conservation: strictly control the amount of water used for irrigation and prevent the impact on surface water reserve within the project area through scientific irrigation methods.

4 Applicable Assessment Standards

Environmental Quality Standards	1. Atmospheric environment: construction projects before 2016 should meet Class II standards of Ambient Air Quality Standards (GB 3095-1996 amended) while construction projects in and after 2016 should conduct Class II standards of Ambient Air Quality Standards (GB 3095-2012). 2. Water Environment: (1) Class III standards of Environment Quality Standards for Surface Water (GB 3838-2002) (2) Class III standards of Environment Quality Standards for Underground Water (GB/T 14848-93) 3. Acoustic Environment: Class II standards of Acoustic Environment Quality Standards (GB 3096-2008) 4. Soil environment: forestland soil follows the Class III standards of the Soil Environment Quality Standards (GB 15618-1995).
Pollutant Emission Standards	1. Mass concentration standards of periphery fugitive emission source of Air Pollutant Release Standards (GB 16297-1996); 2. Limit value stated in Noise Limits for Construction Site (GB 12523-90).
Method and Standard	1. *Technical Guidelines for Environmental Impact Assessment General Principles* (HJ/T 2.1-2011) 2. *Technical Guidelines for Environmental Impact Assessment Atmospheric Environment* (HJ/T 2.2-2008) 3. *Technical Guidelines for Environmental Impact Assessment Surface Water Environment* (HJ/T 2.3-93) 4. *Technical Guidelines for Environmental Impact Assessment Acoustic Environment* (HJ/T 2.4-2009) 5. *Technical Guidelines for Environmental Impact Assessment Ecological Impact* (HJ 19-2011)

5 Analysis of Construction Project

5.1 Construction Environment Feasibility Analysis

5.1.1 Analysis of Policy and Plan Compliance

According to Guide Directory of Industry Structure Adjustment (2011), this project belongs to national encouraging project. The project construction is in line with basic principles of forestry development stated in Decision on Accelerating Forestry Development issued by the State Council. It meets construction requirements of forestry development encouraged in Key Points of Forestry Industry Policy (2007 and requirements of making forestry as the leading industry in the policy. It also keeps consistent with the requirement of “focusing on establishing high quality and efficient timber production bases so as to relieve the current contradiction between supply and demand of wood and reserve precious local rare tree species and large diameter timber forest for the future” stated in Construction Plan for National Timber Strategic Reserve Production Bases (2013-2020) issued by the State Forestry Bureau.

The project keeps consistent with the content of "Green Jingchu" plan of Hubei province and national model construction of rare tree species cultivation, winning great support and attention from national, provincial and municipal governments. The project objective is to increase total forest resources and construct rare forests. It mainly reflects in focusing on the construction of "Five Expectations for Hubei Province" and the strategic deployment of "Building the Pivot and Being the Pioneer", accelerating rare forest base construction and forest tending in Hubei Province in accordance with the general requirements of "Competition Improves Quality While Upgrading Increases Efficiency", further promoting "Green Jingchu" plan, and fully improving sustainable management of rare forest. Selecting suitable land for afforestation and developing forest tending, rare timber forest and economic forest fully indicate eco-priority principle, support the development ideas of forestry of Hubei Province, and act a positive role in promoting the construction of national strategic reserve timber production base.

5.1.2 Analysis of Afforestation Land

In accordance with (No. 257 Decree, the State Council) the 17th provision of the Regulations on the Protection of Basic Farmland: "any unit and individual is prohibited to occupy basic farmland to develop horticulture or dig ponds for fishing." According to the feasibility study of the project, land types for forest include: barren hills and wasteland suitable for forest, old cutting blanks and low-quality and low-efficient plantations, forest land returning from farmland, degraded plantations with bare land and invasive weed species, shrub land and open forest land. Project implementation sites should be located in areas outside of basic farmland conservation area and should be in line with the requirements of this law with promise of no occupation of basic farmland.

In addition, the project will follow the environmental protection requirements of the European Investment Bank and strictly prohibit large area of afforestation in the core area and buffer area of special ecologically sensitive areas such as nature reserve, especially the introduction of exotic species.

5.1.3 Analysis of the Selection of Tree Species

To enhance the protection of biodiversity and prevent ecological invasion, the project should prioritize native tree species, superior provenance of native tree species, and pedigree or clonal afforestation so as to strengthen the ability of the forest to resist pests and diseases and reduce the risk from the threat of pests and. Only when the growth and resistance of exotic tree species are better native species, can exotic species be selected. According to above principles, 16 tree species selected for afforestation are *Liquidambar formosana*, *Osmanthus fragrans*, *Zelkova serrata*, *Toxicodendron vernicifluum*, *Cunninghamia lanceolata*, *Ginkgo biloba*, *Choerospondias axillaris*, *Liriodendron chinense*, *Cinnamomum camphora*, *Koelreuteria paniculata*, *Camellia oleiferam*, *Torreya grandis*, *Taxus wallichiana* var. *chinensis*(*Taxus mairei*), *Phyllostachys heterocycla*, *Pinus elliottii* and *Houpoëa officinalis* (*Mangnolia officinalis*). Above 16 species are native tree species except for *Pinus elliottii* (exotic species). Two species—*Ginkgo biloba* and *Taxus wallichiana* var. *chinensis* are national Class I protected plants. Five species—*Zelkova serrata*, *Liriodendron chinense*, *Cinnamomum camphora*, *Torreya grandis* and *Houpoëa officinalis* are national Class II protected plants.

5.1.4 Analysis of Land Preparation Method

The land preparation method should focus on environmental protection, mainly include:

1) Land preparation should decided by the gradient of the slope so as to choose the right mode—hole cultivation, band cultivation or full cultivation. Groundbreaking dimension should be within 20% to 25%. The relationship between modes of land preparation and plantation slopes should be: when the plantation slope is more than 26°, hole cultivation land preparation arranging in the structure of character "品"character, set catchwater alongside the contour line shall be applied; when the plantation slope is between 16° and 25°, hole cultivation, band cultivation alongside the contour line or cascade land preparation shall be applied; when the plantation slope is less than <15°, full cultivation shall be applied.

2) There should be a 10-meter-wide vegetation protection strip between parcel edge of the plantation and the farmland, and a 3-meter-wide sward protection strip every 100 meters on long slopes which applies full cultivation for land preparation.

3) To construct economic forest on slopes above 15°, cascade cultivation (anti-corner terrace) should be applied so that the surface runoff water can be transferred to the stable ground or into streams that can receive extra water.

5.2 Analysis of Pollution Source during the Construction Period

According to the type and characteristics of the project, project construction plan and construction methods and features, the construction activities involved in the project mainly include land preparation, mechanical trenching, seedling transport, planting and irrigation. Their impact on the environment mainly concentrates in the construction period. The construction dust, noise, solid wastes and wastewater will have certain impact on the environment.

5.1.1 Air Pollution

During the construction period, the air pollution within the proposed project area is mainly caused by dust, construction materials transport and fuel.

Large amount of earth-rock excavation and filling that damages the land surface and results in loose soil and the transport, loading and unloading of seedlings both provide a fertile source for dust. During dry weather, it's easy to generate dust when there's wind, which

will cause dust pollution to atmospheric environment and residents around.

In the construction of project, it's important to arrange construction period appropriately, especially mechanical site preparation time. Avoid windy conditions in order to reduce the impact of construction dust on the surrounding environment.

The fuel used by transportation tools (fuel consumption motor vehicles) is diesel. Emissions come mainly from construction machinery exhaust emissions and vehicle emissions. Major pollutants include soot particulates, NO_X, SO_2, etc.

5.1.2 Noise

Noise during the construction period mainly comes from construction machinery and traffic noise of transport vehicles. The noise caused by brush cutters, excavators and other construction equipment has the characteristics of great sound level, strong sound source and continuity while the traffic noise has wide range of sound source and strong liquidity. The project area is sparsely populated with no noise-sensitive targets. Construction machinery noise primarily affects construction workers. Measures should be taken to protect the workers in order to reduce the harm on them.

5.1.3 Solid Wastes

Basically there's no solid waste in the construction of this project. Earthwork produced by temporary pavement and excavation is only piled up provisionally and will be refilled into forest ditches and filled to roadbed. Project construction staffs are mainly local labor, therefore the construction process basically does not produce household garbage.

5.1.4 Waste Water

No wastewater will be produced during the construction period. Water used for production is mainly water used for irrigation. And there is no living quarters hence no sanitary wastewater will be generated.

5.1.5 Ecological Impact

During the construction period, land preparation, mechanical trenching, pavement opening and other projects need to carry out activities such as excavation of the land surface. Such activities will take up land as well as damage vegetation and landscape. Damages of

vegetation and disturbance to the stability of the land surface will make the soil loose. Meanwhile the project will produce a certain amount of temporary soil residue during the construction period. In high winds and rainfall season, a certain degree of water and soil erosion will be generated without protective measures.

5.2 Analysis of Pollution Source during the Operation and Decommissioning Period

5.2.1 Analysis of the Impact of Pesticide and Fertilizer

During the management and maintenance period of the plantation, the application of chemical fertilizer and pesticide will have an impact on the environment.

First of all, various forms of nitrogen fertilizer entering into the soil will form nitrate and nitrite. The soil will be in hard structure with excessive accumulation of nitrate and nitrite due to Long-term and frequent use of fertilizers, which will deteriorate soil chemical and physical properties. Phosphate fertilizer contains a certain amount of heavy metal pollutants. Long-term use will increase the content of heavy metal in the soil.

Second, the process of applying pesticides will case soil environment pollution. Improper use of pesticides will contaminate other farm and sideline products.

In addition, residues of fertilizer and pesticide may be flow into surface water through irrigation and water and soil loss, which will increase the concentration of pollutants such as total nitrogen, ammonia nitrogen, total phosphorus and nitrates, causing a certain amount of water pollution.

According to the project feasibility study report and stringent requirements of environment protection European Investment Bank Loan project, the projects uses safe and low toxicity pesticides, recommend bio-pesticides (BT) and chemical pesticides that are in line with WHO and national safety standards. Please refer to table 5-1 for details.

Table 5-1 List of Pesticide Used in the Project of Hubei Province

Tree Species	Diseases & Insect Pests	Control Measures	biological pesticide	Recommend Chemical Pesticide	Pesticide Classification（WHO）	EC number	National/ Industrial Standard of China

Tree Species	Diseases & Insect Pests	Control Measures	biological pesticide	Recommend Chemical Pesticide	Pesticide Classification（WHO）	EC number	National/ Industrial Standard of China
Liquidambar formosana	black spot	1. Forest culture and management measures: select good strong seedling and enhance tending management, keep ventilated and translucent within the forest. 2. Chemical control: spray 70% mancozeb, the spray concentration should be 1:1000.		mancozeb	III	Plant protection product	GB 20700-2006
	dictyploca japonica, eriogyna pyretoyum	1. Forest culture and management measures: match species with the right site and expand afforestation scale. 2. Biological control: spray Bt wettable powder, the spray concentration should be 1:1000 to 1:1600.	BT		III	microorganism	HG 3617-1999
Osmanthus fragrans	brown patch, leaf blight	1. Forest culture and management measures: strengthen water and fertilizer management, increase the use of humus fertilizer, and enhance plant premunition. 2. Chemical control: spray 70% mancozeb wettable powder, the spray concentration should be 1:500.		mancozeb	III	Plant protection product	GB 20700-2006
	scale insect, whitefly	1. Chemical control: spray 30% acetamiprid emulsifiable concentrates, the spray concentration should be 1:2000.		acetamiprid	III	Plant protection product	HG 3755-2004
Zelkova serrata	inchworm, tussock moth	1. Forest culture and management measures: strengthen tending management and clear away the weeds. 2. Chemical control: spray 1% abamectin, the spray concentration should be 1:1000.		abamectin	III	265-610-3	GB 19337-2003
Toxicodendron vernicifluum	gall acaridiasis	1. Forest culture and management measures: strengthen tending		abamectin	III	265-610-3	GB 19337-2003

Tree Species	Diseases & Insect Pests	Control Measures	biological pesticide	Recommend Chemical Pesticide	Pesticide Classification（WHO）	EC number	National/ Industrial Standard of China
		management and clear away the weeds. 2. Chemical control: spray 1% abamectin, the spray concentration should be 1:1000.					
	locastra muscosalis	1. Forest culture and management measures: strengthen tending management and clear away the weeds. 2. Chemical control: spray 9% crystal, the spray concentration should be 1:1000 to 1:1500.		trichlorfon	III	200-149-3	GB 334-2001
Cunninghamia lanceolata	spruce budworm	1. Forest culture and management measures: strengthen tending management and clear away the weeds. 2. Chemical control: spray 9% crystal, the spray concentration should be 1:1000 to 1:1500.		trichlorfon	III	200-149-3	GB 334-2001
Ginkgo biloba	leaf blight	1. Forest culture and management measures: strengthen tending management and clear away the weeds. 2. Chemical control: spray 50% carbendazim wettable powder, the spray concentration should be 1:1000.		carbendazim	III	234-232-0	HG 3290-2000
	eriogyna pyretoyum, dictyploca japonica	Biological control: spray 16000 IU/mg Bt wettable powder during the larval phase, the spray concentration should be 1:1000 to 1:1600.	BT		III	microorganism	HG 3617-1999
Choerospondias axillaris	armyworm	Chemical control: spray 90% trichlorfon crystal, the spray concentration should be 1:1000 to 1:1500.		trichlorfon	III	200-149-3	GB 334-2001
Liriodendron chinese	anthracnose	1. Forest culture and management measures: strengthen tending management, clear away the weeds and keep ventilated and translucent within the		mancozeb	III	Plant protection product	GB 20700-2006

Tree Species	Diseases & Insect Pests	Control Measures	biological pesticide	Recommend Chemical Pesticide	Pesticide Classification（WHO）	EC number	National/ Industrial Standard of China
		forest. 2. Chemical control: spray 70% mancozeb, the spray concentration should be 1:500.					
	leaf roller	Chemical control: spray 90% trichlorfon crystal, the spray concentration should be 1:1000 to 1:1500.		trichlorfon	III	200-149-3	GB 334-2001
Cinnamomum camphora	mesoneura rufonota	Chemical control: spray 90% trichlorfon crystal, the spray concentration should be 1:1000 to 1:1500.		trichlorfon	III	200-149-3	GB 334-2001
Koelreuteria paniculata	bleeding disease	Chemical control: spray 50% carbendazim, the spray concentration should be 1:1000.		carbendazim	III	234-232-0	HG 3290-2000
	aphid	Chemical control: spray 20% imidacloprid during the very beginning of aphid hatch time, the spray concentration should be 1:2500.		imidacloprid	III	105827-78-9	GB 28143-2011
Camellia oleifera	anthracnose, sooty mould	Chemical control: spray 50% carbendazim during the fruit disease peak season, the spray concentration should be 1:1000.		carbendazim	III	10605-21-7	HG 3290-2000
	camellia oleifera tussock moth, biston marginata, camellia oleifera curculio	Biological control: spray 16000 IU/mg Bt wettable powder during the larval phase, the spray concentration should be 1:1000 to 1:1600.	BT		III	microorganism	HG 3617-1999
Torreya grandis	leaf roller	Biological control: spray 16000 IU/mg Bt wettable powder during the larval phase, the spray concentration should be 1:1000 to 1:1600.	BT		III	microorganism	HG 3617-1999
Taxus mairei	aphid	Chemical control: spray 20% imidacloprid during the very beginning of aphid hatch time, the spray concentration should be 1:2500.		imidacloprid	III	428-004-8	GB 28126-2011

Tree Species	Diseases & Insect Pests	Control Measures	biological pesticide	Recommend Chemical Pesticide	Pesticide Classification（WHO）	EC number	National/ Industrial Standard of China
Phyllostachys heterocycla	phyllostachys heterocycla die-back	Chemical control: spray 50% carbendazim during sprouting period of Phyllostachys heterocycla, the spray concentration should be 1:1000.		carbendazim	III	234-232-0	HG 3290-2000
	bamboo locust	1. Forest culture and management measures: strengthen tending management, clear away the weeds and keep ventilated and translucent in the forest. 2. Chemical control: spray 7.5-15g/HA of 5% imidacloprid emulsifiable concentrates during the locust season; when the locust appears on the bamboo, spray 350ml/HA of 1% abamectin oil formulation mixed with diesel, the mixture rate should be 1:15.		imidacloprid	III	428-004-8	GB 28126-2011
				abamectin	III	265-610-3	GB 19337-2003
Pinus elliottii	die-back, needle cast of conifers	1. Forest culture and management measures: select good strong seedling and enhance tending management. 2. Chemical control: spray 70% mancozeb, the spray concentration should be 1:500.		mancozeb	III	Plant protection product	GB 20700-2006
	pine moth	1. Biological control: evenly spray 1600 IU/mg wettable powder, the spray concentration should be 1:1600 to 1:2400.	BT		III	68038-71-1	HG 3617-1999
Magnolia officinalis	leaf blight	1. Forest culture and management measures: strengthen tending management and clear away the weeds and diseased branches. 2. Chemical control: spray 50% carbendazim wettable powder, the spray concentration should be 1:1000.		carbendazim	III	234-232-0	HG 3290-2000

Tree Species	Diseases & Insect Pests	Control Measures	biological pesticide	Recommend Chemical Pesticide	Pesticide Classification（WHO）	EC number	National/ Industrial Standard of China
	parasa consocia and setora postornata	1. Biological control: evenly spray 1600 IU/mg wettable powder, the spray concentration should be 1:1600 to 1:2400.	BT		Ⅲ	microorganism	HG 3617-1999

The utilization of fertilizer and pesticide. Please refer to table 5-2 for the amount of organic manure/fertilizers, herbicides (pesticide), commercial names, total amount and the amount per HA of this project. By calculation, the total amounts of organic manure/fertilizers and herbicides (pesticide) are respectively 43,949kg and 360kg in construction period, while the total amounts of organic manure/fertilizers and herbicides (pesticide) are respectively 30,500kg and 220.2kg in the management period.

Table 5-2 Table of Fertilizer and Pesticide Needed per HA

Model	Forest spieces	Tree Species	Calculation Year	Fixed amount per HA							
				Fertilization (kg)				Pesticide (kg)			
				Spieces	SUM	Construction period	Operation period	Spieces	SUM	Construction period	Operation period
Afforestation Model 1	Timber forest	*Liquidambar formosana*	1	Organic fertilizer	1667	1667		mancozeb	11	22.5	
			2-3	Compound fertilizer	1667	1667		BT	11.5		
Afforestation Model 2	Economic forest	*Osmanthus fragrans*	1	Organic fertilizer	1667	1667		mancozeb	29	22.5	36.7
			1-25	Compound fertilizer	5667	1667	4000	acetamiprid	30.2		
Afforestation Model 3	Timber forest	*red beech*	1	Organic fertilizer	1667	1667		abamectin	22.5	22.5	
			2-3	Compound fertilizer	1667	1667					
Afforestation Model 4	Economic forest	*Toxicodendron vernicifluum*	1	Organic fertilizer	1111	1111		abamectin	29	22.5	36.7
			1-25	Compound fertilizer	4111	1111	3000	trichlorfon	30.2		
Afforestation Model 5	Timber forest	*Cunninghamia lanceolata*	1	Organic fertilizer	1667	1667		trichlorfon	22.5	22.5	
			2-3	Compound fertilizer	1667	1667					
Afforestation Model 6	Economic forest	*Ginkgo biloba*	1	Organic fertilizer	833	833		carbendazim	29	22.5	36.7
			1-25	Compound fertilizer	11833	833	11000	BT	30.2		
Afforestation	Timber	*Choerospon*	1	Organic	1667	1667		trichlorfon	22.5	22.5	

Model	Forest spieces	Tree Species	Calculation Year	Fixed amount per HA							
				Fertilization (kg)				Pesticide (kg)			
				Spieces	SUM	Construction period	Operation period	Spieces	SUM	Construction period	Operation period
Model 7	forest	*dias axillaris*		fertilizer							
			2-3	Compound fertilizer	1667	1667					
Afforestation Model 8	Timber forest	*liriodendron chinese*	1	Organic fertilizer	833	833		mancozeb	11	22.5	
			2-3	Compound fertilizer	833	833		trichlorfon	11.5		
Afforestation Model 9	Timber forest	*Cinnamomum camphora*	1	Organic fertilizer	1667	1667		trichlorfon	22.5	22.5	
			2-3	Compound fertilizer	1667	1667					
Afforestation Model 10	Timber forest	*koelreuteria paniculata*	1	Organic fertilizer	1111	1111		carbendazim	11	22.5	
			2-3	Compound fertilizer	1111	1111		imidacloprid	11.5		
Afforestation Model 11	Economic forest	*Camellia oleifera*	1	Organic fertilizer	1667	1667		carbendazim	29	22.5	36.7
			1-25	Compound fertilizer	5667	1667	4000	BT	30.5		
Afforestation Model 12	Economic forest	*Torreya grandis*	1	Organic fertilizer	1667	1667		BT	59.2	22.5	36.7
			1-25	Compound fertilizer	3166	166	3000				
Afforestation Model 13	Timber forest	*Taxus mairei*	1	Organic fertilizer	1667	1667		imidacloprid	22.5	22.5	
			2-3	Compound fertilizer	1667	1667					
Afforestation Model 14	Timber forest	*Phyllostachys heterocycla*	1	Organic fertilizer	500	500		carbendazim	11	22.5	
			1-25	Compound fertilizer	3000	500	2500	imidacloprid	11.5		
Afforestation Model 15	Timber forest	*Pinus elliottii*	3	Organic fertilizer	1667	1667		mancozeb	11	22.5	
				Compound fertilizer	1667	1667		BT	11.5		
Afforestation Model 16	Economic forest	*magnolia officinalis*	1	Organic fertilizer	1667	1667		carbendazim	29	22.5	36.7
			1-25	Compound fertilizer	4167	1667	2500	BT	30.5		
Tending model 17	Timber forest	*Phyllostachys heterocycla*	1	Compound fertilizer	500		500				

5.2.2 Analysis of Ecological Impact

After the implementation of this project, replacing the natural plant communities with artificial plant community will change the types and structure of plant species in the project

area, which will have some adverse impact on the sustainability of regional communities. Newly planted trees and the original plant species reserved in the original soil grow together, forming artificial plant communities.

Tree species selected for the project are generally suitable for the local conditions and have some planting history. Therefore changes of the vegetation are only partial adjustment and will not have a significant impact on regional vegetation types after the project is completed. Afforestation on barren land is conducive to improve the ecology so as to generate ecological environment benefit.

5.2.3 Analysis of Irrigation Impact

As for the forestry development in the operation period, if the project goes against the status quo of water resource utilization and plan and fails to balance water resources, excessive utilization of surface water will not only result in water reduction in the lower reaches of the region, but also affect the growth of natural vegetation and ecosystem within the watershed. Irrational irrigation and irrigation system will also affect the evaluation of reserves of water resources in the region and worsen the current degree of soil salinization, which will have the potential to cause soil salinization in the region. Therefore, it's important to rationally allocate and use water resources and avoid wasting of water resources under the condition of satisfying the irrigation demand of the project area.

5.2.4 Analysis of Decommissioning Impact

There will be little impact of decommissioning on the environment under strict implementation of the plan that is in line with the feasibility study of the project.

6 Production and Expected Emission of Major Pollutants

Content / Type	Emission source	Pollutant name	Concentration and amount before treatment (per unit)	Emission concentration and amount (per unit)
Air pollutants	Construction dust, fuel exhaust gas	TSP, soot particulates, NO_X, SO_2	Fugitive emission	Fugitive emission
Water pollutant	-	-	-	-
Solid waste	Land preparation	General waste slag	-	Small and temporary stack
Noise	Bulldozer, excavator, transport vehicle	Leq (A)	-	70~80dB (A)
Other	No			

Main Ecological Impacts:

During the construction period, land preparation, mechanical trenching, pavement opening and other projects need to carry out activities such as excavation of the land surface. Such activities will take up land as well as damage vegetation and landscape. Damages of vegetation and disturbance to the stability of the land surface will make the soil loose and cause water and soil erosion. Meanwhile the infrastructure such as road construction will produce a certain amount of temporary soil residue, which will affect the wild animal resources.

After the implementation of this project, replacing the natural plant communities with artificial plant community will change the types and structure of plant species in the project area. Tree species selected for the project are generally suitable for the local conditions and have some planting history. Therefore changes of the vegetation are only partial adjustment and will not have a significant impact on regional vegetation types after the project is completed.

The project will be conducive to improve the ecological environment, resulting in series of environmental benefit.

7 Analysis of Environmental Impact

7.1 Brief Analysis of Environmental Impact during the Construction Period

The negative impact on the environment of afforestation project is mainly due to the unreasonable use of inputs and illegal management activities during the project implementation process. New afforestation projects often have large initial effect on the environment, mainly including adverse impact caused by inappropriate land clearance, land preparation, planting and tending as well as excessive application of pesticides and fertilizers.

7.1.1 Analysis of Ecological Environmental Impact

Activities during the construction period will take up land as well as damage vegetation and landscape, such as temporary land occupation of construction pavements and construction areas. New afforestation will be carried out on the same spot after the construction is

completed. Forest land selected should be land with few vegetation such as barren hills and unreclaimed lands, beaches, slope farmland, burned areas, cutover land, near levees and canals. Judging from the plant species, plants being damaged or affected in construction sites are mostly dispersed species and common species, which are evenly distributed. There's no national key protected plant in the project area. There will be strict management system and plans during the construction period so as to minimize damages to the natural vegetation.

Land clearance and preparation during the construction period shall not damage the original vegetation on the land surface. It's necessary to carry out intermediate or block weeding to the afforestation plots before land preparation. Land preparation method should be hole-pattern preparation except for poplar which will use root-cutting afforestation. The construction scope should be strictly. Avoid massive land preparation. Develop a new block when the former block is finished. Retain a certain area of original vegetation so as to avoid large area of bare land and serious soil erosion due to late response to the damage to the natural vegetation and soil surface after land reclamation.

Noise in the construction period may affect the habitat of wild animals in the region. The effect is short and will disappear with the end of the construction. In addition, activities such as land-clearance will disturb the original habitat place of wild animals, forcing the outward migration of some wild animals. Population density of small animals around the base perimeter will increase, especially rodents, during and after the project is completed, which will bring adverse impacts on surrounding agricultural production.

The construction will not change the number of wildlife species within the assessment area but will change the uneven distribution of wildlife species and number in the region. Therefore, there will be no significant adverse impact on wildlife during construction period as long as the management of construction workers get strengthened and wildlife hunting get controlled.

To sum up, the project area is mainly native environment with scarce population, the duration of eco-environmental impact due to the construction is short and small and will disappear with the end of the construction.

7.1.2 Analysis of Atmospheric Environmental Impact

Air pollution during the construction period is mainly caused by mechanical dust generated in the process of land preparation and diesel combustion of transport machinery. Transport vehicles will also generate dust, especially when using pavement transport.

Dust in the project area is mainly derived from weathering soil of the surface land and sabotage of the stability of the earth surface. The project area is easy to generate dust in windy conditions due to low vegetation coverage and serious soil degradation. Land preparation, construction of supporting facilities during the afforestation process and massive excavation will also damage surface stability and produce dust.

The amount of dust emission depends on the size of the construction, dust particle size, soil type, vegetation coverage and ambient wind velocity. Vegetation coverage and wind velocity are two major factors which determines the effect of dust on air quality. The more vegetation coverage in the project area, the less dust will there be. When prepare the environmental management plan for the construction period, it's prohibited to carry out construction in windy weather as the amount of dust will be increased as the wind speed increases.

7.1.3 Analysis of Water Environmental Impact

And there is no living quarters hence no sanitary wastewater will be generated under reasonable arrangements for the construction and strengthened collection and treatment of pollutants during the construction period. Therefore, the project construction has little influence on the water environment.

7.1.4 Acoustic Environmental Impact analysis

Acoustic environment impact of this project mainly appears in the construction, period. The noise sources are mechanical noise and noise of construction vehicles. The project has characteristics of short turnaround time, no night operation and free of sensitive targets within the project area. Construction machinery noise primarily affects construction workers. Measures should be taken to protect the workers in order to reduce the harm on them. The noise impact is temporary and will disappear with the end of the construction.

7.1.5 Solid Waste Environmental Impact Analysis

Solid waste of this project mainly comes from waste soil due to pavement construction and other construction. Construction waste soil is temporary and will be refilled into forest ditches and filled to roadbed. Project construction staff is mainly local labor, therefore the construction process basically does not produce household garbage. Strict construction management measures will be carried out during the construction period, prohibit litter solid waste and maximize the recycling of waste. Waste that cannot be collected in uniform should be shipped to designated place for disposal required by the environmental protection department. Thus, construction solid waste will have small impact on the environment.

7.1.6 Analysis of Soil Environmental Impact

The construction has wide range of impact on the soil. As the construction scale is large, activities such as earthwork excavation, machinery work, temporary setting of supporting projects and dust generated will also have certain negative impacts on soil environment within the project area. Main influences include: topsoil clearance will fundamentally change the type and nature of the surface layer; borrowing and abandon of earthwork will fundamentally change the type and nature of the soil and change the soil compaction and permeability so as to affect physical properties of the soil. The common characteristic of these impacts is no change to the soil type. After the construction is completed, the earth surface will be restored and protected while the soil function will also be gradually restored. Special attention should be paid to the protection of the surrounding environment during the construction period. Clean up all waste after the construction period.

In addition, most fertilizers used during the plantation construction period (1 year) are organic fertilizers. Chemical fertilizers (compound fertilizer) only account for a small part, which will have no obvious adverse impact on the soil. Thus, fertilizers application will have small impact on the soil environment.

7.1.7 Impact of Water and Soil Loss

Forest road construction, woodland clearance, land preparation and harvesting are major factors that may cause environmental impact during the construction period. Impacts mainly contain destabilizing the original surface and water and soil loss caused by loose surface of backfilled parts. These backfilled parts are affected by exogenic force such as rain and wind

so as to lead to water and soil loss. During the construction of forest roads, the original vegetation is damaged, forming a bare pavement and side slope, which causes water and soil loss, increases the turbidity of the water and pollute water. After illustrating the situation of water and soil loss by comparing the comprehensive land preparation and existing targets, the prediction model applies the US Universal Soil Loss Equation (USLE). The predictive equation is:

A=R•K•LS•C•P

Where: A—erosion intensity, namely erosion amount per unit time (a) per unit area (HA),

R—erosion factor,

K—edaphic factor,

LS—topographic factor,

C—biotic factor,

P—conservation of water and soil factor.

During the project implementation process, if the amount of erosion area caused by full land preparation is 2.465 million tons/year, the amount of water and soil erosion will be 0.744 million tons/year by improving land preparation methods, that is making use of artificial level bench or digging holes. Then it can help to reduce 1.721 million tons of soil and water erosion the same year. At the same time, strengthen the education of soil and water conservation for construction personnel in the construction period, strictly allocate construction scope. Activities of construction machinery and construction personnel should be within the range defined. Then water and soil erosion caused by human factors during the construction process will get greatly controlled.

To sum up, the major impacts of water and soil erosion due to project construction are the disturbance of the earth surface and the damage to vegetation. Therefore, necessary land leveling and timely afforestation at the end of the construction will minimize water and soil erosion during the construction period.

7.2 Analysis of Environmental Impact during the Operation and

Decommissioning Period

7.2.1 Analysis of Ecological Environmental Impact

(1) Analysis of Impact on Wild Plants

The level of biomass or productivity of the ecosystem represents the level and integrity of the ecosystem. Afforestation projects will greatly increase the local biomass and facilitate regional integrity standard. But the damage to the original vegetation will affect the diversity and stability of the vegetation within the region since the original vegetation already has adapted to their environment for a long time and naturally distributed in the project area with more stable form of communities. So enclosure protection must be carried out for surrounding vegetation to ensure the diversity and stability of the vegetation in the region. There should also retain a certain amount of the original vegetation within the project area. The recommended area is 10% of the development area. Newly planted trees and the original plant species reserved in the original soil grow together, forming artificial plant communities. Trees in such plant communities will become the dominant species, taking up more space, more resources and having higher productivity. When there is no major change or human disturbance to the environment, the number of species in the community won't have big change but will remain relatively stable, which will be conducive to the stability and sustainability of communities. If balance of water and soil and soil improvement can be ensured, then there will be no big changes to natural vegetation and forest succession.

(2) Analysis of Impact on Wild Animals

During the construction period, the original natural vegetation in the project area will become plantations, which will reduce the original habitat and activity scope of the wild plants, forcing outward migration of some wild animals. Population density of small animals around the base perimeter will increase, especially rodents, during and after the project is completed, which will bring adverse impacts on surrounding agricultural production. Meanwhile natural enemies of mouse such as weasels and eagles will also increase accordingly.

After the project is completed, the overall vegetation coverage of the project area will be improved through 2-4 years of growth and natural recovery so as to create favorable

conditions for the habitat and survival of wild animals.

(3) Analysis Biodiversity

Through qualitative analysis of the project, during early 1-2 years of the operation period, populations of vegetation, the number of animal species and biomass in the project area will change after the completion of the project. Artificial plant communities will replace natural plant communities, leading to single plant species, reduced biomass and unstable ecosystem compared with the situation before construction. But after 2-3 years of natural restoration and human tending, the vegetation coverage will be improved due to the formation and development of artificial vegetation in the project area. The structure of plant community will experience complex succession which will again create favorable conditions for the habitat and survival of wild animals.

Creating artificial broad-leaved forest will significantly improve forest structure and increase biodiversity. Calculate biodiversity index by investigate waste hills and unreclaimed lands and sample plot of targeted forest. Shannon-wiener index is applied to the index. The formula is:

$H' = \Sigma PilnPi,\ Pi = Ni/N$

The average biodiversity index of waste hills and unreclaimed lands is 1.67 while the biodiversity index of targeted forest is 2.18, with biodiversity significantly increased. It can be concluded that the construction will have limited impact oon biodiversity when there's no significant climate change or obvious human activities. There will be a certain degree of positive effect to the region after the completion of the project.

(4) Analysis of Ecological Risk

As stated above, 16 species used for afforestation for this project are native tree species except for pinus elliottii (exotic species). Two species—ginkgo biloba and wallichiana var. Chinensi are national Class I protected plants. Five speices—zelkova serrata, liriodendron chinense, cinnamomum camphora, torreya grandis and mangnolia officinalis (houpoëa officinalis) are national Class II protected plants. Planting native trees won't bring ecological invasion. Exotic species of pinus elliottii is also known as "pinus cubeasis", originating in southeast coastal area of lowland wet zones with the height of 600m of North America, Cuba

and Central America where the weather is hot and rainy in summer and dry in spring and autumn. The "pinus cubeasis" prefers to moist soils of 150-500m above sea level and grows well in subtropical climate area. It has strong adaptability to temperature and can endure the absolute temperature of 40℃ and the absolute low temperature -20℃. It also grows well in hilly land of with neutral or strong acid red earth and iron nodule layer and sandy clay 50-60cm under the topsoil. It grows particularly well in the edge of low-lying swampland, which is the origination of its name. It's also drought-tolerant and can flourish in dry and barren hilly land. It rarely gets injured under the 11-12 grade typhoon attacks. Its root system is resistant to sea water for irrigation. But its needles cannot be infected by salt. Pinus elliottii is photophilous and an intolerant tree species, but not shade-tolerant. Plains in the south of 32 degrees north latitude and the apricus low mountain can be cultivated. Pinus elliottii is tall and well-shaped, which is appropriate to plant on mountain slopes, both sides of streams. It can be planted as a block or in the garden or singly in the grassland, or in a group as shade trees and background trees. It's a fast growing evergreen tree and widely introduced in the Yangtze River basin and the southern provinces of China. There is more than 60 years of introduction and history with no ecological hazard.

7.2.2 Analysis of Atmospheric Environmental Impact

(1) Quantitative Calculation of Carbon Reserve

According to the requirement of *Guide for Carbon Sink Measurement Minitoring of Afforestation Project* prepared by State Forestry Bureau in 2011, the aboveground and belowground biomass carbon pool is the carbon pool that must be selected. According to the principle of conservatism and cost effectiveness, the carbon pool of dead wood, litter, soil organic carbon and wood products can be ignored.

According to the requirement of Technical Guide for National Forestry Carbon Sink Measurement Minitoring (trial) prepared by State Forestry Bureau in 2011, the carbon reserve should be calculated through the standing timber stock, the relation between by standing timber stock, different dominant tree species (groups) relationship between the biomass and the stock volume of major tree species (groups) as well carbon content of different tree species.

The relational model between biomass and stock volume of different dominant tree

species (groups) is:

$Mi = aXi + b$.

Note: Mi refers to the biomass of the i type tree species (groups) per unit area; Xi refers to the stock volume of the i type tree species (groups) per unit area; a and b are parameters, the parameters of regression equations of biomass and stock volume of major tree species.

Carbon reserve calculation formula:

$Ci = \sum (Mi \times Ai \times CFi)$

$C = \sum Ci$

Note: C refers to the total carbon reserve, Ci refers to the carbon reserve of the i type tree species (groups), Mi refers to the biomass of the i type tree species (groups) per unit area, Ai refers to the area of the i type tree species (groups), CF refers to the carbon content of the i type tree species (groups).

In the 25-year calculation period, the carbon reserve will increase by 308,078 tons, with 61,880 tons during the construction period and 246,198 tons during the operation period.

(2) Greenhouse Gas Emission of Greenhouse Gas Emission

Related formulas and parameters are derived from *Guide for Carbon Sink Measurement Minitoring of Afforestation Project*.

1) Fertilization

Calculate the N2O emissions directly according to type, area, the application rate and the nitrogen content of the fertilizer used each year.

Only calculate the compound fertilizer. 1 ton of compound fertilizer can be converted to 0.52 ton of carbamide (here set the nitrogen content of carbamide as 46% and set the nitrogen content of compound fertilizer as 24%). Set the volatility value of carbamide as 20% (data comes from "Analysis of the Loss of Nitrogen in the Farm Field and the Utilization Efficiency of Water and Nitrogen High-yielding Farmlands under different Fertilization Models", which is the Master thesis in 2011 of Linli who is a graduate from Shandong Agricultural University). 5555.37 tons of compound fertilizer have been applied for this project, with 13.33 tons of greenhouse gas emission.

2) Fuel

It mainly considers the CO2 emission caused by transportation (fuel-driven motor vehicles). Collect different types of vehicles used for transporting fertilizers, seedlings and

timber, the fuel type, the average travel distances and fuel consumption per km as the calculation basis.

The main fuel used within the project is diesel fuel. Set the greenhouse gas emission factor as 2.778Kg.CO2/L (IPCC data). The total diesel consumption is 4830 tons, with 15,785.64 tons of greenhouse gas emission. 864 tons of diesel fuel has been used during the construction period, with 2,823.04 tons of greenhouse gas emission. 3,966 tons of diesel fuel has been used during the operation period, with 12,962.60 tons of greenhouse gas emission.

Table 7-1 Table of Greenhouse Gas Emission of Different Afforestation Tree Species within the Calculation Period

Tree Species	Total afforestation area (HA)	Construction Period (the 1st year to the 5th year)			Operation Period (the 6th year to the 25th year)		
		SUM (t)	Fertilization (t)	Fuel (t)	SUM (t)	Fertilization (t)	Fuel (t)
SUM	3876.44	2836.37	13.33	2823.04	12962.60		12962.60
Liquidambar formosana	198.11	35.94	0.68	35.26	839.09		839.09
Osmanthus fragrans	104.74	8.94	0.36	8.58			
Taxus mairei	85.03	2.76	0.29	2.47			
red beech	381.46	88.39	1.31	87.08			
magnolia officinalis	267.13	473.82	0.92	472.91			
koelreuteria paniculata	389.67	97.96	1.34	96.62	3110.47		3110.47
liriodendron chinese	139.73	39.57	0.48	39.09	1499.78		1499.78
Phyllostachys heterocycla	53.01	1.71	0.18	1.52	12.14		12.14

Tree Species	Total afforestation area (HA)	Construction Period (the 1st year to the 5th year)			Operation Period (the 6th year to the 25th year)		
		SUM (t)	Fertilization (t)	Fuel (t)	SUM (t)	Fertilization (t)	Fuel (t)
Toxicodendron vernicifluum	323.08	1088.18	1.11	1087.06			
Cunninghamia lanceolata	189.36	20.44	0.65	19.79	833.27		833.27
Pinus elliottii	332	110.51	1.14	109.37	5225.41		5225.41
Choerospondias axillaris	202.43	53.53	0.70	52.83	1442.44		1442.44
Torreya grandis	82.75	2.92	0.28	2.63			
Cinnamomum camphora	271.26	85.99	0.93	85.06			
Ginkgo biloba	397.93	485.84	1.37	484.47			
Camellia oleifera	458.75	239.88	1.58	238.30			

Note: 1. The main fuel used for the project is diesel. Set the carbon emission factor as 2.778Kg.CO2/L. Calculation parameters of carbon emission can be found in the attached table. 2. This project only calculate the result of compound fertilizer. 1 ton of compound fertilizer can be converted to 0.52 ton of carbamide (here set the nitrogen content of carbamide as 46% and set the nitrogen content of compound fertilizer as 24%). Set the volatility value of carbamide as 20%. The reference value of the carbon emission factor is 0.01. The reference value of Global Warming potential of N2O is 310. 3. The formula comes from 2011 Technical Guide for National Forestry Carbon Sink Measurement Minitoring while the parameter comes from 1994 National Communication on Climate Change.

(3) Net Carbon Content

During the 25-year calculation period, the project will produce net carbon content of 291579.03 tons, with 58343.63 tons during the construction period and 233235.40 tons during the operation period.

Table 7-2 Table of Net Carbon Sequestration

Year	Changes of Carbon Sequestration (A)		Emission of Greenhouse Gas (B)		Net Carbon Sequestration (C=A-B)	
	Average annual change	Accumulative total	Average annual emission	Accumulative total	Average annual change of carbon sequestration	Accumulative total
	(tCO_2-e.a^{-1})	(tCO_2-e)	(tCO_2-e.a^{-1})	(tCO_2-e)	(tCO_2-e.a^{-1})	(tCO_2-e)
SUM		307378		15798.97		291579.03
Construction Period (the 1st year to the 5th year)	15295.00	61180.00	567.27	2836.37	14727.73	58343.63
Operation Period (the 6th year to the 25th year)	12309.90	246198.00	648.13	12962.60	11661.77	233235.40

Note: the ratio causing the conversion from carbon to CO2 is 44/12.

Regardless of the project, during the 25-year period, there will be 99,400 tons of carbon reserve, with 31,800 tons during the construction period and 67,600 tons during the operation period.

It can be concluded that the operation period of this project will have good atmospheric environment benefit.

7.2.3 Analysis of Soil Environmental Impact

Fertilizers used during the operation period of the project (the 6th to the 25th year) are compound fertilizers, which are applied in small amounts. Fertilizers are mainly used for seven species including osmanthus fragrans, toxicodendron verniciflnum, ginkgo biloba, camellia oleiferatea, torreya grandis, and phyllostachys heterocycla and mangnolia officinalis. Compound fertilizers are used for other species. Appropriate amount of compound fertilizer is beneficial to the growth of trees and will improve the resistance of trees. And the compound fertilizer applied to trees will largely be absorbed by trees and won’t have an adverse impact on forest soil.

Plantation can increase coverage of the surface and reduce evaporation of water of the soil. The tillage changes the soil aeration and soil structure, which to some extent, prevent or reduce soil erosion. Forest coverage will be improved after the plantation is complete,

forming a sound forest environment. Dry branches and fallen leaves on the ground will help to improve the physicochemical property of soil, increase number of edaphon and enhance soil nutrients. The vegetation coverage and the content of root system are both high, far higher than the productivity of barren hills and waste lands, which will significantly improve the performance soil production services.

It can be concluded that the operation period of this project will have good soil environment benefit.

7.2.4 Analysis of Social Environment Impact

(1) Economic Benefit

The economic benefit mainly reflected in the direct economic income of construction units and executors. Considering the project scale and product output, it's estimated that after the completion of the project 264,900 m^3 of timber, 54,500 tons of fuel wood, 2.2263 million pieces of bamboo wood, 761,700 pieces of transplanted wood and 83,800 tons of economic product are expected to be produced, which will bring a total sales revenue of 19.558306 billion RMB yuan, achieving the profit of 10.038652 billion RMB yuan and paying taxes of 28.2833 million RMB yuan.

(2) Social Benefit

This project will play a positive role in promoting the "Green Jingchu" plan of Hubei Province and protecting rare tree species in Hubei Province. It's of great importance to develop rare tree species so as to adjust tree species structure, cultivate high quality strategic resources and increase farmers' income. The project will also help to make forestry scientific and technological achievements get further popularized and applied through active application of advanced forest cultivation technology, promotion of fine seedling and good method and intensive management, which will improve forestry operation and management quality in Hubei, drive the intensive management of forestry production and accelerate the forestry "Double Growth" target.

Nearly 1,018,207 work days will be invested for the construction period, with 4,073 positions and 815 positions per year. The fixed positions during the operation period are project management positions. It's estimated that almost 2,455,467 work days will be invested

for the operation period, with 9,822 fixed positions and 491 positions per year.

7.3 Analysis of Environmental Risk

Risk analysis for construction project is to discuss major environmental incidents that might arise due to natural or anthropogenic factors during the construction and operation period so as to take corresponding measures to control the maximum impact on the environment as well as the possible occurrence of this risk.

7.3.1 Risks and Harms

According to the characteristic of the project and the analysis of environmental impact of engineering, the risk of the project mainly features in poor economic performance of ecological economic forest due to large area of forest pests and severe weather or land waste due to large area death of trees, and forest fires due to improper management measures during the operation period.

(1) Pests and Diseases

Large area of pests and diseases during the project operation period may result in the death of economic forest and risk of land waste. Poor cultivation performance of economic forest and abandoned land may also result in waste land.

The tree species of the economic forest within the project is camellia oleifera. The tree species of protection forest are poplar and pine, etc. The ecological vulnerability of single tree species is increasingly obvious. Pests and diseases caused by defoliators and Capricorns often occur. The plantations have small capacity to resist pests and diseases in the early construction period. When there are plant diseases and insect pests, it's easy to become massive infection which will cause widespread death of trees.

(2) Land Waste

The afforestation process destroys the original natural vegetation and the relatively stable surface and makes the soil become loose. During the forest management process, if large area of trees are killed due to the poor economic performance or large scale of pests and diseases so as to make the planting base deserted again, the earth surface will become bare or sandy and cause new water and soil erosion, which will seriously damage the regional ecological environment and landscape.

(3) External Environment Risks

The most frequent and serious natural disasters within the project area are floods and droughts. Flood primarily happens from April to October. The flood frequency varies due to differences in geographic position, terrain and weather system. Flood disaster happens every year in Jianli county located in Jianghan Plain, Honghu city, suburb of Jingzhou city, Songzi county and Chibi city, causing serious economic damage to agricultural production. In Xian'an, Chongyang, Tongcheng and Jichun county, there're both floods and droughts. Drought appears in the summer and autumn, seriously affecting the autumn sowing and production in rural areas. Other counties (cities and districts) of the project area also suffer from low temperature freeze injury, hail, high wind, frost, pests and diseases, forest fire, water and soil erosion and other disasters, bringing a certain degree of impact on agricultural and forestry production.

(4) Fire Risks

There is potential of fire risk in the project area during the dry autumn and winter.

7.3.2 Preventive Measures of Risks

(1) Prevention Measures for Pest Risk

1) The key to control pest is to use native tree species, apply rational close planting and mix different tree species for afforestation. The afforestation project uses excellent native trees, adjust measures to local conditions, and allocate rationally in order to enhance the ability to resist diseases and pests.

2) When selecting and allocating tress species, prioritize camellia oleifera, cunninghamia lanceolata and poplar. Allocate different tree species in accordance with the actual situation of different sections so as to form different forest structure in order to enhance the ability to resist diseases and pests.

3) Strengthen the training to the management and maintenance personnel of forest bases so that they can master basic skills of forest tree cultivation in order to carry out general pest control work. Establish emergency mechanism to meet the goal of early detection and prevention on the treatment of diseases and pests.

(2) Prevention Measures for Land Waste Risk

1) The construction unit will conduct careful market survey on forest plant species and consult with related experts prior to the implementation of the project. Then the feasibility and market prospects of planting ecological economic forest will be decided according to the field visit and the feasibility study of provincial specialists. Therefore, there's minimal possibility of land waste due to poor economic performance of the project.

2) During the forestry development process, it's important to balance water resources in accordance with the status quo of utilization and plan of water resources and avoid excessive use of surface water so as to prevent the reduction of water flow in the lower reaches of the region, which will have adverse impact on the growth of natural vegetation and the ecosystem balance within the drainage basin.

3) During the forestry development process, environmental risks of soil and water imbalances will occur due to the change of the project area from farmland and unreclaimed land suitable for forest to eco-economic forests. Rational and appropriate development of water and soil resources during the management period is good for preventing land abandon once again, preventing soil and water erosion due to bare or sandy surface. The development and utilization of water and soil shall focus on improving regional ecological environment and landscape.

(3) Prevention Measures for External Environment Risk

1) Enhance the management water, fertilizer, pruning and pest control, strengthen weather forecast, and take anti-freezing measures in order to reduce the risk of natural disasters.

2) Plant good and strong seedlings, strengthen tending management and enhance the stress resistance ability so as to withstand natural disasters.

(4) Prevention Measures for Forest Fire Risk

1) Establish forest fire monitoring system within project bases so as to include the prevention and prediction of forest fires into the local forest fire prevention system. Relying on county-level forest fire prevention headquarters and based on the existing number of forest fire prevention staff, increase the number of forest rangers and liaison men in order to expand the forest fire prevention team. Sign liability form for forest protection and fire prevention so

as to clearly define the duty of forest rangers. Combine remuneration and performance with incidents in order to carry out clear rewards and punishments mechanism.

2) Build fire forest belts and fire lanes: make full use of conditions such as rivers, ridges, gullies, bare rock, roads (highways, railways) and field and integrate natural barriers, project barrier and biological barrier in order to build a fire-forest barrier network system based on biological fireproofing forest.

3) Develop forest fire prevention plans, carry out monitoring and forecast of forest fire, and connect local meteorological departments to establishment monitoring and forecasting points for forest fire. Release fire weather forecast and high fire weather warnings in time through local news media so as to strengthen the monitoring and forecast of forest fire. During the annual fire season, carry out field fire patrol system, prohibit fires in mountains, and conduct indoor fire 24-hour duty system. Organize emergency rescue and disaster relief and arrange for fire-fighting tools in a timely manner.

To sum up, forest vegetation coverage and plants will be significantly increased during the management period. The increase of biomass and biodiversity will bring overall increase to the region, such as the complexity and diversity of the community structure and community succession. Such succession will strengthen the capacity of resisting disturbance. Afforestation projects are conducive to the integrity and stability of the ecosystem. Tree species selected for afforestation can be adapt to local conditions, which will reject native tree species and threaten the survival of native species. The biomass per unit area after the afforestation will increase significantly compared with that before afforestation, which increases the degree of heterogeneity and enhance the stability of the landscape. More intuitive ecological benefits brought by the project mainly reflect in: water conservation of, soil and water conservation, oxygen production of carbon sequestration and air purification.

3876.44 HAs area of new afforestation in the project area will improve the provincial forest coverage rate by 0.02% and the forest quality of 2330.01 HAs area of forest. It can also improve forest carbon reserve. The carbon reserve will increase 308,078 tons and produce a net carbon sequestration volume of 291,579 tons within the 25-year calculation period, which

will absorb harmful gas like SO2, slow down greenhouse effect, and create a living and reproduction environment for flora and fauna population so as to enhance species diversity. Meanwhile the ecological system of afforestation can improve the adaptability of agro-ecological system to the disturbances such as regional climate change, which will protect farmland, increase production and effectiveness, strengthen the material flow and information flow between the project area and the agro-ecosystem, increase regional stability, and other positive impacts.

8 Proposed Control Measures and Expected Treatment Effect

Content / Type	Emission source	Pollutant name	Control Measures	Expected treatment effect
Air pollutants	Construction dust, fuel exhaust gas	TSP, soot particulates, NO_X, SO_2	watering to reduce dust, control utilization amount	Small effect on environment
Water pollutant	-	-	-	-
Solid waste	-	-	-	Small effect on environment
Noise	bulldozer, excavator, transport vehicle	Leq (A)	Integrated approaches will be applied to noise control. Measures such as necessary sound insulation, noise elimination, sound absorption and vibration reduction will be taken to control the acoustic noise within the required standards. Select low-noise device. Set necessary sound insulation envelopes near sensitive points within the construction area. Stop construction at night.	Small effect on environment
Other				

Ecological Protection Measures and Expected Benefits:

(1) Project Plan and Design Period

1) Strictly protect existing natural vegetation and appropriately plan afforestation sites. Recommend choosing the burned land, deforested land and wasteland suitable for forest and cropland as afforestation program, is prohibited in the rich natural forest planting.

2) Avoid large area of single plantation and facilitate biological diversity. Encourage mixed forests with multiple tree species, types and levels. Single plantation shall mix with other strains in different patterns such as star-shape and small block shape.

3) Project design should be optimized. Infrastructure projects such as roads and fences should avoid occupy forest land and locations with fine vegetation condition such as scrub. Do not affect or damage existing forestry irrigation facilities and water and soil conservation facilities within the project area. The infrastructure and living quarters of

construction shall borrow earth from areas with poor vegetation condition so as to reduce the damage to the natural vegetation on the earth surface.

4) Strictly control large scale of afforestation in special core and buffer zones of ecologically sensitive areas, such as nature reserves. Particularly prohibit the introduction of exotic species.

(2) The Project Construction Period

1) The clearance of forest land will adopt hole-shape method in order to protect vegetation isolation belt. Fully eliminate infected and dead vegetation. Focus on the protection and retain natural vegetation and broad-leaved tree species that does not affect the forest growth in order to protect biodiversity.

2) Prohibit controlled burning for forest land clearance in case of water and soil erosion. For small classes with steep slopes, long slopes or slopes with water and soil erosion, pay attention to retain the native vegetation on the hill top, hillside, and the foot of the hill.

3) Choose the suitable method for land preparation according to different site conditions and forest tending goals. Full cultivation is totally prohibited in mountains and hills. Encourage band-cultivation and hole-cultivation and land. The land preparation should be carried out along the contour direction in the shape of the Chinese character "品". Counter-slope terrace and level bench shall be adopted for the land preparation of slopes with serious water and soil erosion.

4) Standing tending and forest land reclamation on slopes should be carried out along the contour direction. Prohibit operations along slopes.

5) Dispose waste timely so as to prevent soil and water pollution. Clear wastes generated in project activities and properly cope with production waste and household garbage. Carry out centralized recovery and disposal. Eliminate the potential ecological risks brought by project activities.

6) For construction failure area, land leveling should be carried out as soon as the construction is completed. Plant fast-growing trees and bushes with excellent resistance against unproductive land to prevent land desertification. In the area where water and soil

erosion may occur, it's primary to carry out engineering protection measures. Then plant poplar shelterbelts to prevent expansion of erosion gullies.

7) During the construction period, strengthen the education of construction personnel on their environmental protection consciousness. Excessive deforestation of surrounding trees and shrubs and heavy catching and killing of wild animals are strictly prohibited. When habitats of wild animals are spotted, the construction work should be avoided. It's prohibited to disturb and destroy places for the habitat and recreation of wild animals. In situ conservation shall be conducted when rare and endangered plants are found. Rare and endangered plants that need transplanting shall be transplanted and ensure their survival.

8) Make great effort in the work of tree species, seedlings, and seedling quality. Select tree species suitable for local land and try to choose suitable native tree species of fast growing, high yield and strong resistance. Special personnel should be assigned for the transport, quarantine, testing and adjusting of nursery seeds and afforestation seedlings in order to ensure Class I seedlings without being infected by pests and diseases.

(3) Project Management Period

1) Determine the variety and quantity of fertilizers based on the fertilizer deficiency of soil. Appropriately arrange fertilization and control fertilizer rate. Encourage the application of pollution-free organic fertilizer or fertilizer of less environmental pollution and promote techniques such as backfilling topsoil to the hole and burying green for fertilization. Advocate planting green manure and intercropping dwarf crops in plain areas in order to maintain the soil fertility of the forest land and protect the environment.

2) Strictly control the amount of pesticide, promote the use of pesticides with small residual, high efficiency and low toxicity, and apply integrated pest control techniques such as biological control and physical control. Try to use biological control instead of pesticides. If necessary, promote the use of safe pesticides with low toxicity, high efficiency and short residual period. Reasonable arrangement of spraying time and number will help to avoid human or animal poisoning.

3) Adjust measures to local conditions and take scientific irrigation methods (such as drop irrigation) to prevent the secondary salinization of the soil;

4) Carry out intermediate cutting. The production and harvesting of forest should select reasonable harvesting modes intensity. Selective felling should be used while methods such as "cut the big ones and remain the small ones" and clearance harvesting should be avoided. The harvesting intensity should be controlled below 30%.

The impact on the ecological environment of the project during the construction and management period will be minimized through strict application of the protective measures.

9. Conclusion and Suggestion

9.1 Conclusion

9.1.1 Project Overview

The construction is planned to be carried out in 11 counties (districts, cities) of six prefectural divisions in Hubei province including Chibi City of Xianning City, Tongcheng County, Tongshan County, Xianan District, Yingshan County of Huanggang City, Xiaonan District of Xiaogan City, Dawu County, Xiangcheng District of Xiangyang City, Zaoyang City, Changyang County of Yichang City as well as Badong County of Enshi prefecture. The project content includes: 6206.45 ha of demonstration base of rare forest protection and development will established, among which 3876.44 ha are new afforestation while 2330.01 ha are tending forest. 11 nurseries are converted or expanded, with an area of 36.7 ha. Necessary subsidiary facilities will also be built. The total project investment is 390 million RMB yuan, in which 25 million Euros are invested by European Investment Bank, equivalent to 195 million RMB yuan, accounting for 50% of the total investment; while 195 million RMB yuan comes from domestic funds, accounting for 50% of the total investment.

This project is a new and technical renovation project. The project construction period is 5 years, namely from 2015 to 2019. 16 tree species selected for afforestation are liquidambar formosana, osmanthus fragrans, zelkova serrata, toxicodendron vernicifluum, cunninghamia lanceolata, ginkgo biloba, choerospondias axillaris, liriodendron chinense, cinnamomum camphora, koelreuteria paniculata, camellia oleiferam, torreya grandis, taxus mairei, phyllostachys heterocycla, pinus elliottii and mangnolia officinalis. The construction area is mainly engaged in agriculture and forestry production, with no obvious sources of pollution within the project area and nearby area. But water and soil erosion is serious

9.1.2 Present Regional Environment Quantity

(1) According to the monitoring data of 2013, comprehensive evaluate the annual concentration of sulphur dioxide, nitrogen dioxide and inhalable particles: Xiangyang city, Xiaogan city, Xianning city and Enshi prefecture have reached national Class II standards, while Yichang city and Huanggang city have reached national Class III standards.

(2) In 2013, the overall water quality of the mainstream of Han River is excellent. The overall water quality of the mainstream and branches of Yangtze River and branches of the Han River is good. The proportion of main lakes and reservoirs with the water quality that is in line with or better than Class III is 78.1%. The overall water quality keeps good. The quality of underground water in the evaluation area complies with Class III standards of Quality Standards for Underground Water (GB/T 14848-1993).

(3) In 2013, the average equivalent sound level of 16 major cities in Hubei province (except for Wuhan) ranges from 50.6dbs to 55.9 dbs, with Huanggang the lowest, Enshi the highest. Within the project area, the acoustic environment quality of Enshi, Yichang and Xiangyang is in general, while that of Xiaogan, Huanggang and Xianning is good.

(4) In the proposed project area, the ecological environment quality of Enshi prefecture, Xianning city and Yichang city is excellent, while the ecological environment quality of Xiangyang city and Huanggang city is good. The ecological environment quality of Xiaogan city is general.

(5) There're rich available land resources in the project area. The soil is thick with high organic matter content, which is suitable for the growth of various tree species.

(6) The project area is rich in forest vegetation and has many national key protected wild plants and animals. The ecologically sensitive areas involved in the project area (nature reserve) are relatively small. There's no nature reserve in other project sites excluding Huangpao Forest Farm in Tongcheng county, Yaogushan Forest Farm and surrounding afforestation sites, and provincial nature reserve of Yaogushan in Hubei Province, Wujiashan Forest Farm in Yingshan county relating to national nature reserve of Dabie Mountain in Hubei province, afforestation sites of Xiongji town in Zaoyang city that may be involved in the county-level nature reserve of Xiong River system and county-level nature reserve of orchid resources in Zaoyang city.

9.1.3 Analysis of Environmental Impact

This project mainly includes the construction of plantation bases. The main project is afforestation, so the project belongs to the ecologically environmental protection project. The ecological impact mainly occurs in the construction period with small impact and will have

positive environmental benefit.

(1) Ecological Environment Impact

Ditching and land preparation during the construction period will damage the native vegetation. The construction shall be divided into several sections and stages so as to reduce the damage to natural vegetation. Strictly prohibit the damage to surrounding original vegetation and guarantee the integrity and stability of regional ecological environment. As the native vegetation of the project is local common species with small coverage, there is no national or prefecture-level rare wild plant. Vegetation due to construction and land preparation will have little effect on the local plant community and won't lead to the disappearance of a certain plant species. Temporary land occupation will have temporary impact on the vegetation. But such impact will disappear with the completion of the construction. Forest vegetation coverage and plants will be significantly increased during the management period. The increase of biomass and biodiversity will bring overall increase to the region, such as the complexity and diversity of the community structure and community succession.

The project will have small impact on the biodiversity of the project area if there is no drastic climate change and obvious influence of human activity. The ecological environment in the region will be better after the completion and stability of the project.

(2) Atmosphere Environment Impact

During the construction period, the air pollution within the proposed project area is mainly caused by dust, construction materials transport and fuel. The surface exposed will also produce dust pollution in dry and windy weather. Wall cover, watering and covering transport vehicles with tarpaulin prevent the reentrainment of dust and reduce the environmental impact caused by dust proliferation. According to forecasts and analogous survey of dust pollution scope, the dust has limited impact scope and has small impact on the environment because of its quick settling velocity and self-purification. The project also has the function of carbon fixation and oxygen so as to improve regional environment and beautify the living environment.

(3) Water Environmental Impact

Water resource can be ensured without affecting water demand of local agriculture as there're abundant underground water resources in the project area. And there is no living quarters hence no sanitary wastewater will be generated under reasonable arrangements for the construction and strengthened collection and treatment of pollutants during the construction period. Therefore, the project construction has little influence on the water environment.

Fertilizers used during the operation period of the project (the 6th to the 25th year) are compound fertilizers. The fertilizer will be applied under the guidance of professional and technical personnel. Hole application will be adopted. The chemical fertilizer will be buried deeply underground and won't be directly applied to the surface or the earth surface, so fertilizers won't flow into water through irrigation and soil erosion, with little pollution.

(4) Impact of Solid Waste

Waste soil during the construction period will be backfilled. Waste should be transported to designated place for disposal required by the environmental protection department.

The major solid wastes during the operation period include braches due to the pruning of plantation and packaging materials of fertilizers and pesticides. All solid wastes get disposed during the operation period. The environmental impact of solid waste is small and acceptable.

(5) Impact of Noise

There is no sensitive point around 1 km within the project area. Reducing vibration and noise and maintain the operation status of the device will reduce the noise and have minimal impact on the surrounding environment. Transportation of fertilizer and forest harvest will generate traffic noise. But trees can reduce noise. There will be little impact on the environment after measures are taken.

(6) Impact on Soil

This project will not only improve the local environment but also effectively contain soil degradation. The use of pesticides will also have very small impact on soil. Compound fertilizers are used with fewer amounts which will be largely absorbed by the forest. Soil conditions will be improved as the fertilizer is only a supplement.

9.1.4 Risk Analysis

After the project is construction completed, if pest and disease monitoring and early warning systems and monitoring and forecasting information management systems are not perfect, it's easy to have pests and diseases. Large areas of pests and diseases will kill large areas of ecological economic forest and lead to land abandon. The poor economic performance of economic forest and fallow land will result in land abandon. The project area is located in barren hills, where waste land is prone to turn into desertification through wind erosion. The dry season in the project area is also conducive to forest fire.

The EIA has proposed preventive measures regarding risk factor during the development process of the project, which will minimize the probability of accidents.

9.1.5 General Conclusion

To sum up, the impact of the project on the environment is very small during the construction period. There will be no negative impact on the environment, but will have positive impact such as increasing local forest coverage, improving the ecological environment, increasing carbon storage, controlling soil erosion and promoting sustainable economic and social development in the project area. Overall, the positive environmental benefits of the project outweigh the negative impact. Hence the project is feasible considering the environment.

9.2 Suggestions

(1) Strengthen the advocacy and training of environment protection and promote environmental awareness among managers at all levels and the broad masses of peasants so as to make them consciously protect the environment. While strengthen the supervision of the implementation of environmental protection measures during the construction period.

(2) Nature reserves, especially the core area and buffer zones must be strictly in accordance with the relevant provisions. Large scale of afforestation and the introduction of exotic species are strictly prohibited.

(3) The workload of forest road construction and maintenance is large. There's still uncertainty during the feasibility study phase. The next step is to implement specific project location and scale. It's not included in the technical documentation of this environmental

impact report, which may need separate environmental impact assessment.

10 Appendix and Attached Figures

Appendix:

1. Power of attorney;

2. Project approval documents (No. 541, Economic correspondence [2014], Foreign Investment office, Development and Reform Commission of Hubei Province).

环评委托书

中国地质大学(武汉):

根据《中华人民共和国环境影响评价法》及《建设项目环境保护管理条例》等相关法规，我单位“欧洲投资银行贷款湖北省珍稀森林可持续经营项目 ”需进行环境影响评价，现委托贵单位编制环境影响报告表（中英文本）。

单位名称（盖章）

2015 年 1 月 8 日

湖北省发展和改革委员会

鄂发改外经函〔2014〕541号

省发展改革委转发国家发展改革委关于利用欧洲投资银行应对气候变化框架贷款一期备选项目计划调整和余款安排的通知

省林业厅：

国家发改委以“发改外资〔2014〕2833 号”文下发了利用欧洲投资银行应对气候变化框架贷款一期备选项目计划调整和余款安排的通知，你厅“湖北省珍稀森林可持续经营项目”被列入备选项目计划。现将此文转发你们，并就有关事项通知如下：

1、请按文件精神和有关规定抓紧做好项目前期准备工作，落实建设条件，履行项目报批手续，积极推动项目实施和建设。

2、加强对项目的监督和管理，帮助或协调解决遇到的实际困难和问题，推进项目进程。

3、项目前期准备和实施过程中如遇重大问题或重大变化，请及时上报我委。

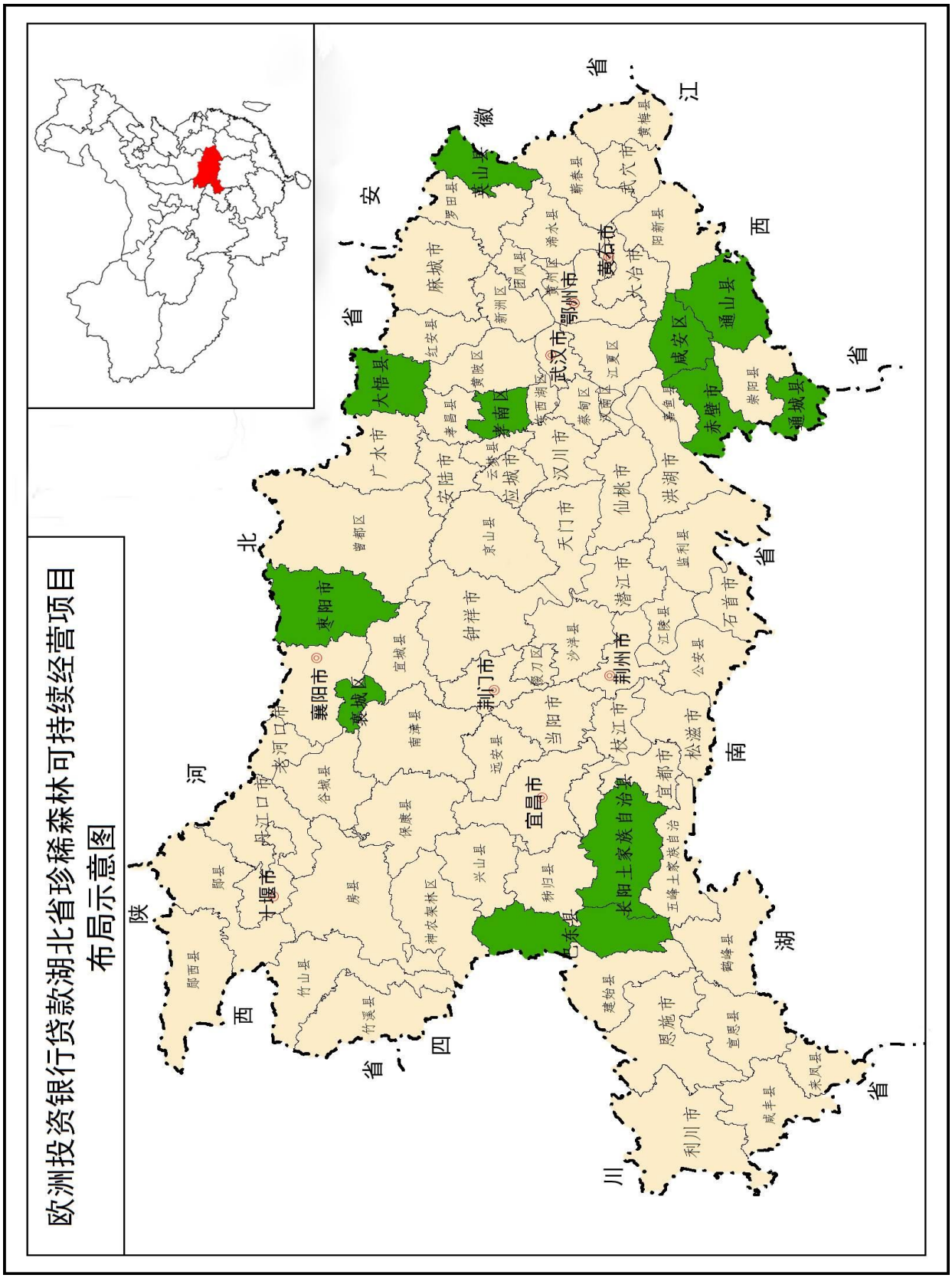
附件：国家发展改革委关于利用欧洲投资银行应对气候变化框架贷款一期备选项目计划调整和余款安排的通知（发改外资[2014]2833号）

湖北省发展和改革委员会

2014年12月24日

Attached Figures 1:

Project Layout Diagram



11 Pretrial and Approval Opinion

Pretrial Opinion: Official seal Agent: DD/MM/YY
Review opinions of lower administrative department of environment protection: Official seal Agent: DD/MM/YY

Review opinions:

Official seal

Agent:

DD/MM/YY

Environment Impact Report

Project name: European Investment Bank Loan—Sustainable Management Project of Rare Forest in Hubei Province

Construction unit (stamp): Forestry Bureau of Hubei Province

Preparation date: Feb 1st, 2015

Prepared by Ministry of Environmental Protection of PRC

建设项目环境影响评价资质证书

机构名称：中国地质大学（武汉）
住　　所：湖北省武汉市洪山区鲁磨路 388 号
法定代表人：王焰新
证书等级：乙级
证书编号：国环评证 乙 字第 2602 号
有效期：至 2016 年 1 月 16 日
评价范围：环境影响报告书范围 — 农林水利；社会区域***
环境影响报告表类别 — 一般项目环境影响报告表；特殊项目环境影响报告表***

中华人民共和国环境保护部
二〇一二年一月十七日

Project name: European Investment Bank Loan—Sustainable Management Project of Rare Forest in Hubei Province

Construction unit: Forestry Bureau of Hubei Province

Assessment unit: China University of Geosciences (Wuhan) (Stamp)

Responsible person for the project: Ge Jiwen (professor)

Roster of preparation staff				
Name	Specialty/title	The EIA engineer registration NO./post certificate NO.	Chapter prepared	Signature
Ge Jiwen	Ecology/Professor	B26020040700	Content and scope of the project, environment impact analysis, conclusions and suggestions	
Miao Wenjie	Environmental engineering /Engineer	B26020110	Basic project information, natural and social environment profile, major pollutants and estimated emission of the project	
Tang Jia	Environmental Science and Engineering/Assistant engineer	B26020119	Environmental quality, analysis of project construction, prevention measures and effect analysis	

Participants: Yang Hao, Li Shanshan

经环境保护部环境影响评价工程师职业资格登记管理办公室审查，**葛继稳**具备从事环境影响评价及相关业务的能力，准予登记。

职业资格证书编号：**0003880**

登记证编号：**B26020040700**

有效期限：**2010 年 07 月 28 日至 2013 年 07 月 14 日**

所在单位：**中国地质大学（武汉）**

登记类别：**农林水利类环境影响评价**

中华人民共和国环境保护部

2010 年 07 月 28 日

再 次 登 记 记 录

时间	有效期限	签章
2013.06.26	延至 2016 年 07 月 14 日 环境工程师再次登记专用章	
	延至 年 月 日	
	延至 年 月 日	
	延至 年 月 日	