

# WLRT — Technical Appendix v1.0

## A. Scope and Relation to White Paper

This Technical Appendix supplements the Wave Liquidity Redistribution Theory (WLRT) — White Paper v1.0.

Its purpose is to:

- provide formal mathematical clarifications of key concepts introduced in the White Paper;
- explicitly state assumptions, axioms, and constraints used implicitly in the core text;
- define the limits of validity of the presented models;
- outline directions for future technical extensions without affecting the conceptual integrity of v1.0.

This appendix does not introduce new theoretical claims.

All definitions and formulations herein are consistent with, and derived from, Sections 01\_Theory and 04\_Mathematical\_Framework of the White Paper.

## B. Formal Definitions

### B.1 Market Liquidity

Market Liquidity (WLRT) is defined as the bounded capability of a market system to reallocate value across price levels and time horizons with finite execution costs.

Formally, liquidity is treated as a functional:

$$L = L(V, D, F, I)$$

where:

- $V$  — available liquid capital,
- $D$  — distribution of liquidity over price levels,

- $F$  — flows of liquidity over time,
- $I$  — execution costs (impact, slippage, delay).

Liquidity is local, finite, and dynamic.

## B.2 Liquidity Distribution

Liquidity Distribution is the spatial-temporal allocation of liquid capital across price and market scales.

It is represented by a density function:

$$\rho_L(p, t, s) \geq 0$$

where:

- $p$  — price level,
- $t$  — time,
- $s$  — market scale.

Properties:

- non-uniform,
- time-dependent,
- partially latent (not fully observable),
- participant-dependent.

## B.3 Liquidity Redistribution

Liquidity Redistribution is the continuous evolution of liquidity distribution driven by participant actions and external factors.

It is described by a conservation-type equation:

$$d \rho_L / dt = - \operatorname{div} J_L + S$$

where:

- $J_L$  — liquidity flow vector,
- $S$  — sources and sinks of liquidity.

Price changes occur as a consequence of asymmetric redistribution.

## B.4 Liquidity Wave

A Liquidity Wave is a localized, directional change in liquidity density propagating through price and time.

Formally:

$$W_L(p,t) = \Delta \rho_L(p,t)$$

Liquidity Waves:

- have amplitude (magnitude of redistribution),
- have direction (net flow bias),
- propagate across scales,
- may superimpose.

Price is interpreted as the observable projection of interacting Liquidity Waves.

## C. Assumptions and Axioms

The WLRT framework relies on the following foundational assumptions:

Axiom 1 — Finite Liquidity

Liquidity is always bounded:

$$0 < L(p,t) < \text{infinity}$$

Axiom 2 — Non-Uniformity

Liquidity distribution is never homogeneous:

$$\rho_L(p,t) \neq \text{const}$$

Axiom 3 — Continuous Redistribution

Liquidity is continuously redistributed:

$$d \rho_L / dt \neq 0$$

Axiom 4 — Liquidity Causality

Liquidity redistribution drives price, not vice versa.

Axiom 5 — Multi-Scale Consistency

Structural properties of Liquidity Waves persist across scales.

## D. Mathematical Formulation

### D.1 Liquidity Flow

Liquidity flow is defined as:

$$J_L(p,t,s) = \rho_L(p,t,s) * v(p,t,s)$$

where  $v$  is the effective redistribution velocity.

### D.2 Evolution Equation

The fundamental evolution equation:

$$d \rho_L / dt + \text{div} (\rho_L * v) = S$$

This equation governs:

- wave formation,
- wave propagation,
- wave dissipation.

### D.3 Price Projection

Price is defined as a functional of liquidity distribution:

$$P(t) = f(\rho_L(p,t))$$

No explicit functional form is imposed in v1.0.

## E. Model Constraints and Limits

The WLRT technical model is subject to the following constraints:

1. Observability Limit

Latent liquidity cannot be fully measured.

2. Resolution Tradeoff

Higher temporal resolution reduces market-scale visibility.

3. Market Frictions

Fees, delays, and spreads distort ideal wave dynamics.

4. Exogenous Shocks

Extreme events may temporarily violate modeled continuity.

5. Non-Stationarity

Market structure evolves; parameters are time-dependent.

WLRT describes structural tendencies, not deterministic outcomes.

## F. Notes for Future Extensions

Planned technical extensions beyond v1.0 include:

- explicit modeling of latent liquidity fields;
- stochastic source terms  $S(p,t)$ ;
- cross-market coupled wave systems;
- algorithmic estimation of  $\rho_L$  from partial data;
- integration with agent-based and AMM-specific dynamics.

These extensions will be addressed in future versions without altering the core axioms.

Status: WLRT — Technical Appendix v1.0

Relation: Supplementary to White Paper v1.0

Consistency: Fully aligned with WLRT core theory