# THE DETERMINATION OF LANDFILL (TPA) ALTERNATIVE LOCATION IN WEST TULANG BAWANG DISTRICT OF LAMPUNG PROVINCE

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## Abstract

West Tulang Bawang is one of the new regencies in Indonesia which was a new expanded area that continues to grow. It is followed by population growth rates resulting in increased volume of waste. The landfill (TPA) is an important component of any waste management system. A good waste has several characteristics. To ensure the appropriate selected land, a systematic process must be developed and followed.

The study of the selection of the landfill (TPA) is aimed at finding feasible area as the location of the landfill, so that the allocation of the new landfill will be in accordance with local policies in regional spatial planning and meet the criteria of ISO No. 19-3241-1994. The role of Geographic Information System (GIS) in the management of solid waste is important because many aspects of planning and operations are highly dependent on the spatial data. The landfill selection process consists of three stages of filtering, i.e., the feasibility of the environment by utilizing Geographic Information System (GIS) to map the location of viable landfill, regional filtering phase based on the regional policy and the elimination filtering using SNI 19-3241-1994.

The results of the study showed that with an estimated population in 2033 which is 330 807 people, the amount of waste that will go to the landfill through the 3R principle reached 309.36 m3 / day or 61.87 tons / day so that the area of the required land for the sanitary landfill pattern with a 20 year planning is 17.70 Ha. The alternative location was selected by with a priority level which is located on the Panaragan Jaya Utama of Central Tulang Bawang sub-district with a land of 99.68 hectares, Tulang Bawang village districts Panaragan Central with a land area of 136.26 ha and the Kagungan Ratu village of Tulang Bawang sub-district of 74 , 65 Ha.

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## 1. Introduction

The magnitude of the Indonesian population is followed by a high rate of population growth resulting in increased volume of waste (Abdullah, 2011). West Tulang Bawang is one of the new regencies in Indonesia which was currently expanded area from its main district based on Law No. 50 of 2008 about the Establishment of the District of West Tulang Bawang in Lampung province. It is an area that continues to grow which is characterized by the increasing residential areas and the development of economic activities. This development may lead to sewages or wastes which impact negatively to the environment, that is the change of the biophysical, socio-economic and cultural environment.

One of the efforts to avoid the negative impact of such waste is the construction of the landfill which is a national program development in the district. The selection of the landfill should consider the environmental aspects to avoid disruption of the ecological balance (Murusali, 2008), then the location of the landfill should be placed in accordance with the aspect of physical and social and meet the requirements/regulations, environmental management and also the applied spatial planning.

The establishment of the landfill is a national development program in the district as it was stated in Law No. 18 of 2008 about Transitional Provisions Chapter XVI. This is in line with the policy of the local government of West Tulang Bawang district contained in West Tulang Bawang District Regulation No. 02 2012 about Spatial Planning of West Tulang Bawang district of 2011-2031 of Article 15 paragraph (2) about the place of the landfill (TPA) with the pattern of *sanitary landfill*.

The development of West Tulangbawang district as one of the new autonomous district in Lampung province has increased the number of population, economic and development activities. Thus, it also affected the amount of wastes that needs to be supported with well-planned waste management systems. One of the systems is determining the location of an alternative location of the landfill (TPA) in accordance with the requirements of the environmental and regional policies in West Tulang Bawang district and the Indonesian National Standard (SNI 03-3241-1994).

The purpose of this study was to calculate population projections and the projections of amount of wastes that will enter the landfill in West Tulang Bawang district, calculate the broad needs of the landfill which is appropriated to its planning age, and determine the alternative location of the landfill in accordance with environmental requirements and policies in West Tulang Bawang district and the Indonesian National Standard (SNI 03-3241-1994).

The subject of the research was to identify the potential of the population growth and the wastes in West Tulang Bawang district, to analyze the needs of the area of the landfill in West Tulang Bawang district and determine the alternative location of the landfill in West Tulang Bawang District.

## 2. Methodology

The method used in this study is descriptive method that is obtained by combining the information sources of the statistical data, thematic maps and data processing

using results from the application of Geographical Information System (GIS) which was used as a tool in mapping the candidate location of the landfill which is then carrying out a feasibility to the government policies and Indonesian national standards in the selection of the landfill.

This study was conducted for 4 months, from October 2013 to January 2014, and it was located on West Tulang Bawang district, which is one of the new districts in Lampung province. The tools used in this study is a set of computers for data processing and report writing and ArcGIS 10.1 software for processing and analyzing spatially physical and social data as well as mapping the location candidate of the landfill. Then, the materials used include economic data, the population data, topographical, geological, and hydrological maps, the natural disasters maps, and the maps of administration of land use.

Through the analysis technique of making a projection of wastes generation, a geographical feasibility, the feasibility made based on the Spatial Planning of the District and the SNI of 03-3241-1994.

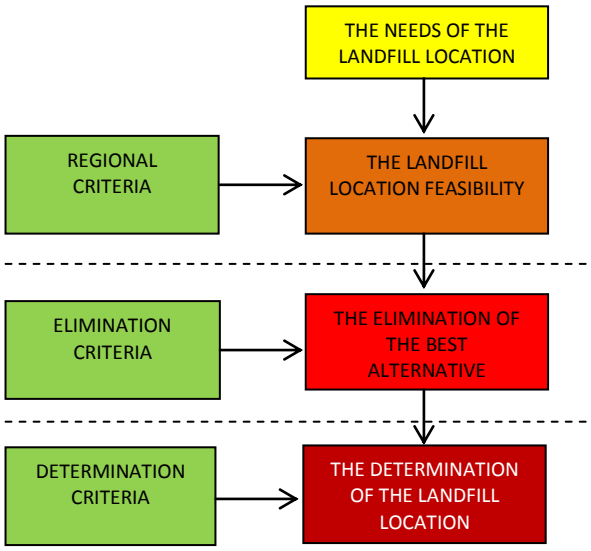



Figure 1. Landfill site selectin stage

## 3. Results and Discussion

### The Overview of West Tulang Bawang District

West Tulang Bawang District was established based on the Law no. 50 of 2005 about the Establishment of West Tulang Bawang District in Lampung Province. Geographically, West Tulang Bawang District is located on the coordinate of 104°55' – 105°10' of East Longitude and 04°10'- 04°42' of South Latitude. West Tulang Bawang district has an area of 120 100 ha or 1,201 km2, consists of 8 (eight) sub-districts, 77 (seventy seven) countries and 2 (two) villages with the Capital District is set in Central Tulang Bawang sub-district.

In general, West Tulang Bawang district is a flat area with the most area is at an altitude of 25-50 meters above the sea level (mdpl), except for 2 (two) countries in Central Tulang Bawang sub-district which is at a height of 0-25 meters above the sea level. They are Chandra Kencana country which is located 25 meters above the sea level and Panumangan country which is located 23 meters above the sea level.

The climatic conditions of an area can be seen from its rainfall, rainy days, temperature, relative humidity, wind speed, and sun exposure intensity. The climate of West Tulang Bawang district based on Smith and Ferguson included in B climate category, which is characterized by a wet month for 6 months, from December to June with an average temperature of 24-34 $^0$C.

In general, the condition of the hydrological system in an area can be observed from the study of the watershed (DAS). Watershed is a landscape that is naturally limited by the topography of hills / mountains and serves to collect, store and drain the water, sediment and nutrients into the river which ultimately disembogue to the single outlet. In West Tulang Bawang there are 15 rivers and 1 (one) watershed.

Natural disasters which could potentially occur in West Tulang Bawang district is flooding. Flooding is defined as a combination of the influence of the depth and duration of flooding. Based on the drainage capacity, West Tulang Bawang district consists of three groups, they are areas that never flooded, occasionally flooded, and continuously flooded. Most of the land in West Tulang Bawang district includes areas that have never flooded and only a relatively small portion frequently flooded areas, i.e., areas with swamps and river basin topography.

### The Overview of Wastes in West Tulang Bawang District

The wastes treatment and management are still conducted manually and individually, considering that West Tulang Bawang district is a new district, so that the pattern of wastes management is still a local treatment that are burned and dumped by people, either living in urban or rural. Therefore, the wastes management will be planned in an integrated manner with the 3R concept, that is reduce, reuse and recycle which is supported by adequate equipments and transportations as well as the provision and development of the location of the landfill, especially in the areas which are planned as urban areas.

The Projection of wastes generation in West Tulang Bawang District is calculated based on the amount of population growth, the percentage of population growth, urban growth both in agricultural and industrial sector and the PDRB of West Tulang Bawang District.

Table 1. The Projection of Wastes Generation of 2013-2033

| Year | Population | The Projection of Wastes Generation | | The Volume of Wastes Generation (m3/day) | The Weight of Wastes Generation (ton/day) |
|---|---|---|---|---|---|
| | | Volume (L/o/h) | Weight (Kg/o/h) | | |
| 2013 | 258.983 | 3,03 | 0,76 | 785,16 | 196,29 |
| 2018 | 275.326 | 3,20 | 0,80 | 879,72 | 219,93 |
| 2023 | 292.700 | 3,37 | 0,84 | 985,68 | 246,42 |
| 2028 | 311.171 | 3,55 | 0,89 | 1104,40 | 276,10 |
| 2033 | 330.807 | 3,74 | 0,94 | 1237,43 | 309,36 |

If the 3R principle is used, thus the wastes which will enter the landfill will reduce

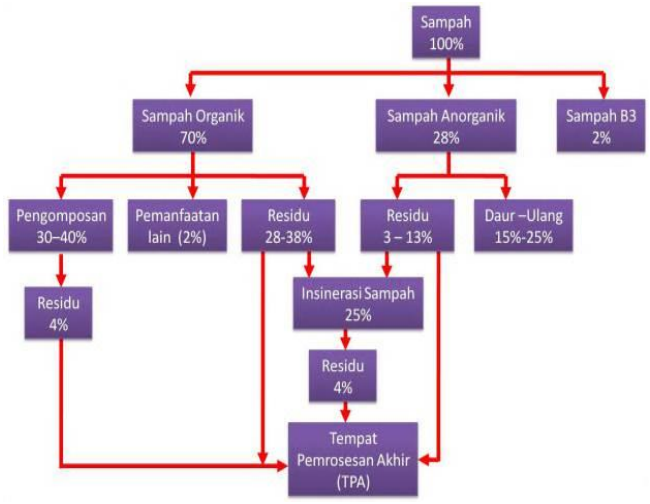



Figure 2. The potential of The Wastes which Enter the Landfill with 3R Principle. (*Source: Dit. Bing Teknik KNPU, 1999*)

Table 2. The Projection of Wastes Generation using 3R principle

| Year | The Amount of Wastes Generation (ton/day) | The Wastes Enter the Landfil without 3R (ton/day) | The Wastes Enter the Landfil with 3R (ton/day) |
|---|---|---|---|
| 2013 | 196,29 | 196,29 | 39,26 |
| 2018 | 219,93 | 219,93 | 43,99 |
| 2023 | 246,42 | 246,42 | 49,28 |
| 2028 | 276,10 | 276,10 | 55,22 |
| 2033 | 309,36 | 309,36 | 61,87 |

**The need of area of the Landfill**

The projection of the need of area needs to be conducted in determining the location of the landfill by using the *sanitary*. The calculation of the projection of the need of the landfill area of West Tulang Bawang District until 2033 can be conducted based on the technical guidance number CT/S/Re-CT/004/98, thus the need of the landfill area for the next 20 years is as the following:

$$L = \frac{(V + SC) \times 365}{T} \times 0{,}7 \times 1{,}15$$

Thus, the need of the landfill area is:

| Definition | Data | Unit |
|---|---|---|
| Wastes Generation on 2033 | 61,7 | ton/day |
| Wastes solidity of *sanitary landfill* | 0,7 | ton/$m^3$ |
| The wastes volume which has been compacted(V) | 88,39 | $m^3$/day |
| *Soil Cover* (SC) | 37,12 | $m^3$/day |
| High Generation Planning of *sanitary landfill*(T) | 5 | m |

$$L = \frac{(88{,}39 + 37{,}12) \times 365}{5} \times 0{,}7 \times 1{,}15$$

= 7.375,61 $m^2$/day

The need of the landfill area for the next 20 years is:

$H = L \times I \times J$

= 7.375,61 $m^2$/hari x 20 tahun x 1,2

= 17.7014,64 $m^2$

= 17,70 Ha

**The Parameter of the Geographical Environment Feasibility**

- Geology: Due to the possibility of the change of the geological conditions, the placement of the landfill which is at 100 meters outside the active fault zone to prevent impacts of the bedrock in the area of the landfill candidate that is very important in minimizing the spread of the *leachate* naturally, both while on the move toward the water surface and lateral move together with the groundwater. Therefore, it requires the study of the area selection that does not have a landfill with the bedrock formations of sandstone, limestone or hollow rock. West Tulang Bawang district is located in eastern Sumatran lowland characterized by hills and plains.

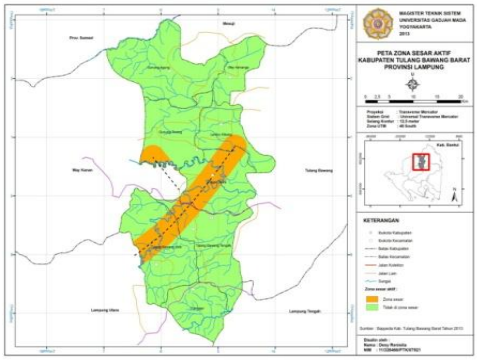



Figure 3. Geology

- The distance of water bodies: there is a need to know the location of the groundwater surface, to detect the ground impermeability, the location of the river or reservoir or groundwater and drinking water resources used by the surrounding society. There is an effect caused by lindi water, resulting from wastes decomposition in the landfill. Therefore, the distance of the landfill from the river is decided to be placed at 300 meters away as the buffer of the feasibility. The location of the landfill which is near the water bodies will have a risk of lindi water pollution which enters the rivers and the groundwater which then mixed into the groundwater.

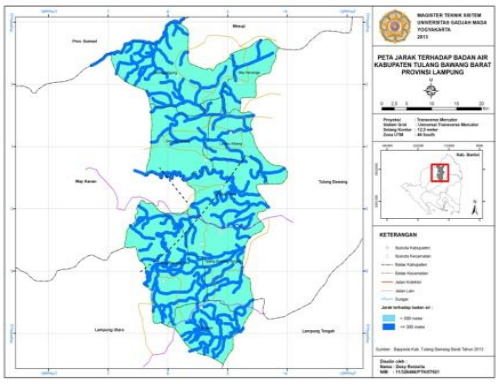



Figure 4. The distance of the water bodies

- Topography: The location of the wastes backfill should not be located on a hill with an unstable slope. An area has bigger value when it is located on a sloping area. Very steep areas considered to have a smaller value because it is feared to cause a fatal landslide, especially when the rainfall or high water seepage. Therefore, in order to prevent the flow of runoff water pollution, the location of which will be used as landfill should have a surface with a natural slope of ≤ 20%.

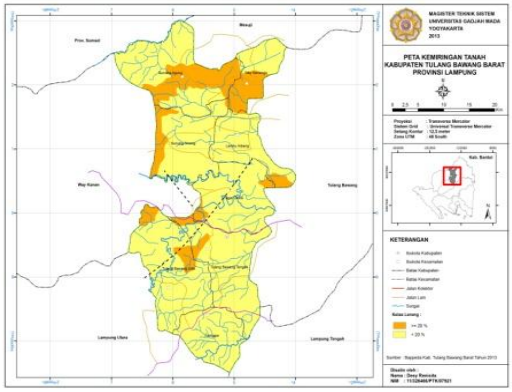



Figure 5. Topography

- The distance between the road and the settlements: The distance which is decided as the buffer of the landfill to the settlements is 500 meters away to prevent water and odor pollution, vector animals, and noise.

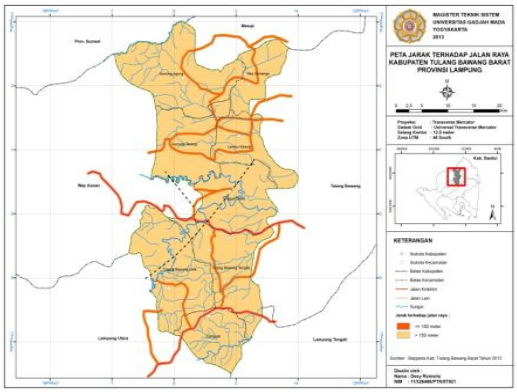



Figure 6. The distance of the road

- The distance from the administrative border: in order to avoid the environmental, social, and political problems such as inter-region conflicts, thus the limitedness of the distance between the location of the landfill and the administrative border is 500 meters minimum.

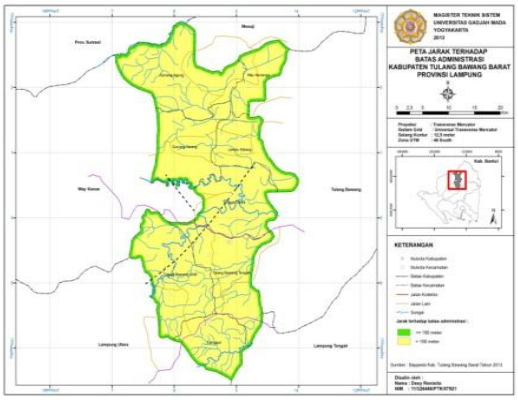



Figure 7. Administrative Border

- The distance from the flooding prone areas: The location of the landfill must be out of the flooding for 25 years.

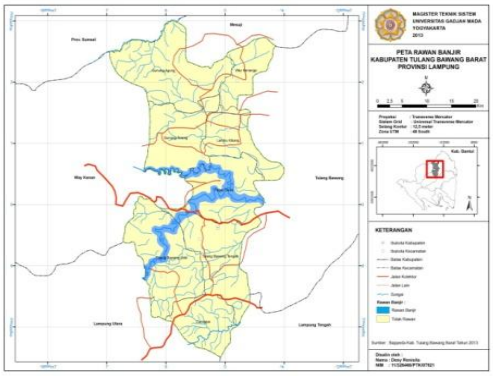



Figure 8. Flooding Prone Areas

**The Feasibility of Environmental Geography**

The selection of the landfill should consider the environmental aspects to avoid disruption of the ecological balance. One of the methods that can be used is to place a landfill on the safe and appropriate geological conditions to reduce the risk of environmental pollution which is a stage to get the information zone and is not worthy for the landfill. It is started by a parameter feasibility analysis of a geographical environment by overlaying thematic maps of West Tulang Bawang District.

The parameters used in this regional analysis are in accordance with the National Standard of Indonesia No. 19-3241-1994 about the selection of the landfill published by the National Standardization Agency. The results of the six parameters overlays are geological maps, the distance of water bodies, topography, the distance of the settlements and the road, administrative border and the maps of flooding prone areas which produce a zone map of landfill feasibility.

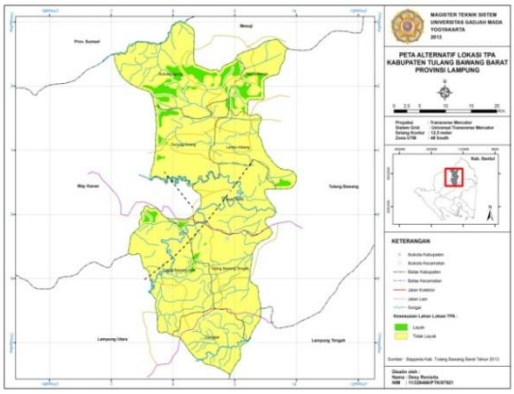



Figure 9. Overlay

A feasible zone for the landfill is green colored and which is not is yellow colored. On each stage of the feasibility, thus the feasible zone will be reduced.

**Feasibility based on The Regional Policies**

In the Regional Regulation of West Tulang Bawang District No. 02 of 2012 Article 5 paragraph (2) states that the landfill to be built lies in Tulang Bawang Udik districts and / or in the Central Tulang Bawang sub-district, which the zone of landfill can be found in the red circle area.

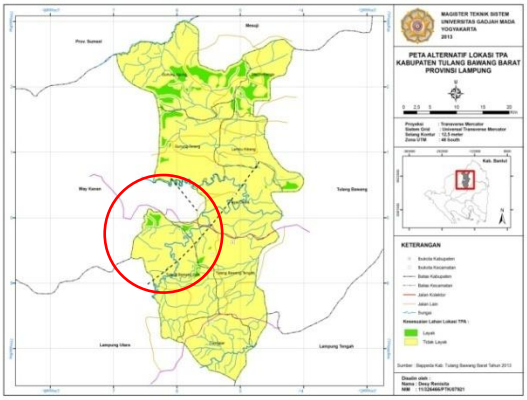



Figure 10. The feasible location

From the calculation of the projection of land requirements for the landfill in West Tulang Bawang District in 2033 through the patterns of sanitary landfill, which is compared with the locations that already have a regional feasibility parameters of the land area that meets the requirements for use as a landfill of 17.70 hectares. Thus, a feasible location based on a regional policy of West Tulang Bawang district as follows:

Table 3. Feasible Location for The Landfill

| Sub District | Village | Luas (Ha) |
|---|---|---|
| **Tulang Bawang Udik** | Gedung Ratu | 178,3791 |
| | Gn. Katun Malay | 59,7881 |
| | Gn. Katun Tanjungan | 166,6107 |
| | Kagungan Ratu | 74,6755 |
| **Tulang Bawang Tengah** | P. Jaya Utama | 99,6767 |
| | Panaragan | 136,2602 |

**Feasibility Based on Indonesian National Standard**

After finishing the feasibility stage of environmental geography and regional policy, the screening phase of the best alternative location of the landfill is conducted by using elimination criteria contained in the Indonesian National Standard (SNI 03-3241-1994).

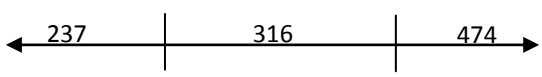
The elimination criteria is the criteria used to choose the best location consisted of regional criteria and added by the following criteria:

1. Climate
2. Utility: The most completed is the best presentation.
3. Biological Environment
4. The Ground Condition
5. Demography: The less population is better
6. Administrative Border: The better location is the one located inside the administrative border
7. Noise: The more supporting zone is the better
8. Odor Pollution: The more supporting zone is the better
9. Aesthetics: The more hidden from outside is the better
10. Economics: The less cost of waste management ($m^3$/ton) is the better

Table 3. Elimination Criteria

| No | Parameter | Udik Tulang Bawang Sub-District | | | | Central Tulang Bawang Sub-District | |
|---|---|---|---|---|---|---|---|
| | | Gedung Ratu | Gn. Katun Malay | Gn. Katun Tanjungan | Kagungan Ratu | Panaragan | Panaragan Jaya Utama |
| **I.** | **General** | | | | | | |
| 1 | Administrative Border | 50 | 50 | 50 | 50 | 50 | 50 |
| 2 | Land Owner | 9 | 9 | 9 | 9 | 9 | 9 |
| 3 | The Capacity of the area | 50 | 50 | 50 | 50 | 50 | 50 |
| 4 | The amount of the land owners | 3 | 3 | 3 | 3 | 3 | 3 |
| 5 | Society Participation | 3 | 3 | 3 | 3 | 3 | 3 |
| **II.** | **Physical Environment** | | | | | | |
| 1 | Ground (Above the Ground-water surface) | 50 | 50 | 50 | 50 | 50 | 50 |
| 2 | Groundwater | 5 | 5 | 5 | 5 | 5 | 5 |
| 3 | Ground stream system | 3 | 15 | 3 | 15 | 15 | 3 |
| 4 | The relationship with the use of the groundwater | 15 | 15 | 15 | 15 | 15 | 30 |
| 5 | Flooding prone | 20 | 20 | 20 | 20 | 20 | 20 |
| 6 | Covering Land | 40 | 40 | 40 | 40 | 40 | 40 |
| 7 | Rainfall Intensity | 30 | 30 | 30 | 30 | 30 | 30 |
| 8 | The access to the location | 5 | 25 | 5 | 50 | 50 | 50 |
| 9 | Wastes Transportation (One Way) | 5 | 5 | 5 | 15 | 40 | 50 |
| 10 | Enterance | 40 | 40 | 40 | 40 | 20 | 20 |
| 11 | Traffic | 24 | 24 | 24 | 24 | 24 | 24 |
| 12 | Land use | 25 | 25 | 25 | 25 | 25 | 25 |
| 13 | Agriculture | 3 | 3 | 3 | 3 | 3 | 3 |
| 14 | Conservation Area | 20 | 20 | 2 | 20 | 20 | 2 |
| 15 | Biological | 15 | 15 | 15 | 15 | 15 | 15 |
| 16 | Noise and Odor Pollution | 10 | 10 | 10 | 10 | 10 | 10 |
| 17 | Aesthetics | 15 | 3 | 15 | 3 | 3 | 15 |
| **Total** | | **440** | **460** | **422** | **495** | **500** | **507** |

Information:
The land feasibility




From the elimination parameter with rating parameter and quality based on SNI 03-3241-1994 on the table 22 can be seen that there are 3 alternative locations of the landfill with the highest total scores are on Udik

Tulang Bawang sub-district and Central Tulang Bawang sub-district with some priority rank as follows:

a) Alternative 1 in the Panaragan Jaya Utama village of Central Tulang Bawang sub-district with an area of 99.68 hectares. From the results of the assessment of the elimination parameters of SNI, this location has a high feasibility with the value of 507 points, thus it is recommended. Based on the direct observation in the location, this is the central of the development, thus it is very near to the wastes centroid location and possible to be the location of the landfill.
b) Alternative 2 is located on Panaragan village of Central Tulang Bawang sub-district with the results of the assessment of elimination parameters of SNI of 500 points which includes a location with high feasibility, and have an area of 136.26 ha. From direct observation, this location is the central government of West Tulang Bawang and which most of population is the indigenous, thus there is a need to be specially reviewed if the location is destined to be the landfill location.
c) Alternative 3 is Kagungan Ratu village of Udik Tulang Bawang sub-district which has an area of 74.65 hectares and assessment elimination parameters of SNI of 495 points, which has a high feasibility. The condition of this area is the plantations area and some are rubber plantations.

## 4. Conclusion

1. The projection of the population on 2033 is 330.087 people with wastes generation in a volume of 1237,43 $m^3$/day and the wastes enter the landfill 247,49 $m^3$/day.
2. The need of area for the landfill with sanitary landfill in West Tulang Bawang District for 20 years is 17,70 Ha;
3. The alternative location of the landfill was chose through the priority rank in Panaragan Jaya Utama village of Central Tulang Bawang sub-district with an area of 99,68 Ha, Panaragan village of Central Tulang Bawang sub-district with an area of 136,26 Ha and Kagungan Ratu village of Udik Tulang Bawang sub-district with an area of 74,65 Ha.

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