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Design of Integrated Sanitation Facilities in Bojonegoro

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ABSTRACT

The availability of land in accordance with the location criteria for sanitation infrastructure development was important. Because the location of inappropriate land has caused the built-up infrastructure to be useless. Land acquisition by the District Government should be carried out appropriately, although it might be possible for land acquisition costs as a consequence of sustainable development. The problem of land availability was the background of the study of sanitation infrastructure development integration on one land in Bojonegoro Sub District of Indonesia. Land use was maximally used for Solid Waste Treatment Facilityand Solid Waste Bank on above the basement, and basement was used as Wastewater Treatment Plant (WWTP). Development planning was carried out with literature review and policies that govern the design criteria of planning. The results of the study in 11 urban villages in Bojonegoro Sub District were five urban villages that did not have sanitation facilities, namely Klangon, Kepatihan, Mojokampung, Karangpacar and Ledok Wetan. Land requirement in each village was ± 600 m2, and land acquisition was required. The result of technical calculation in Karangpacar Urban Village, has been found that the land area for Solid Waste Treatment Facility and Solid Waste Bank with service area of 1 village is ± 600 m2. Furthermore, the basement of the Solid Waste Treatment Facility, covering an area of ± 60 m2 was utilized for WWTP with Anaerobic Baffle Reactor (ABR) system, with a processing capacity of 400 home connection.

KEYWORDS: Location Criteria, Solid Waste Treatment Facility, Wastewater Treatment Plant, Solid Waste Bank

INTRODUCTION

As per 2030 in the Sustainable Development Goals (SDGs) milestone, each country was expected to be able to realize 100% Sanitation Access for its inhabitants (Goal # 6). Indonesia has placed its initial target of achievement at the end of 2019 as mandated by the RPJMN 2015 – 2019 [1]. Bojonegoro sub-district was the administrative center of Bojonegoro District with the condition of waste management with domestic coverage of household waste service non-transported settlement areas to Solid Waste Transfer Facility or Sanitary Landfill less than 2 times a week, averaging ± 35% [2]. And waste management with a 3 R (reuse, reduce and recycle) system is only about 0.5%, is expected to be 10% in the short term, in the medium term to 30% [3]. Furthermore, for wastewater management in the Bojonegoro sub-district is mostly mixed between domestic sewerage channel and environmental drainage, with an average of 85.89% [2]. The Bojonegoro District Government target for Bojonegoro District in its long-term wastewater system is planned to develop a medium-density off-site waste water system [3].

The availability of land was important in any infrastructure development, including in sanitation infrastructure. The various problems that have occurred in the provision of land for the construction of sanitation infrastructure this sector has hampered the achievement of the Government target 100 - 0 - 100 in 2019 [4]. Coordinating Minister for Economic Affairs Darmin Nasution has said the problem of land acquisition has dominated the cause of infrastructure development, reaching 44 percent of reported problems [5].Based on Regulation of Minister of Public Works and Public Housing No. 33 Year 2016, about Planning and Programming Mechanism and Implementation of Infrastructure Development for Sanitary Sector, location for wastewater infrastructure and location of area-scale waste management activities must already exist in the planned area [6]. Therefore, the integration study of sanitation infrastructure development on one land was expected to utilize one field for three sanitation infrastructure, namely Solid Waste Treatment Facility, Wastewater Treatment Plant (WWTP) and Solid Waste Banks. The land that was used as the location of the study was the land that complies with the location criteria based on the existing Standard of Regulations and Policies (NSPK) [7].

Problems of land availability and the achievement of targets in the field of sanitation was the background of this Integrated Infrastructure Development Study on One Area District Bojonegoro. This research was expected to be a reference for the Government of Bojonegoro Regency in planning and programming and implementing the development and management of sanitary infrastructure in one land.

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Location criteria for Solid Waste Treatment Facility, WWTP and Solid Waste Bank based on the regulations governing them will be used as reference in analyzing suitable land. The results of the literature study of these regulations, can be summarized matters related to service coverage, land area and site criteria of each sanitation infrastructure, as shown in Table 1.

Table 1. Integration of Sanitation Infrastructure Development

Sanitation Infrastructure	Regulation	Service Coverage	Land Area	Location Criteria
Solid Waste Treatment Facility	Regulation of the Minister of Public Works and People's Housing No.03/2013	At least 400 families	At least 200 m^2	Radius 1 km from service area
WWTP	Regulation of the Minister of Public Works and Public Housing No.04/2017	20 - 50,000 (soul)	Appropriate choice of processing technology	Adjacent to the service area
Solid Waste Bank	Regulation of the Minister of Environment No.13/2012	At least 1 Village (>500 Families)	At least 40 m^2	Can be integrated with 3R

METHODS

Study Area

The research was conducted in Bojonegoro Sub-district, with study locations in 11 urban villages, that are: Jetak, Sumbang, Klangon, Kepatihan, Mojokampung, Kadipaten, Ngrowo, Karangpacar, Banjarjo, Ledok Wetan, and Ledok Kulon Villages. Calculation example of Solid Waste Treatment Facility, WWTP, and Solid Waste Banks, one village was chosen based on technical criteria and recommendation from related institution.

Methods

The method used in this research was quantitative research method. The study used numerical data as a tool to analyze information about what you want to know. The data required in the study were obtained through literature study (secondary data), and survey and interview (primary data). The literature study was carried out by reviewing the Government regulations governing the criteria for the location of sanitation infrastructure development. Criteria for Solid Waste Treatment Facility based on Minister of Public Works Regulation No.3 Year 2013 [8]. Further criteria for WWTP based on Regulation of Minister of Public Works and People's Housing No. 4 Year 2017 [9]. And the criteria of Solid Waste Bank based on Regulation of the Minister of Environment No. 13 Year 2012 [10]. The method of studying the integration of infrastructure development was as shown in Figure 1.

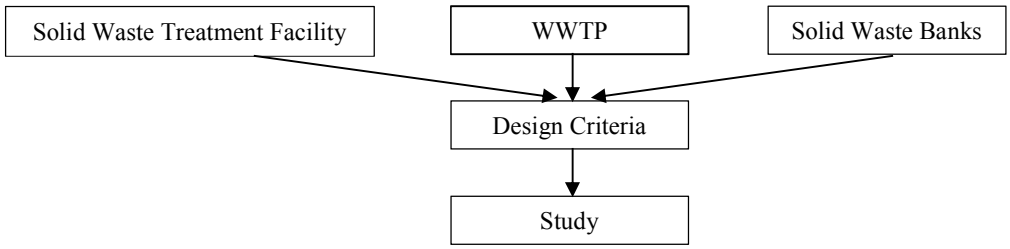

Figure 1. Method of Integration Review

Further surveys and interviews were conducted in the study sites to collect the necessary data. Survey results and interviews were analyzed to determine the condition of waste and waste water management in each urban village. The results of the analysis of sanitation management conditions will be generated villages which require sanitation infrastructure development. The next stage was that the urban villages were analyzed to determine the location of selected land based on the location criteria. Subsequently, one urban village was chosen based on related recommendations. Selected urban village will be analyzed to determine the development planning of Waste Material Facilities and Waste Banks on the upper land, and WWTP on the lower land.

RESULTS AND DISCUSSION

Land for Site Development Plan

Surveys have been conducted in Bojonegoro District, at 11 (eleven) urban villages. Based on the results of the head of urban village interviews in the 11 (eleven) urban villages, it has been analyzed that the wastewater

and waste management conditions in each kelurahan are shown in Table 2. There were still 5 (five) urban villages that did not have Solid Waste Treatment Facility, namely Klangon, Kepatihan, Mojokampung, Karangpacar and Ledok Wetan.

Table 2. Condition of Wastewater and Solid Waste Management in Bojonegoro Sub-district

Village	Management of Domestic Wastewater		Solid Waste Management	
	Number of WWTP	Information	Number of Solid Waste Transfer Facility & Solid Waste Bank	Information
Jetak	1 WWTP with 70 home connections	The rest is still mixed with drainage channels	1 Solid Waste Transfer Facility	No Solid Waste Bank yet
Sumbang	1 WWTP with 60 home connections	The rest is still mixed with drainage channels	1 Solid Waste Transfer Facility& 1 Solid Waste Bank	Solid Waste Transfer Facility is used by other sub-districts as well
Klangon	1 WWTP with 150 home connections	The rest is still mixed with drainage channels	1 Solid Waste Bank	Solid Waste Transfer Facility participates with other Village
Kepatihan	1 WWTP with 60 home connections	The rest is still mixed with drainage channels	1 Solid Waste Bank	Temporary Waste Shelter participates with other Village
Mojokampung	1 WWTP with 67 home connections	The rest is still mixed with drainage channels	There is no Solid Waste Transfer Facility & Solid Waste Bank	Solid Waste Transfer Facility participates with other Village
Kadipaten	1 WWTP with 100 home connections	The rest is still mixed with drainage channels	2 Solid Waste Transfer Facility & 1 Solid Waste Bank	Solid Waste Transfer Facility is used by other sub-districts as well
Ngrowo	1 WWTP with 150 home connections	The rest is still mixed with drainage channels	1 Solid Waste Transfer Facility& 1 Solid Waste Bank	Solid Waste Transfer Facility is used by other sub-districts as well
Karangpacar	1 WWTP with 90 home connections	The rest is still mixed with drainage channels	There is no Solid Waste Transfer Facility & Solid Waste Bank	Solid Waste Transfer Facility participates with other Village
Banjarjo	1 WWTP	The rest is still mixed with drainage channels	1 Solid Waste Treatment Facility	No Solid Waste Bank yet
Ledok Wetan	1 Public Toilet	The rest is still mixed with drainage channels	There is no Solid Waste Transfer Facility & Solid Waste Bank	Solid Waste Transfer Facility participates with other Village
Ledok Kulon	4 WWTP	The rest is still mixed with drainage channels	1 Solid Waste Transfer Facility& 1 Solid Waste Bank	Solid Waste Transfer Facility is used by other sub-districts as well

Furthermore, it was analyzed related to the availability of land to be the location plan of Solid Waste Treatment Facility development, WWTP and Solid Waste Bank, as shown in Table 3. Location of the land in the five urban villages can be seen in Figure 2.

Table 3. Land Availability for Study Sites

Village	Land for TPS 3R, IPALD-T Settlement & Garbage Bank			
	Location Criteria	Land Location	Land Area	Land Status
Klangon	Adjacent to the residential area	Irigasi Walkway	± 600 m^2	Land acquisition is required
Kepatihan	Adjacent to the residential area	Dr. Soetomo Street	± 600 m^2	Land acquisition is required
Mojokampung	Adjacent to the residential area	Ma'ruf Walkway	± 600 m^2	Land acquisition is required
Karangpacar	Adjacent to the residential area	Kuncoro 2 Walkway	± 1500 m^2	Land acquisition is required for road access
Ledok Wetan	Adjacent to the residential area	K. H. Mansyur Street	± 600 m^2	Land acquisition is required

(a). Klangon(b). Kepatihan

(c). Karangpacar **(d). Ledok Wetan** **(e). Mojokampung**

Figure 2. Location of The Land in Five Urban Villages (a) Klangon, (b) Kepatihan, (c) Karangpacar (d) Ledok Wetan, and (e) Mojokampung

The results of analysis in five urban villanges selected Karangpacar Village as study location for calculation of Solid Waste Treatment Facility, WWTP and Solid Waste Bank. This election was based on the recommendation of urban villange preparedness, which has proposed the construction of WWTP at the location in deliberation of urban village development plans.

Solid Waste Treatment Facility and Solid Waste Bank Planning in Karangpacar Urban Village, Bojonegoro Sub-district

Solid Waste Treatment Facility inKarangpacarUrban Villange planned to serve one urban villange, with service area according to administrative boundary Karangpacar Village. Determination of service area based on location criteria at Ministry of Public Works No.03 of 2013 and Handbook of Practical Implementation of TPS 3R [11]. The amount of waste generation is calculated based on the projected population up to 2027 [12]. The amount of waste generation in Bojonegoro sub-district is 2.5 liters / person / day and garbage service reaches 100% of the population, then the projection of waste generation that will be entered into Solid Waste Treatment Facility in 20127 is 13.810 liters / day = 13.81 m3 / day ~ 14 m3 / day.

Based on data on recovery factor [13] and data of waste generation along with its service coverage, it can be calculated recyclable waste and residual waste that will enter Sanitary Landfill with assumption of solid waste composition was as follows in Table 4.

Table 4. Weight of Recyclable Solid Waste Components & Residues

Component	Composition (%)*)	Weight of Solid Waste (kg/day)	Recovery Factor **)	Potential Recycling (kg/day)	Residual Weight (kg/day)
Organic Materials	75%	3035,34	80%	2428,27	607,07
Paper	8%	323,77	40%	129,51	194,26
Glass	1%	40,47	70%	28,33	12,14
Plastic	7%	283,30	50%	141,65	141,65
Cans / Metal	2%	80,94	80%	64,75	16,19
Etc	7%	283,30	-	-	283,30

Source: * Environment Agency of Bojonegoro Regency
**** [13]**

The land needs analysis was calculated based on the amount of waste generation, garbage composition, recovery factor, mass balance, and waste processing at TPS 3R, which was shown in Table 5.

Table 5. Solid Waste Treatment Facility and Solid Waste Bank

Main Facility	Land Area (m2)
Reception & sorting	47
Storage of stalls	45
Composting	340
Leachate shelter	1
Place of residue / container	19
Total Main Facility	452
10% Total Primary Facility	45,2
Supporting Facilities	50
Room Buffer Zone	50
Total Land Requirements	± 600

Implementation of the Reduce, Reuse, Recycle (3R) principle as close as possible to the source of waste was also expected to solve the waste problem in an integrated and comprehensive manner, so that the ultimate goal of the Indonesian Waste Management policy can be properly implemented [14]. Therefore, the location of Solid Waste Treatment Facility was integrated with Solid Waste Bank. In Table 5 there are storage facilities for stalls and supporting facilities in the form of offices, this facility has accommodated the space requirement of Solid Waste Treatment Facility and Solid Waste Bank.

Planning IPALD-T Settlement in Karangpacar Village, Bojonegoro District

Impaired environmental conditions especially in densely populated and coastal areas was due to poor sanitation management and irrelevant used of local sanitation systems in densely populated low-cost areas. These conditions result in environmental pollution, especially water and soil pollution which will then be given special treatment through wastewater management technology with communal system [15]. The centralized processing system becomes the main alternative because local processing systems such as the existing septic tank technology in the community werw generally rarely depleted after more than 15 years of operation, indicating a leak in the tank [16]. Alternative wastewater treatment technology selected was processing using an anaerobic system, whose construction was underground, namely Anaerobic Baffled Reactor (ABR).

Furthermore, WWTP area covered Neighborhood Association.7, 9, 10, 11, 12, 13, 14, 15. The service area was determined based on the ease of construction of its waste water distribution network provided that it was still within the administrative area of the Village. Topography became a very important consideration, because it determines the direction of flow and WWTP design.The calculations used the design criteria from Sasse et al [17]. Based on the result of laboratory test on waste water to be processed, obtained COD value 212 mg/L, BOD 123 mg/L and TSS 112 mg/L. Wastewater parameters to be treated have been included in the domestic wastewater value range of BOD 121 - 151 mg/L and COD 700 - 700 mg/L [18]. WWTP is planned to serve 400 house connections with a population of ± 1,600 inhabitants. Use of clean water = 126 l / org / day.

Based on the design criteria and data above, land requirement for WWTP in Karangpacar Urban Village can be determined. The length of ABR @ 1.5 m with the number of compartments of 11, totaled length of 16.5 m. The width of ABR was 2.5 m so that the area of ABR is 41.25m2. Before entering the ABR, the wastewater went to the settling basin with the depth and width of the tub following the depth and width of the ABR compartment of 2.5 m. So as to get the length of the settling tub was 4.5 m. Construction of WWTP was placed under the wastepaper storage area of the Solid Waste Bank and the compost storage warehouse of Solid Waste Treatment Facility.

Domestic wastewater treatment process with the above planning design was analyzed, to know the concentration of BOD, COD and TSS effluent. The results of the analysis produced astable effluent [19] that has met the wastewater quality standard permitted to be discharged into river water bodies [20], shown in Table 6.

Table 6. Treatment of Domestic Wastewater from Planning Results WWTP in Karangpacar Urban Village

Parameter	Influent Settler	Efficiency Settler	Effluent Settler (Influent ABR)	Efficiency ABR	Effluent ABR	Domestic Wastewater Quality Standard *
BOD	123	37,85%	82,82	76,01%	19,87	30
COD	212	35,71%	146,67	68,24%	46,59	100
TSS	112	-	112	80%	22,4	30

Source: * Regulation of the Minister of LHK No. 68 of 2016

CONCLUSIONS

Bojonegoro Sub-district consisting of 11 urban villages, there were still 5 urban villages that did not have a Solid Waste Transfer Facility, namely Klangon, Kepatihan, Mojokampung, Karangpacar and Ledok Wetan. Land for the sanitation infrastructure location in the five urban villages was planned to be located near the settlement, in accordance with the technical criteria.

Land utilization was integrated with sanitation infrastructure development planned in Karangpacar Urban Village, Bojonegoro Sub-district. The planned sanitation facilities on the land, that was the above basement was planned for Solid Waste Treatment Facility and Solid Waste Bank with service area of one urban village. Land area required ± 600 m2. The location of the land was located near the settlement and in the middle of the urban village, in accordance with the location criteria of Solid Waste Treatment Facility, which had a maximum distance of 1 km from the service area. Basement was planned for WWTP using Anaerobic Baffle Reactor (ABR) processing technology. WWTP wasplanned to serve ± 400 home connections. WWTP with land requirement ± 60 m2, placed under storage areas and compost storage warehouses.

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