Treatment of Nitrogen and Phosphorus Point and Non-point Source Pollution with Algal Turf Scrubber® Technology - Case Studies and Potential for NC

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What is an Algal Turf Scrubber®?

• Uses native algae to remove nitrogen and phosphorus, while adding dissolved oxygen to source water

• Once algae is established, it is regularly harvested and processed, and as it regrows, new biomass maintains the accelerated growth phase, which extracts nutrients at higher rates

• With favorable conditions, algae grows and nutrients are continuously recovered and removed from the source water
Algal Turf Scrubber® Early Stage Development
1970s – 1990s  Dr. Walter Adey
6 Process Patents

Basic ATS™ Pilot Floway Design Components
ATS – Algal Floway Community

Patterson ATS™ (1995-1996) Stanislaus County, CA
0.2 MGD x 500'

Medium Scale ATS
Egret Marsh ATS™
Indian River County, FL
10 MGD x 575’ (2010-Ongoing)

Large Scale ATS

The ATS technology has been implemented at the very large scale in Florida and Texas by a commercial company named HydroMentia, headquartered in Ocala, Florida. Biohabitats is partnered with HydroMentia on scaling up further systems.

Large Scale Algal Turf Scrubber® Design
Algal Turf Scrubber® Design
System Inflow

Water is surged down the sloped floway in a pulsing motion. The pulsing surge stimulates algal growth.

Algal Turf Scrubber® Design
Algal Turf Floway

The algal turf biomass is recovered on a 7-14 day cycle using HydroMentia's proprietary harvest design. The recovered algal biomass contains excess nutrients removed from the water.
Algal Turf Scrubber® Design
Biomass Production

Algal turf or dense mats of simple algae are cultivated on the surface of the floway. As the algae grow, they remove nutrient pollutants (phosphorous and nitrogen) from the water.

Algal Turf Scrubber® Tractor Mounted Scraper

The algal turf biomass is recovered on a 7-14 day cycle using HydroMentia’s proprietary harvest design. The recovered algal biomass contains excess nutrients removed from the water.
Algal Turf Scrubber® Design
Centralized Biomass Recovery

Harvested algae is conveyed by the water via a concrete flume to a centralized recovery facility.

Algal Turf Scrubber® Design
Centralized Biomass Recovery System
The harvested algae is removed from the water with a Flex Rake.

Algal Biomass Products

Biofuel Production and Bioplastics
Sandia Labs Texas A&M

Compost/Organic Fertilizer and Potting Media

Livestock Feed
Peat-based (PB) substrate amended with composted algae (CA) at 10% increments by volume. From left to right, 100% CA to 100% PB to the far right. Plant number 6 (yellow tag) from either direction is 50/50 CA/PB.
Algal Turf Scrubber® Systems - History

1. EAA ATS™, Palm Beach County, FL (1992)
4. Fall River ATS™_ABES, Fall River, TX (2000 – 2003)
5. S-154 ATS™ with WHS™ Pre-treatment, Okeechobee County, FL (2003-2004)
7. S-154 ATS™ (LHLR 8.5 gal/min-ft), Okeechobee County, FL (2004)
8. S-154 ATS™ (LHLR 18.9 gal/min-ft), Okeechobee County, FL (2004)
9. Egret Marsh ATS™, Indian River County, FL (2005)
10. Lake Lawne ATS™, Orange County, FL (2009)
11. Powell Creek ATS™, Lee County FL (2009)
12. STA-1W ATS™, Palm Beach County, FL (2009)
13. Spring Creek ATS™_CER, Lee County, AR (2009)
16. Santa Fe ATS™, Alachua County, FL (2009 – 2010)
17. Egret Marsh ATS™, Indian River County, FL (2010)
18. Dalton WWTF ATS™, Murray County, GA (2010 - 2011)
19. USDA ATS™, Indian River County, FL (2010 - ongoing)
20. NYCDEP ATS™, Queens County, NY (2010 - 2012)
21. South Canal ATS™, Indian River County, FL (In Design)
22. Phosphate Mining Company, Polk County, FL (2012)

• Nutrient removal by the algal production systems is calculated as follows:
• Nutrient removal rate = biomass production rate x nutrient content of biomass
• Typical biomass production rates for ATS™ in the Chesapeake Bay region range from 10 – 35 grams dry weight/m²/day and typical nutrient contents are 3 – 5% nitrogen and 0.3 – 0.5% phosphorus.
• A unique quality of the ATS™, relative to other BMPs, is that nutrient removal is quantifiable and easily verifiable.

Algal Turf Scrubber® Relationship of Phosphorus Inflow Concentration and Removal Rates
Nutrient removal by the algal production systems is calculated as follows:

\[ \text{Nutrient removal rate} = \text{biomass production rate} \times \text{nutrient content of biomass} \]

Typical biomass production rates for ATS™ in the Chesapeake Bay region range from 10–35 grams dry weight/m²/day and typical nutrient contents are 3–5% nitrogen and 0.3–0.5% phosphorus.

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ATS™ and Chesapeake Bay

ATS™ Pilot locations around Chesapeake Bay and the draft technical report supporting Executive Order 13508 directing Chesapeake Bay cleanup. The cleanup includes ATS™ as an emerging technology in the effort.
Areal Nutrient Uptake Rates for an ATS in the Chesapeake Bay Region

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Lower Boundary Estimate</th>
<th>Upper Boundary Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>214 lbs / acre / year</td>
<td>3900 lbs / acre / year</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>43 lbs / acre / year</td>
<td>390 lbs / acre / year</td>
</tr>
</tbody>
</table>

Nutrient removal by the algal production systems is calculated as follows:

- Nutrient removal rate = biomass production rate x nutrient content of biomass

- Typical biomass production rates for ATS™ in the Chesapeake Bay region range from 10 – 35 grams dry weight/m²/day and typical nutrient contents are 3 – 5% nitrogen and 0.3 – 0.5% phosphorus.

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Averages from data collected from ATS studies on outdoor raceways operated for at least one annual cycle.

<table>
<thead>
<tr>
<th>System Location</th>
<th>Water Treated</th>
<th>%N</th>
<th>%P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lancaster, PA</td>
<td>Susquehanna River</td>
<td>2.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Beltsville, MD</td>
<td>Dairy Manure</td>
<td>5.9</td>
<td>0.8</td>
</tr>
<tr>
<td>Bridgetown, MD</td>
<td>Ag Drainage Ditch</td>
<td>2.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Gloucester, VA</td>
<td>York River</td>
<td>1.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Reedville, VA</td>
<td>Great Wicomico River</td>
<td>2.5</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Nutrient Areal Removal Rates (ARR) based on Algal Productivity (dry-g/m²-yr) and Tissue Nutrient Concentrations
Nutrient removal by the algal production systems is calculated as follows:

\[
\text{Nutrient removal rate} = \text{biomass production rate} \times \text{nutrient content of biomass}
\]

Typical biomass production rates for ATS™ in the Chesapeake Bay region range from 10–35 grams dry weight/m²/day and typical nutrient contents are 3–5% nitrogen and 0.3–0.5% phosphorus.

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Algal Turf Scrubber® Potential for High Level Total Nitrogen Reduction – Recycle Mode

![Nitrogen Reduction Graph](image)

Algal Turf Scrubber® Potential for High Level Total Phosphorus Reduction – Recycle Mode

![Phosphorus Reduction Graph](image)
Nitrogen and Phosphorus Load Reduction in North Carolina
QUESTIONS?

Good Information Summary Paper on ATS Technology
