Simplified Load Quantification for CAPTure™ Box Installations *(Revised May 7, 2024)*

AAFS50 activated alumina media, the currently preferred media for CAPTure™ boxes, removes a mass of phosphorus relative to the mass of media present and the mass of phosphorus that enters the media as influent. The Langmuir equation is commonly used to model sorption curves, and was found to fit well with phosphorus concentrations observed in various tests of the AAFS50 media.[1,2] As long as two of the three variables utilized by the equation are known, the unknown variable can be calculated using a derivation of the Langmuir equation (EQ 1).

Equation 1:

$$w = \frac{c}{\frac{a}{r} - \frac{1}{m}}$$

Where:

- w = influent phosphorus mass (mg)
- c = 13,605 (fitted coefficient)
- a = 13,358 (fitted coefficient)
- r = mass of phosphorus removed (mg)
- m = mass of filter media (kg)

For CAPTure™ boxes, the mass of media in the box is known and the mass of phosphorus removed can easily be determined via lab analysis of the filter media at the end of the season. These two variables can then be used to estimate the mass of phosphorus that was present in the box influent. If total flow volume is known, the computed influent phosphorus mass can be used along with the volume to estimate an average influent phosphorus concentration throughout the treatment season.

If flow into the CAPTure™ box is measured in a Drainage Water Management (DWM) structure that will also measure box bypass (see diagram below), bypassed load can also be estimated. Treatment efficiency for the system can be calculated by dividing the mass of phosphorus retained by the sum of the influent P mass and the bypass P mass (EQ 2). This overall approach will provide reliable estimation of box performance and load reduction benefits that otherwise

[1] Kieser & Associates. (2023). Advancing Systematic and Fundamental Changes in Agricultural Water Resources. Final Report – GLPF Project #1112.

[2] SPC Scott, I., J. Penn, C., & Huang, C. H. (2020). Development of a regeneration technique for aluminum-rich and iron-rich phosphorus sorption materials. Water, 12(6), 1784.

would require expensive and frequent monitoring of box inflows, bypassed flows, influent and effluent concentrations.

Equation 2:

$$T = \frac{100r}{w\left(1 + \frac{V_b}{V}\right)}$$

Where:

- T = system treatment efficiency (%)
- r = mass of phosphorus removed (mg)
- w = influent phosphorus mass (mg) (see EQ 1)
- V = volume of influent water (L)
- V_b = volume of bypass water (L)

The simplified tile line CAPTure™ box design can therefore remain un-attended throughout a treatment period, with easy download of flow data and media sampling at the end of the treatment season, or with any necessary media change-out. These data can then be reviewed for subsequent year box preparation, O&M and year-end servicing refinements to ensure optimized treatment going forward.