

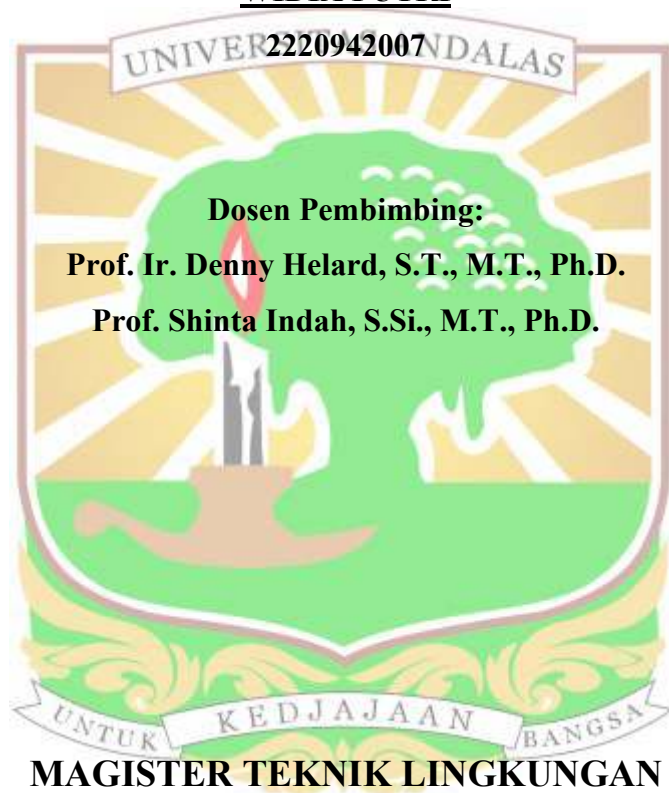
**TESIS**

**PENGEMBANGAN MODEL DINAMIS *STOCK-FLOW* UNTUK  
PENGELOLAAN AIR LIMBAH DOMESTIK  
KOTA PARIAMAN PROVINSI SUMATERA BARAT**

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## ABSTRAK

Pengelolaan air limbah domestik di Kota Pariaman menghadapi kesenjangan antara timbulan air limbah dan kapasitas pengolahan, meningkatkan risiko pencemaran Sungai Batang Pariaman. Kondisi ini diperberat oleh karakteristik pesisir Kota Pariaman dengan pertumbuhan penduduk tinggi dan muka air tanah dangkal. Penelitian ini bertujuan menganalisis faktor pendorong timbulan air limbah domestik, mengembangkan model dinamis stock-and-flow untuk sistem pengelolaannya, dan mensimulasikan efektivitas skenario kebijakan pengelolaan periode 2026–2046 terhadap kualitas sungai. Kebaruan penelitian terletak pada pengintegrasian keberfungsian dan kapasitas IPAL, beban pencemar, serta kualitas sungai ke dalam satu model System Dynamics, berbeda dari penelitian terdahulu yang mengkaji aspek-aspek tersebut secara terpisah. Model dikembangkan melalui Causal Loop Diagram dan Stock Flow Diagram pada PowerSim Studio 10, menggunakan data primer kualitas efluen enam IPAL komunal (BOD, COD, TSS, amoniak, Fecal Coliform) dan data sekunder kependudukan, sanitasi, kapasitas pengolahan, debit, serta kualitas sungai, lalu diverifikasi, divalidasi, dan disimulasikan pada skenario pesimis, moderat, dan optimis. Model memiliki akurasi sangat baik terhadap data historis (MAPE 0,03%). Kapasitas pengolahan eksisting hanya melayani sekitar 10% kebutuhan, sedangkan timbulan limbah terus meningkat hingga 2046. Skenario optimis mencapai rasio pelayanan 100% pada 2046 dan memperbaiki kualitas sungai, namun sungai tetap tercemar sedang karena amoniak dan Fecal Coliform masih melampaui baku mutu. Model hanya menghitung kontribusi domestik; sumber non-domestik, terutama industri yang kontribusinya lebih besar, belum diperhitungkan sehingga hasil dapat berbeda bila seluruh sumber disertakan. Penelitian ini menjawab ketiga tujuan: faktor pendorong timbulan teridentifikasi, model stock-and-flow yang valid dihasilkan, dan skenario optimis terbukti paling efektif meningkatkan pelayanan serta kualitas sungai.

**Kata kunci:** *air limbah domestik, model dinamis, stock-flow, Sungai Batang Pariaman, River Quality Index (RQI).*

## ABSTRACT

*Domestic wastewater management in Pariaman City faces a gap between wastewater generation and treatment capacity, increasing pollution risk in the Batang Pariaman River. This is compounded by Pariaman's coastal setting, high population growth, and shallow groundwater table. This study analyzes the drivers of domestic wastewater generation, develops a stock-and-flow dynamic model for the management system, and simulates policy scenario effectiveness for 2026-2046 on river quality. The novelty lies in integrating treatment-plant functionality and capacity, pollutant load, and river quality into a single System Dynamics model, unlike prior studies that examined these aspects separately. The model was built through Causal Loop and Stock Flow Diagrams in PowerSim Studio 10, using primary effluent-quality data from six communal treatment plants (BOD, COD, TSS, ammonia, Fecal Coliform) and secondary data on population, sanitation, capacity, discharge, and river quality, then verified, validated, and simulated under pessimistic, moderate, and optimistic scenarios. The model shows excellent accuracy against historical data (MAPE 0.03%). Existing capacity serves only about 10% of demand, while generation keeps rising through 2046. The optimistic scenario reaches 100% service by 2046 and improves river quality, yet the river remains moderately polluted as ammonia and Fecal Coliform still exceed standards. The model covers only domestic contributions; non-domestic sources, particularly industry, whose contribution is larger, are excluded, so results may differ if all sources were included. This study answers all three objectives: drivers of generation were identified, a valid model was produced, and the optimistic scenario proved most effective at improving service and river quality.*

**Keywords:** Batang Pariaman River, domestic wastewater, dynamic model, River Quality Index (RQI), stock-flow.