Evaluation of Roadside Drainage Capacity and Flooding Problems Along Jalan Mayor Oking Jaya Atmaja

Raja Rhamadhan Sudirman Putra, Arien Heryansyah, Dini Aryanti, Nurul Chayati

Civil Engineering Department, Ibn Khaldun University, Bogor, INDONESIA

E-mail: rajaramadhan789@gmail.com, arien@uika-bogor.ac.id, nurul-chayati@uika-bogor.ac.id

| Submitted: June 29, 2026 | Revised: October 22, 2026 | Accepted: October 26, 2026 |

| Published: October 28, 2026 |

ABSTRACT

Drainage channels are designed to handle excess water from roads and surrounding areas due to high rainfall. Flooding frequently occurs along Jalan Mayor Oking Jaya Atmaja, along 50 meters, during the rainy season. Therefore, an evaluation is needed to ensure the drainage system is functioning properly. This study uses a quantitative approach, referring to the provisions of SNI 2415:2016. Rainfall data is processed using a frequency distribution and then tested using the Chi-Square method. After analyzing the rainfall data, rainwater discharge analysis is performed using the Rational method. The analysis results indicate that the drainage channel cannot accommodate the planned discharge. The channel Q_s (Q_s) is 6.90 m3/second, lower than the planned Q_r (Q_r) of 9.87 m3/second, indicating that Q_s < Q_r, whereas the value of Q_s should be greater than Q_r.

Keywords: drainage, rainfall, discharge, rational, channel dimensions.

INTRODUCTION

Inundation occurs when an area is filled with water because there is no drainage to prevent the water from flowing out [1]. Therefore, inundation is closely related to infiltration and drainage channels. Inundation is defined as a collection of water that stops flowing in places that are not water bodies [2]. According to the Big Indonesian Dictionary, inundation comes from the word "genang," which means to stop flowing. Therefore, the definition of inundation is water that stops flowing in a specific area that is not a water body or reservoir. However, for the general public, both inundation and flooding are generally considered the same term.

This research was conducted on Jalan Raya Mayor Oking Jaya Atmaja Cibinong, specifically in front of the Eka Wijaya access road, in line with the increasing construction of buildings, restaurants, offices, and so on, all of which require water channels for waste disposal. One of the waterways discussed is the Mayor Oking Jaya Atmaja Highway drainage channel, as this area frequently experiences water puddles on the roadway, which can hinder traffic and even impact road construction. This is often observed during heavy or moderate rainfall. According to a report [3], heavy rain in Bogor Regency caused flooding in Mayor Oking Highway, Cibinong District, Bogor Regency. The flooding occurred on the highway since the afternoon of December 23, 2023. The flooding was only visible on one lane, toward Citereup, while the lane toward Cibinong appeared normal. However, due to the flooding, several motorcycles experienced engine failure [6]-[10].

RESEARCH METHODS

Materials

In this research, the author implemented a series of stages and implementations to achieve the study's goals and objectives. The stages included:

a. Collecting literature relevant to the research topic, including books, scientific articles, and other academic publications.

b. Defining the scope of the problem and identifying the data needed to support the research analysis.

Data Collection

a) Channel Geometry Data

pISSN 2302-4240
eISSN 2655-2086
Volume 15, Issue 4, December 2026, pp.01326-01334
DOI: http://dx.doi.org/10.32832/astonjadro.v15i4.24304 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

This data consists of the dimensions of the channels on the road sections (right and left) of various sizes, obtained from direct observations at the research location. The data obtained is in the form of tables [12]-[15].

b) Rainfall Data

Rainfall data was obtained from the Bogor Climatology Station of the Meteorology, Climatology, and Geophysics Agency (BMKG).

Rainfall Data Analysis

This analysis is used to obtain rainfall with return periods of 2, 5, and 10 years. Rainfall data is obtained from the Rainfall Post. This analysis uses several distribution analysis methods to estimate rainfall for a specific return period.

Calculating Rainfall Intensity

The planned rainfall intensity calculation uses the Mononobe method.

Conducting Hydraulic Analysis

The hydraulic analysis involves calculating the existing and planned flow rates using the rational method.

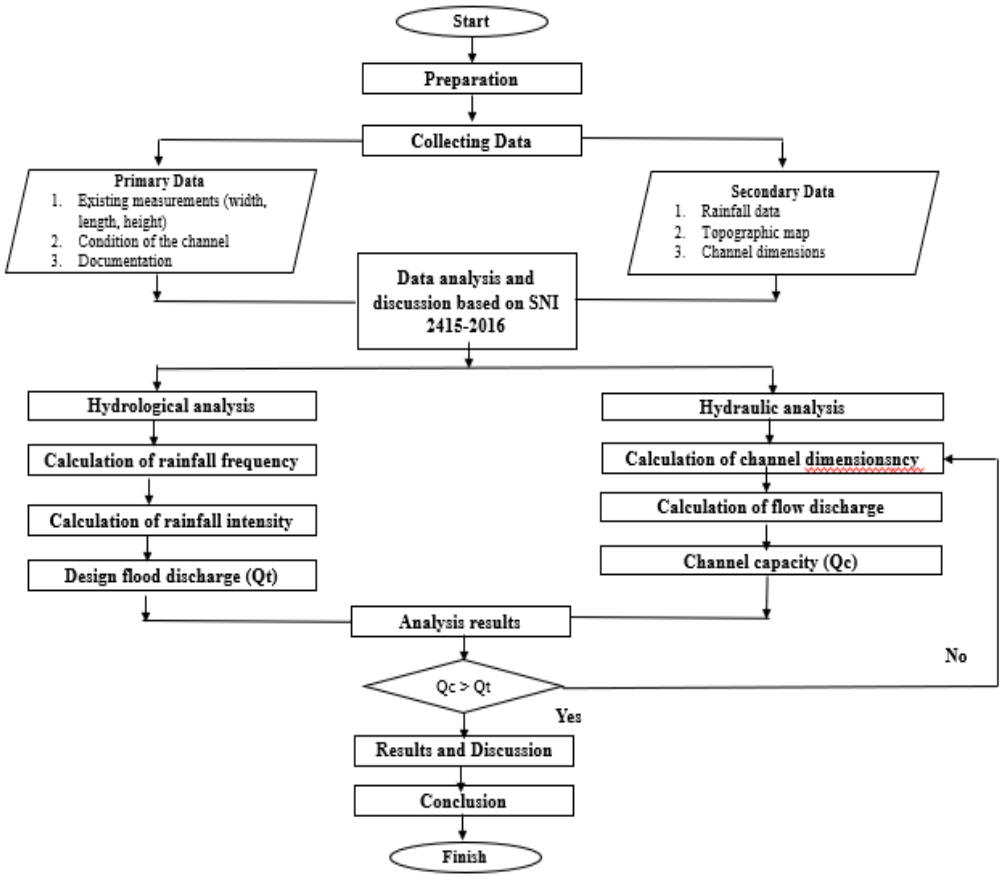


Figure 1. Flowchart

RESEARCH METHOD

The research methodology used in this study is qualitative. Qualitative research aims to obtain numerical results. Qualitative methods can also be defined as data processing or mathematical analysis based on findings or data obtained during direct observations at the research location on

Jalan Mayor Oking Jaya Atmaja, Cibinong District, Bogor Regency. This research was conducted from February to March 2025.

Data Analysis

Data analysis was conducted using the Hydrological Analysis Method. Procedures for Calculating Design Flood Discharge, the analysis was conducted following the applicable new principles. Analysis of the design flood discharge, which is then used as the basis for the construction of a water structure, requires the collection of data and information, particularly data for hydrological calculations [4]. More data collection results in greater cost and time savings, which speeds up the analysis process and produces more accurate computational results. The process of collecting fundamental data and verifying (calibrating) the collected data can be used to obtain comprehensive hydrological data.

This data consists of the dimensions of the road channels (right and left), which vary in size. This data was obtained from direct observations at the research location, showing the direction of water flow from each tertiary channel to the secondary channel located at the research location.

Drainage is a system designed to collect, convey, and discharge excess water from an area to prevent flooding, waterlogging, and environmental damage. It plays an essential role in urban development, transportation infrastructure, agriculture, and residential areas. Drainage systems generally consist of surface drainage, subsurface drainage, and natural drainage channels, including rivers and streams [16]. Surface drainage collects rainwater through gutters, roadside ditches, and channels, while subsurface drainage removes excess groundwater through underground pipes. Effective drainage planning requires consideration of rainfall intensity, catchment area, topography, soil characteristics, land use, and channel capacity [17]. Properly designed and maintained drainage systems improve public health, protect buildings and roads, and support environmental sustainability [18].

RESULTS AND DISCUSSION

Rainfall Analysis

The maximum daily rainfall data obtained from the Cibinong station is presented in Table 1.

Table 1. Maximum Rainfall

Years	Maximum Rainfall
2023	893,00
2024	671,00
2020	575,00
2022	566,00
2016	559,00
2019	479,00
2015	448,00
2018	386,00
2021	329,00
2017	115,00

Analysis of the distribution of maximum rainfall using several methods to determine the skewness coefficient (Cs) and kurtosis coefficient (Ck) values to determine the next method to be used in calculating flood discharge.

pISSN 2302-4240
eISSN 2655-2086
Volume 15, Issue 4, December 2026, pp.01326-01334
DOI: http://dx.doi.org/10.32832/astonjadro.v15i4.24304 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

Table 2. Distribution Analysis Calculation

m	Probability (P) P = m / (N + 1)	Years	d (mm)	Log d (mm)
1	0,091	2023	893,000	2,951
2	0,182	2024	671,000	2,827
3	0,273	2020	575,000	2,760
4	0,364	2022	566,000	2,753
5	0,455	2016	559,000	2,747
6	0,545	2019	479,000	2,680
7	0,636	2015	448,000	2,651
8	0,727	2018	386,000	2,587
9	0,818	2021	329,000	2,517
10	0,909	2017	115,000	2,061
Number of Data Points (n)			10	10
Mean			502,100	2,653
Median			519,000	2,714
Standard Deviation (δx)			208,357	0,241
Skewness Coefficient (Cs)			0,007	-1,746
Kurtosis Coefficient (Ck)			5,028	7,784
Coefficient of Variation (Cv)			0,415	0,091

Table 3. Distribution Determination

No.	Type of Distribution	Conditions	Calculation Results	Conclusion
1	Gumbel	Cs ≤ 1.1306	0,01	Fulfil
		Ck ≤ 5.40	5,03	Fulfil
2	Log Normal	$Cs = Cv^3+3Cv$	1,32	Does not meet the
		$Ck = Cv^8 + 6Cv^6 + 15Cv^4 +16Cv^2 + 3$	6,23	Does not meet the
3	Normal	Cs = 0	0,01	Does not meet the
		Ck = 3	5,03	Does not meet the
4	Log Person Type III	Other than the value mentioned above/flexible		Fulfil

Based on the results in Tables 2 and 3, the Gumbel distribution function was used with the following equation:

$X_T = \bar{X} + K.Sd$

Table 4. Results of the Gumbel Distribution Analysis Method

No.	Year of Observation	Xi	Xi-X	$(Xi - X)^2$
1	2023	893	390,9	152.802,81
2	2024	671	168,9	28.527,21
3	2020	575	72,9	5.314,41

No.	Year of Observation	Xi	Xi-X	$(Xi - X)^2$
4	2022	566	63,9	4.083,21
5	2016	559	56,9	3.237,61
6	2019	479	-23,1	533,61
7	2015	448	-54,1	2.926,81
8	2018	386	-116,1	13.479,21
9	2021	329	-173,1	29.963,61
10	2017	115	-387,1	149.846,41
Total		5021		390.714,90

Table 5. Gumbel Method Planned Rainfall Period

Re-examination (Year)	Yt	K	Rmax (mm)
2	0,3665	-0,1355	473,86
5	1,4999	1,0580	722,55
10	2,2502	1,8481	887,17
20	2,9606	2,5963	1043,05
25	3,1985	2,8468	1095,25
50	3,9019	3,5875	**1249,58**
100	4,6001	4,3228	**1402,78**

Table 5 shows that the planned rainfall is 887.17 mm. The data above uses a 10-year PUH. The drainage area is 5-25 ha (secondary canal with a high risk, 10-year return period) [5], [11].

Chi-Square Distribution Goodness-of-Fit Test

Table 6. Chi-Square Test

Class	Interval	Class limit value	Oi	Ei	(Ei - Oi)	$(Ei - Oi)^2$	$(Ei - Oi))^2 /Ei$
1		P < 289,0	1	2	1	1	0,5
2	289,03	< P < 412,6	2	2	0	0	0
3	412,6	< P < 540,8	2	2	0	0	0
4	540,8	< P < 722,6	4	2	-2	4	2
5		P < 722,6	1	2	1	1	0,5
Total			10	10	0	6	3
Results			Accepted				

The comparison results above show that C2 = Chi-Square value = 3 < C2cr = 6, thus the tested hypothesis is accepted.

Designed Flood Discharge Analysis

The field research results obtained data on the catchment area, secondary channel length, carrier channel length, flow coefficient, and secondary channel elevation are presented in the following table and figure:

Table 7. Channel Data

DTA	Area	Channel Length (m)
DTA A1	9613,69	482,76
DTA 2	10173,91	458,71

pISSN 2302-4240
eISSN 2655-2086
Volume 15, Issue 4, December 2026, pp.01326-01334
DOI: http://dx.doi.org/10.32832/astonjadro.v15i4.24304 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

DTA	Area	Channel Length (m)
DTA 3	6210,93	365,89
DTA 4	8607,94	520,7
DTA 5	8595,75	575,6
DTA 6	3132,52	265,08
DTA 7	3931,64	295,47
DTA 8	8213,35	377,38
DTA 9	8146,86	369,4
DTA 10	16044,79	580,61

Concentration Time

To calculate the concentration time, use Kirpich's equation as follows:

tc = 0.0195 L^0.77 S^(-0.385)

The calculation results are presented in Table 8.

Table 8. Concentration Time Calculation

DTA	Area	Channel Length (m)	S	V	Lo	Ld	To	Td	TC
DTA A1	9613,69	482,76	0,41	1,5	55	205	1,65	5,36	7,01
DTA 2	10173,91	458,71	0,65	1,5	72	163	1,16	5,10	6,26
DTA 3	6210,93	365,89	0,82	1,5	106	155	1,02	4,07	5,09
DTA 4	8607,94	520,7	0,96	1,5	52	239	1,34	5,79	7,13
DTA 5	8595,75	575,6	0,35	1,5	42	262	2,13	6,40	8,53
DTA 6	3132,52	265,08	1,13	1,5	46	89	0,59	2,95	3,53
DTA 7	3931,64	295,47	0,68	1,5	32	113	0,86	3,28	4,15
DTA 8	8213,35	377,38	0,53	1,5	91	114	0,96	4,19	5,15
DTA 9	8146,86	369,4	0,81	1,5	112	178	1,14	4,10	5,25
DTA 10	16044,79	580,61	0,52	1,5	112	226	1,63	6,45	8,08

Rainfall Intensity

To calculate rainfall intensity, the Monoboe Equation is used. The following is the calculation of rainfall intensity:

I = 887.17/24(24/0.142)^(2/3)

I = 730.84 mm/hour

Designed Flood Discharge (Q)

To calculate the planned flood discharge, the rational method can be used.

Q = C.I.A. The calculation results can be seen in Table 9.

Calculation of Drainage Channel Capacity

Calculation of capacity is carried out by calculating channel dimensions and conducting discharge analysis.

The calculation results can be seen in Table 9.

Table 9. Calculation of Designed Flood Discharge and Capacity

DTA	Monitoring Point	Channel Type	Channel Analysis						
			B	H	A	P	R	V	Q_s
DTA 1	A1-A2	Tertiary	0,3	0,3	0,09	0,9	0,1	0,13	0,01
	A1-A3	Secondary	0,3	0,3	0,09	0,9	0,1	0,22	0,02
	A2-A4	Secondary	0,3	0,3	0,09	0,9	0,1	0,39	0,03
	A3-A4	Primary	1,2	1,4	1,68	4	0,42	4,11	6,90
DTA 2	B1-B2	Tertiary	0,3	0,3	0,09	0,9	0,1	0,27	0,02
	B1-B3	Secondary	0,3	0,3	0,09	0,9	0,1	0,36	0,03
	B2-B4	Secondary	0,3	0,3	0,09	0,9	0,1	0,33	0,03
	B3-B4	Primary	1,2	1,4	1,68	4	0,42	3,94	6,61
DTA 3	C1-C2	Tertiary	0,3	0,3	0,09	0,9	0,1	0,15	0,01
	C1-C3	Tertiary	0,3	0,3	0,09	0,9	0,1	0,31	0,03
	C2-C4	Secondary	0,3	0,3	0,09	0,9	0,1	0,23	0,02
	C3-C4	Tertiary	0,3	0,3	0,09	0,9	0,1	0,16	0,01
DTA 4	D1-D2	Tertiary	0,3	0,3	0,09	0,9	0,1	0,17	0,02
	D1-D3	Secondary	0,3	0,3	0,09	0,9	0,1	0,25	0,02
	D2-D4	Secondary	0,3	0,3	0,09	0,9	0,1	0,24	0,02
	D3-D4	Primary	1,2	1,4	1,68	4	0,42	2,27	3,81
DTA 5	E1-E2	Tertiary	0,3	0,3	0,09	0,9	0,1	0,12	0,01
	E1-E3	Tertiary	0,3	0,3	0,09	0,9	0,1	0,25	0,02
	E2-E4	Secondary	0,3	0,3	0,09	0,9	0,1	0,16	0,01
	E3-E4	Primary	0,3	0,3	0,09	0,9	0,1	0,21	0,02
DTA 6	F1-F2	Tertiary	0,3	0,3	0,09	0,9	0,1	0,14	0,01
	F1-F3	Secondary	0,3	0,3	0,09	0,9	0,1	0,26	0,02
	F2-F4	Secondary	1,2	1,4	1,68	4	0,42	3,12	5,24
	F3-F4	Primary	0,3	0,3	0,09	0,9	0,1	0,09	0,01
DTA 7	G1-G2	Tertiary	0,3	0,3	0,09	0,9	0,1	0,10	0,01
	G1-G3	Primary	1,2	1,4	1,68	4	0,42	2,42	4,06
	G2;G4	Secondary	0,3	0,3	0,09	0,9	0,1	0,17	0,02
	G3-G4	Primary	1,2	1,4	1,68	4	0,42	2,48	4,17

Table 10. Channel Analysis Results

DTA	Monitoring Point	Channel Type	Channel Length (m)	Ratio		Results
				Q_s	Q_R	
DTA 1	A3-A4	Primary	190,79	6,90	80,24	UNSAFE
DTA 2	B3-B4	Primary	149,39	6,61	20,06	UNSAFE

DTA 3 D3-D4 Primary 259.15 3.81 93.87 NOT SAFE

CONCLUSION

Based on the results of the evaluation of the drainage network system on Jalan Mayor Oking Jaya Atmaja, several conclusions were drawn, as outlined below: 1. Jalan Raya Mayor Oking Jaya Atmaja, Cibinong Village, Bogor Regency, experiences relatively high rainfall, with a rainfall intensity (I) of 730.84 mm/hour and a planned flood discharge of 93.87 m3/second for a 10-year return period. The drainage channel capacity on Jalan Raya Mayor Oking Jaya Atmaja is 6.90 m3/second, which is lower than the planned flood discharge (Qr). This proves that the existing

pISSN 2302-4240
eISSN 2655-2086
Volume 15, Issue 4, December 2026, pp.01326-01334
DOI: http://dx.doi.org/10.32832/astonjadro.v15i4.24304 http://ejournal.uika-bogor.ac.id/index.php/ASTONJADRO

drainage channels are unable to accommodate the planned flood discharge, resulting in waterlogging or flooding. The low-lying topography of Jalan Raya Mayor Oking Jaya Atmaja, or the basin-like area, causes water to pool at certain points on the road. This is due to the lack of inlet channels connecting the water flow from the road pavement to the road drainage channels, and the poor flow direction.

SUGGESTIONS

1. The local government needs to increase the dimensions of the primary channel located directly on the shoulder of the Pakansari Access Road, as it is unable to accommodate the discharge during high rainfall.
2. Normalize the drainage channel on the Pakansari Access Road by dredging the channel periodically every month to remove accumulated sediment, debris, and debris.

REFERENCES

[1] Suripin (2004). Sistem Drainase Perkotaan yang Berkelanjutan, Edisi Kesatu. Yogyakarta: ANDI Offset.

[2] Poerwadarminta, W.J.S. (1990). Kamus Besar Bahasa Indonesia. Balai Pustaka, Jakarta.

[3] TribunnewsBogor.com (2023, 26 Desember). Hujan Deras Sejak Sore Hari, Jalan Raya Mayor Oking Bogor Tergenang, Pengendara WasWas. https://bogor.tribunnews.com/2023/12/26/hujan-deras-sejak-sore-jalan-raya-mayor-oking-bogor-tergenang-pengendara-was-was

[4] Badan Standarisasi Nasional, SNI 2415:2016. Tata Cara Perhitungan Debit Banjir Rencana. Bandung: Panitia Tekniks 91-01 Bahan Konstruksi Bangunan dan Rekayasa Sipil pada Subkomite Teknis Sumber Daya Air 91-01-S1 melalui Gugus Kerja Balai Hidrologi dan Tata Air, Pusat Penelitian dan Pengembangan Sumber Daya Air.

[5] Dhea Nabilla Hersy (2021). Peninjauan Struktur Jaringan Drainase Terhadap Bencana Banjir Kawasan Pemukiman Kelurahan Besar Kecamatan Medan Labuhan, Kota Medan. Jurnal Ilmiah Mahasiswa Teknik[JIMT]. ISSN: 2808-7720

[6] Irwan (2018). Arahan Pemanfaatan Ruang Berbasis Mitigasi Bencana Banjir di Kota Bima Kecamatan Rasanae Timur. Skripsi. UIN Alauddin Makassar.

[7] Andana, Bayu Dkk (2018). Evaluasi Daya Tampung Sistem Drainase di Kecamatan Banjarmasin Selatan. http://ppjp.unlam.ac.id/journal/index.php/jpg

[8] Anggraini, Try Ayu (2018). Evaluasi Sistem Drainase dalam Upaya Penanggulangan Banjir di Kelurahan Lumpue Kecamatan Bacukiki Barat Kota Parepare. http://repositori.uin-alauddin.ac.id/id/eprint/13092

[9] Badan Pusat Statistik (BPS) Kabupaten Bogor (2024). Kecamatan Cibinong Dalam Angka 2024.

[10] Priambodo, SA (2009). Panduan Praktis Menghadapi Bencana. Yogyakarta: Kanisus.

[11] Kementrian Pekerjaan Umum. Peraturan Menteri Pekerjaan Umum No.12 Tahun 2014 tentang Penyelenggaraan Sistem Drainase Perkotaan.

[12] Kurnilasari Eti Putri (2021). Evaluasi Sistem Drainase Perkotaan di Kelurahan Gerung Utara. Skripsi. Universitas Muhammadiyah Mataram

[13] Pulungan, P. (2023). Evaluasi Sistem Jaringan Drainase Jalan Raya Pada Jalan Kapten Patimura Kelurahan Kenali Besar - Kota Jambi. Skripsi. Universitas Batanghari Jambi

[14] Marcos, dkk. 2017. Evaluasi Sistem Drainase Terhadap Genangan Di Kecamatan Wates Kabupaten Blitar. Jurnal Penelitian Teknik Sipil dan Teknik Kimia. 1(1), h.1-15

[15] Elsa Dwi Relaga (2022). Studi Evaluasi Saluran Drainase di Dusun Banyakan Kecamatan Mertoyudan Kabupaten Magelang. Jurnal Ilmu-ilmu Teknik Sipil

https://doi.org/10.32832/komposit.v8i1.14763

[16] Lutfi, M., Syaiful, S., Chayati, N., Wulandari, R. A., & Insan, M. K. (2026). Structural and Spatial Development Study for TU Kemang Market in Bogor City. ASTONJADRO, 15(2), 394–405. https://doi.org/10.32832/astonjadro.v15i2.19290

[17] Wardhani, A. K., Ngadimo, N., & Muhtadi, A. (2025). Analysis of Road Preservation on the Parung-Bogor Road Traffic Flow. ASTONJADRO, 14(1), 349–365. https://doi.org/10.32832/astonjadro.v14i1.18277

[18] Arsana, I. G. N. K., & Astiti, S. P. C. (2023). Handling and Control of Floods in the Pulukan River/Tukad Macro Drainage System in Jembrana Regency. ASTONJADRO, 12(3), 845–858. https://doi.org/10.32832/astonjadro.v12i3.14115