Evaluating Inundation in Urban Drainage Systems in Tamalanrea District Makassar Based Ecodrainase

Rizky Alfidhdha\(^1\) and Nieke Karnaningroem\(^2\)

\(^1\)Sanitation Environmental Master Program Engineering Department, Faculty of Civil and Planning, Sepuluh Nopember Institute of Technology, Indonesia
\(^2\)Sanitation Environmental Engineering Department, Faculty of Civil and Planning, Sepuluh Nopember Institute of Technology, Indonesia

Email: rizkyalfidhdha@gmail.com

Abstract— Makassar City is one of the major cities in Indonesia with a population of approximately 1.7 million inhabitants, which continues to grow and followed the development of urban infrastructure facilities. The development also resulted in adverse effects on the environment, especially for water catchment area turns into a watertight region resulting changes in surface runoff were greater, especially in the rainy season because the drainage coefficient values are increasing as well. The purpose of this study was to analyze the capacity of the capacity of drainage channels in terms of technical aspects, analyze and formulate efforts to address flooding in a drainage channel system environmentally friendly in terms of environmental aspects, and Calculating the cost and benefit the development of the handling of flooding with a drainage channel system environmentally friendly in terms of financial aspects. The results obtained from the analysis of the technical aspects there are 14 of 41 channel capacity is insufficient accommodation capacity, resulting in the analysis of environmental aspects require 867 infiltration wells, and 3.19 rate of Benefit Cost Ratio (BCR).

1. Introduction
Currently the drainage system has become one of the most important urban infrastructure. The quality management of a city can be seen from the quality of the existing drainage system. Good drainage system can liberate the city from puddles. Stagnant water causes the environment dirty and slovenly, become mosquito breeding, and sources of other diseases, which can degrade the quality of the environment and public health. One way of realizing a good drainage system will require a valid network data associated drainage system from upstream to downstream. The existence of a map of the flow of drainage network can facilitate the identification of the interference problem drainage and land-use planning Sustainable drainage (sustanable) and Environmental (Ecology). The drainage system in the district has a primary drainage Tamalanrea with a length of 14.65 km 33.63 km of secondary channels. The water level reaches 50 cm in Tamalanrea and Tamalanrea Jaya village, 150 cm in the village Tamalanrea Beautiful, Kapasa, Parangloe, and Bira with an average time of low tide more than 2 hours. With an area of inundation varied, but the overall total inundation area in District Tamalanrea of 649.7 ha (BPBDs Makassar, 2014). The number of roads that run into puddles in the district as much as 670 road, or about 40% of the roads in 1708 with an area of 375,017.4 m\(^2\). Now, then the concept of the drainage needs to be changed from the conventional concept (old concept), a principled drain surface water as soon as possible to the body of water, into a new concept of urban drainage environmentally sound principled drain excess water to accommodate and absorb into the body of water. Therefore, the analysis of the environmental aspects is necessary so that the drainage
system has the goal of accommodating, soak, drain, and maintain, so that soil water conservation is maintained and can take place continuously and dimensions can be more efficient drainage infrastructure. In addition to technical and environmental analysis, financial analysis needs to be reviewed in this study.

2. Material and Methods

In this study, the method used is descriptive quantitative method to evaluate the condition of existing drainage channels are supported by primary data, the survey results in the determination of alternative ways control inundation accordance with the conditions of research areas. Activities carried out by conducting site surveys, analyze and interpret the data obtained for solutions and solving problems found in the field. Data obtained derived from the information society and institutions.

**Figure 1.** The Flowchart of research step.

3. Result and Discussions

3.1 Technical Aspect
The technical aspects include: rainfall averages region, analysis of rainfall plan, analysis of the frequency of the maximum daily rainfall (HHM) plan, test the suitability of the distribution, analysis of arch rainfall plans, analysis discharge storm water runoff, water analysis household waste, the analysis of the flow rate channel.

3.1.1. Capacity of Drainage Channels

Hydraulics analysis includes the calculation capacity of the existing channels. Hydraulics analysis calculation is hereinafter used as the basis for the evaluation of the capacity of existing channels. Channel capacity is analyzed to determine the amount of water flow capable drained by the channel cross section. Water discharge capable drained by the channel are affected by such broad dimensions, hydraulic radius and velocity of flow or runoff.

Table 1. The capacity of drainage channel

| Channel orientation | Location | L | Shape Of Channel | Dimension | S | m | n | A | P | R | V | Capacity |
|---------------------|----------|---|------------------|-----------|---|---|---|---|---|---|---|---------|
| Secondary 1         | 870      |   | Trapesium        | 1         | 0.7 | 0.8 | 0.005 | 1.25 | 0.023 | 0.7 | 3.56 | 0.191 | 4.37 | 2.972   |
| Secondary 2         | 120      |   | Trapesium        | 0.8       | 0.6 | 0.6 | 0.071 | 1.33 | 0.023 | 0.4 | 2.80 | 0.150 | 3.26 | 1.371   |
| Secondary 3         | 350      |   | Trapesium        | 0.6       | 0.5 | 0.6 | 0.034 | 1.00 | 0.023 | 0.3 | 2.30 | 0.144 | 2.19 | 0.722   |
| Secondary 4         | 870      |   | Trapesium        | 0.6       | 0.5 | 0.6 | 0.047 | 1.00 | 0.023 | 0.3 | 2.30 | 0.144 | 2.59 | 0.855   |
| Secondary 2 ke 4    | 620      |   | Trapesium        | 1         | 0.8 | 1   | 0.046 | 1.00 | 0.023 | 0.9 | 3.83 | 0.235 | 3.56 | 3.205   |
| Secondary A         | 800      |   | Trapesium        | 1.5       | 1   | 1   | 0.024 | 1.50 | 0.023 | 1.3 | 5.11 | 0.245 | 2.65 | 3.312   |
| Secondary 5         | 170      |   | Trapesium        | 1.2       | 0.6 | 0.8 | 0.032 | 1.50 | 0.023 | 0.7 | 4.08 | 0.176 | 2.44 | 1.759   |
| Secondary 6         | 180      |   | Trapesium        | 0.7       | 0.6 | 0.6 | 0.013 | 1.17 | 0.023 | 0.4 | 2.54 | 0.153 | 1.42 | 0.556   |
| Secondary 7         | 500      |   | Trapesium        | 0.8       | 0.5 | 0.5 | 0.006 | 1.60 | 0.023 | 0.3 | 2.69 | 0.121 | 0.84 | 0.274   |
| Secondary 8         | 470      |   | Trapesium        | 0.5       | 0.4 | 0.4 | 0.042 | 1.25 | 0.023 | 0.2 | 1.78 | 0.101 | 1.92 | 0.346   |
| Secondary 9         | 340      |   | Trapesium        | 0.6       | 0.4 | 0.4 | 0.031 | 1.50 | 0.023 | 0.2 | 2.04 | 0.098 | 1.62 | 0.323   |
| Secondary 10        | 90       |   | Trapesium        | 0.5       | 0.4 | 0.3 | 0.037 | 1.67 | 0.023 | 0.1 | 1.67 | 0.081 | 1.57 | 0.212   |
| Secondary 11        | 100      |   | Trapesium        | 0.6       | 0.5 | 0.5 | 0.041 | 1.20 | 0.023 | 0.3 | 2.16 | 0.127 | 2.22 | 0.610   |
| Secondary 12        | 650      |   | Trapesium        | 0.6       | 0.5 | 0.5 | 0.071 | 1.20 | 0.023 | 0.3 | 2.16 | 0.127 | 2.92 | 0.804   |
| Secondary 13        | 610      |   | Trapesium        | 0.3       | 0.2 | 0.3 | 0.061 | 1.00 | 0.023 | 0.1 | 1.15 | 0.065 | 1.74 | 0.130   |
| Secondary 14        | 310      |   | Trapesium        | 1         | 0.5 | 0.8 | 0.029 | 1.25 | 0.023 | 0.6 | 3.56 | 0.168 | 2.25 | 1.352   |
| Secondary 15        | 200      |   | Trapesium        | 0.7       | 0.5 | 0.6 | 0.009 | 1.17 | 0.023 | 0.4 | 2.54 | 0.142 | 1.13 | 0.407   |
| Secondary 16        | 1330     |   | Trapesium        | 1.2       | 0.8 | 0.8 | 0.061 | 1.50 | 0.023 | 0.8 | 4.08 | 0.196 | 3.61 | 2.886   |
| Secondary 17        | 720      |   | Trapesium        | 2         | 1.5 | 1.2 | 0.003 | 1.67 | 0.023 | 2.1 | 6.94 | 0.303 | 1.07 | 2.253   |
| Secondary 18        | 210      |   | Trapesium        | 0.4       | 0.3 | 0.5 | 0.010 | 0.80 | 0.023 | 0.2 | 1.68 | 0.104 | 0.96 | 0.168   |
| Secondary 19        | 720      |   | Trapesium        | 1.2       | 0.8 | 0.8 | 0.009 | 1.50 | 0.023 | 0.8 | 4.08 | 0.196 | 1.40 | 1.124   |
| Secondary 20        | 320      |   | Trapesium        | 0.8       | 0.5 | 0.5 | 0.061 | 1.60 | 0.023 | 0.3 | 2.69 | 0.121 | 2.62 | 0.851   |
| Secondary 21        | 310      |   | Trapesium        | 0.7       | 0.5 | 0.5 | 0.037 | 1.40 | 0.023 | 0.3 | 2.42 | 0.124 | 2.08 | 0.625   |
| Secondary 22        | 900      |   | Trapesium        | 2         | 1.5 | 0.8 | 0.003 | 2.50 | 0.023 | 1.4 | 6.31 | 0.222 | 0.87 | 1.222   |
| Secondary 23        | 820      |   | Trapesium        | 0.6       | 0.5 | 0.5 | 0.010 | 1.20 | 0.023 | 0.3 | 2.16 | 0.127 | 1.10 | 0.302   |
| Secondary 24        | 2360     |   | Trapesium        | 1.5       | 1.5 | 2   | 0.010 | 0.75 | 0.023 | 3.5 | 7.00 | 0.500 | 2.74 | 9.584   |
| Primary             | 6700     |   | Trapesium        | 4         | 3   | 2   | 0.010 | 2.00 | 0.023 | 7.0 | 12.94 | 0.541 | 2.89 | 20.197  |
| Secondary 26        | 830      |   | Trapesium        | 0.8       | 0.6 | 0.6 | 0.032 | 1.33 | 0.023 | 0.4 | 2.80 | 0.150 | 2.19 | 0.921   |
| Secondary 27        | 510      |   | Trapesium        | 2         | 1.2 | 1   | 0.031 | 2.00 | 0.023 | 1.6 | 6.47 | 0.247 | 3.00 | 4.799   |
| Secondary 28        | 1460     |   | Trapesium        | 1.8       | 0.9 | 1   | 0.029 | 1.80 | 0.023 | 1.4 | 5.92 | 0.228 | 2.76 | 3.723   |
| Secondary 29        | 520      |   | Trapesium        | 0.7       | 0.6 | 0.5 | 0.003 | 1.40 | 0.023 | 0.3 | 2.42 | 0.134 | 0.62 | 0.203   |
3.1.2. Condition of existing drainage

Based on previous calculations that the calculation of the existing channel capacity to discharge the design flood drainage channel conditions at this time can be evaluated. Design flood discharge is the sum of debits that go into the channel. The results of the evaluation will indicate that the channel is still able to function optimally, or is not able to function optimally. Based on the analysis evaluation in District Tamalanrea channel capacity of 41 channels that exist, there are 14 channel capacity is not able to accommodate the design discharge. So as to channel that does not meet the capacities, will be planned one of the technologies that is well catchment ecodrainage for handling. The technically meet the capacities but in the field occurred inundation for trash and sediment that much on the line, so it is necessary for handling channel normalization.

| Channel orientation | Location | L. | Shape Of Channel | Dimension  | S | m | n | A | P | R | V | Capacity |
|---------------------|----------|----|------------------|------------|---|---|---|---|---|---|---|--------|
| Secondary | 30 | 840 | Trapesium | 0.6 | 0.5 | 0.8 | 0.024 | 0.75 | 0.023 | 0.4 | 2.60 | 0.169 | 2.07 | 0.941 |
| Secondary | 31 | 2500 | Trapesium | 1 | 0.5 | 0.5 | 0.024 | 2.00 | 0.023 | 0.4 | 3.24 | 0.116 | 1.61 | 0.603 |
| Secondary | 32 | 1670 | Trapesium | 2.5 | 1.5 | 1 | 0.009 | 2.50 | 0.023 | 2.0 | 7.89 | 0.254 | 1.67 | 3.339 |
| Secondary | 33 | 3940 | Trapesium | 3 | 4 | 2 | 0.024 | 1.50 | 0.023 | 7.0 | 10.21 | 0.686 | 5.27 | 36.858 |
| Secondary | 34 | 790 | Trapesium | 2 | 1.5 | 0.8 | 0.006 | 2.50 | 0.023 | 1.4 | 6.31 | 0.222 | 1.26 | 1.769 |
| Secondary | 35 | 3000 | Trapesium | 1.8 | 0.8 | 1 | 0.009 | 1.80 | 0.023 | 1.3 | 5.92 | 0.220 | 1.52 | 1.972 |
| Secondary | 36 | 2160 | Trapesium | 1 | 0.8 | 0.6 | 0.010 | 1.67 | 0.023 | 0.5 | 3.33 | 0.162 | 1.29 | 0.697 |
| Secondary | 37 | 1500 | Trapesium | 1 | 0.8 | 0.6 | 0.010 | 1.67 | 0.023 | 0.5 | 3.33 | 0.162 | 1.29 | 0.697 |
| Secondary | 38 | 140 | Trapesium | 0.5 | 0.4 | 0.3 | 0.010 | 1.67 | 0.023 | 0.1 | 1.67 | 0.081 | 0.81 | 0.110 |
| Secondary | 39 | 910 | Trapesium | 1 | 0.8 | 0.6 | 0.029 | 1.67 | 0.023 | 0.5 | 3.33 | 0.162 | 2.20 | 1.186 |

| Location | Flood Discharge with Sediment | Capacity with Sediment | Inundation with Sediment | Requires | Capacity > Flood Disc. | No Sediment | Inundation | Requires | Capacity > Flood Disc. | No Sediment | Inundation |
|----------|--------------------------------|------------------------|---------------------------|----------|------------------------|------------|-----------|----------|------------------------|------------|-----------|
| 1        | 1.98 | 2.23 | 0.25 | Qualify | Capacity > Flood Disc. | 2.97 | 1.00 | Qualify |
| 2        | 0.04 | 1.12 | 1.08 | Qualify | Capacity > Flood Disc. | 1.37 | 1.34 | Qualify |
| 3        | 0.54 | 0.63 | 0.08 | Qualify | Capacity > Flood Disc. | 0.72 | 0.18 | Qualify |
| 4        | 1.46 | 0.68 | -0.77 | Not Qualify | Capacity > Flood Disc. | 0.86 | -0.60 | Not Qualify |
| 2 to 4   | 0.64 | 2.56 | 1.92 | Qualify |
| A        | 3.03 | 2.32 | -0.71 | Not Qualify | Capacity > Flood Disc. | 3.31 | 0.28 | Qualify |
| 5        | 1.40 | 1.52 | 0.11 | Qualify | Capacity > Flood Disc. | 1.76 | 0.35 | Qualify |
| 6        | 0.77 | 0.37 | -0.40 | Not Qualify | Capacity > Flood Disc. | 0.56 | -0.21 | Not Qualify |
| 7        | 1.37 | 0.26 | -1.11 | Not Qualify | Capacity > Flood Disc. | 0.27 | -1.10 | Not Qualify |
| 8        | 0.36 | 0.17 | -0.18 | Not Qualify | Capacity > Flood Disc. | 0.35 | -0.01 | Not Qualify |
| 9        | 0.39 | 0.25 | -0.14 | Not Qualify | Capacity > Flood Disc. | 0.32 | -0.07 | Not Qualify |
| 10       | 0.45 | 0.19 | -0.26 | Not Qualify | Capacity > Flood Disc. | 0.21 | -0.24 | Not Qualify |
| 11       | 0.10 | 0.50 | 0.40 | Qualify | Capacity > Flood Disc. | 0.61 | 0.51 | Qualify |
| 12       | 0.63 | 0.66 | 0.03 | Qualify |
| 13       | 1.01 | 0.09 | -0.93 | Not Qualify | Capacity > Flood Disc. | 0.13 | -0.88 | Not Qualify |

**Table 2. The condition of existing drainage**
### 3.2 Environmental Aspect

Alternative inundation reduction referred to in this research is the need for change in the concept of conventional drainage systems become environmentally friendly drainage system in this study is the use of Infiltration wells.

| Location | Flood Discharge with Sediment (m³/sec) | Capacity > Inundation with Sediment (m³/sec) | Requires Capacity > No Sediment Disc. (m³/sec) | Inundation Area Of Disc. (m²) | Height Of Inundation (m) | Period Of Inundation (Hour) |
|----------|----------------------------------------|---------------------------------------------|-----------------------------------------------|----------------------------|-------------------------|---------------------------|
| 14       | 0.23                                   | 1.01                                        | 0.78                                          | Qualify                    | 1.35                    | 1.12                      | Qualify                   | -                         | -                        | -                        |
| 15       | 0.05                                   | 0.34                                        | 0.28                                          | Qualify                    | 0.41                    | 0.35                      | Qualify                   | -                         | -                        | -                        |
| 16       | 1.31                                   | 2.16                                        | 0.86                                          | Qualify                    | 2.89                    | 1.58                      | Qualify                   | -                         | -                        | -                        |
| 17       | 0.44                                   | 1.50                                        | 1.06                                          | Qualify                    | 2.25                    | 1.81                      | Qualify                   | -                         | -                        | -                        |
| 18       | 0.19                                   | 0.16                                        | -0.03                                         | Not Qualify                | 0.17                    | -0.03                     | Not Qualify               | 452.98                    | 0.15-0.20                | 1                        |
| 19       | 0.57                                   | 0.70                                        | 0.14                                          | Qualify                    | 1.12                    | 0.56                      | Qualify                   | -                         | -                        | -                        |
| 20       | 0.05                                   | 0.82                                        | 0.77                                          | Qualify                    | 0.85                    | 0.81                      | Qualify                   | -                         | -                        | -                        |
| 21       | 0.14                                   | 0.50                                        | 0.36                                          | Qualify                    | 0.63                    | 0.48                      | Qualify                   | -                         | -                        | -                        |
| 22       | 0.57                                   | 0.92                                        | 0.34                                          | Qualify                    | 1.22                    | 0.65                      | Qualify                   | -                         | -                        | -                        |
| 23       | 1.14                                   | 0.24                                        | -0.90                                         | Not Qualify                | 0.30                    | -0.84                     | Not Qualify               | 30,173.3                  | 0.15-0.20                | 2                        |
| 24       | 9.87                                   | 6.57                                        | -3.29                                         | Not Qualify                | 9.58                    | -0.28                     | Qualify                   | -                         | -                        | -                        |
| 25       | 20.95                                  | 16.16                                       | -4.79                                         | Not Qualify                | 20.20                   | -0.75                     | Qualify                   | -                         | -                        | -                        |
| 26       | 1.61                                   | 0.61                                        | -0.99                                         | Not Qualify                | 0.92                    | -0.68                     | Not Qualify               | 36,961.1                  | 0.15-0.20                | 3                        |
| 27       | 4.73                                   | 2.88                                        | -1.85                                         | Not Qualify                | 4.80                    | 0.07                      | Qualify                   | -                         | -                        | -                        |
| 28       | 1.36                                   | 2.98                                        | 1.62                                          | Qualify                    | 3.72                    | 2.36                      | Qualify                   | -                         | -                        | -                        |
| 29       | 0.91                                   | 0.16                                        | -0.74                                         | Not Qualify                | 0.20                    | -0.70                     | Not Qualify               | 37,929.7                  | 0.15-0.20                | 3                        |
| 30       | 0.50                                   | 0.85                                        | 0.35                                          | Qualify                    | 0.91                    | 0.41                      | Qualify                   | -                         | -                        | -                        |
| 31       | 2.25                                   | 0.51                                        | -1.74                                         | Not Qualify                | 0.60                    | -1.64                     | Not Qualify               | 59,128.8                  | 0.25-0.30                | 3                        |
| 32       | 5.94                                   | 3.00                                        | -2.93                                         | Not Qualify                | 3.34                    | -2.60                     | Not Qualify               | 140,217.95                | 0.35-0.4                 | 6                        |
| 33       | 30.56                                  | 25.80                                       | -4.76                                         | Not Qualify                | 36.86                   | 6.29                      | Qualify                   | -                         | -                        | -                        |
| 34       | 0.27                                   | 1.33                                        | 1.05                                          | Qualify                    | 1.77                    | 1.50                      | Qualify                   | -                         | -                        | -                        |
| 35       | 4.28                                   | 1.77                                        | -2.50                                         | Not Qualify                | 1.97                    | -2.31                     | Not Qualify               | 124,612.45                | 0.35-0.4                 | 6                        |
| 36       | 1.29                                   | 0.65                                        | -0.64                                         | Not Qualify                | 0.70                    | -0.60                     | Not Qualify               | 32,138.7                  | 0.15-0.20                | 3                        |
| 37       | 0.54                                   | 0.64                                        | 0.10                                          | Qualify                    | 0.70                    | 0.16                      | Qualify                   | -                         | -                        | -                        |
| 38       | 0.07                                   | 0.08                                        | 0.01                                          | Qualify                    | 0.11                    | 0.04                      | Qualify                   | -                         | -                        | -                        |
| 39       | 1.23                                   | 0.99                                        | -0.24                                         | Not Qualify                | 1.19                    | -0.04                     | Qualify                   | -                         | -                        | -                        |
Table 3. The condition of existing drainage

| Channel | Location | Type Of Infiltration Well | Inundation (m³/sec) | A (km²) | I | C | Recharge (m³/sec) | Quantity Housing Infiltration wells | Quantity Road Infiltration wells |
|---------|----------|--------------------------|---------------------|---------|---|---|------------------|-------------------------------------|----------------------------------|
| Secondary 4 | Housing | -0.60 | 0.00048 | 223.59 | 0.65 | 0.01939 | 31 |
| Secondary 6 | Road | -0.21 | 0.00050 | 224.69 | 0.56 | 0.01749 | 12 |
| Secondary 7 | Road | -1.10 | 0.00050 | 222.52 | 0.41 | 0.01268 | 86 |
| Secondary 9 | Housing | -0.07 | 0.00048 | 224.41 | 0.42 | 0.01258 | 6 |
| Secondary 10 | Housing | -0.24 | 0.00048 | 225.24 | 0.45 | 0.01343 | 18 |
| Secondary 13 | Housing | -0.88 | 0.00048 | 229.79 | 0.44 | 0.01315 | 67 |
| Secondary 18 | Housing | -0.03 | 0.00048 | 224.35 | 0.62 | 0.01856 | 1 |
| Secondary 23 | Housing | -0.84 | 0.00048 | 221.80 | 0.44 | 0.01302 | 64 |
| Secondary 26 | Housing | -0.68 | 0.00048 | 223.34 | 0.55 | 0.01639 | 42 |
| Secondary 29 | Housing | -0.70 | 0.00048 | 221.36 | 0.49 | 0.01447 | 49 |
| Secondary 31 | Housing | -1.64 | 0.00048 | 218.72 | 0.37 | 0.01077 | 153 |
| Secondary 32 | Road | -2.60 | 0.00050 | 219.51 | 0.54 | 0.01648 | 158 |
| Secondary 35 | Road | -2.31 | 0.00050 | 215.44 | 0.51 | 0.01527 | 151 |
| Secondary 36 | Housing | -0.60 | 0.00048 | 217.54 | 0.53 | 0.01550 | 38 |
| Amount Of Infiltration Wells | 468 | 407 |

3.3 Economic Aspect
A development activity is said to be economically viable if the cost of the investment (cost) required is less than the benefits (benefits) obtained. Gains on drainage activity generally in the form of indirect revenue, for example, loss or reduction in loss due to waterlogging or flooding, environmental improvements, improved public health and aesthetic improvements.

Table 4. The Benefit, and Cost of infiltration wells

| Channel | Location | Type Of Infiltration Well | Quantity Housing Infiltration Wells | Quantity Road Infiltration Wells | Cost Housing Infiltration Wells (Rupiah) | Cost Road Infiltration Wells (Rupiah) | Losses due to flood 5 years period (Rupiah) |
|---------|----------|--------------------------|-------------------------------------|----------------------------------|------------------------------------------|------------------------------------------|---------------------------------------------|
| Secondary 4 | Housing | 31 | 88,149,124.38 | 88,149,124.38 | 188,364,242.40 |
| Secondary 6 | Road | 12 | 32,122,742.46 | 32,122,742.46 | 95,555,452.15 |
| Secondary 7 | Road | 86 | 226,597,999.24 | 226,597,999.24 | 606,187,637.35 |
| Secondary 9 | Housing | 6 | 15,835,193.80 | 15,835,193.80 | 16,041,598.05 |
| Secondary 10 | Housing | 18 | 50,133,549.37 | 50,133,549.37 | 163,801,440.45 |
| Secondary 13 | Housing | 67 | 191,642,432.65 | 191,642,432.65 | 495,236,725.25 |
| Secondary 18 | Housing | 1 | 3,864,162.97 | 3,864,162.97 | 5,422,266.45 |
| Secondary 23 | Housing | 64 | 183,428,266.79 | 183,428,266.79 | 184,273,040.45 |
| Secondary 26 | Housing | 42 | 119,010,380.62 | 119,010,380.62 | 304,315,418.35 |
| Secondary 29 | Housing | 49 | 138,311,010.28 | 138,311,010.28 | 206,394,904.30 |
| Secondary 31 | Housing | 153 | 434,641,123.13 | 434,641,123.13 | 665,015,858.80 |
| Secondary 32 | Road | 158 | 412,895,579.29 | 412,895,579.29 | 2,366,032,290.45 |
| Secondary 35 | Road | 151 | 395,868,155.86 | 395,868,155.86 | 2,044,322,741.15 |
| Secondary 36 | Housing | 38 | 109,424,652.98 | 109,424,652.98 | 2,725,533,562.95 |
| Amount | 468 | 407 | 1,334,439,896.98 | 1,334,439,896.98 | 7,613,497,178.55 |
4. Conclusion
Urban street drainage need of improvement by infiltration wells viewed groundwater conditions of diminishing returns. Based on the analysis technical aspect found that there are 14 channel in Tamalanrea district was not qualify to accommodate wastewater and rainwater. Based on the analysis environmental aspect Infiltration wells absorb water into the soil and also reduce the inundation that occur in urban areas. Diameter 1.0 m, depth of water 4 m and soil permeability 0.00015 m/sec. Discharge of infiltration wells 0.0019 m³/sec. Based on the analysis inundation treatment with the application of absorption wells in Sub Tamalanrea able to absorb 100% to the total amount of recharge wells as many as 875 pieces. Total costs required to manufacture 875 unit of infiltration wells is IDR 2,401,924,372.00. Based on analysis economic aspect (BCR) benefit cost ratio the result of rate is 3.19 and its mean that feasible to develop.

5. References

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