

Permeable Reactive Barriers for Passive Treatment of Nitrate in Groundwater

What, Why and How



Truslow Resource Consulting LLC

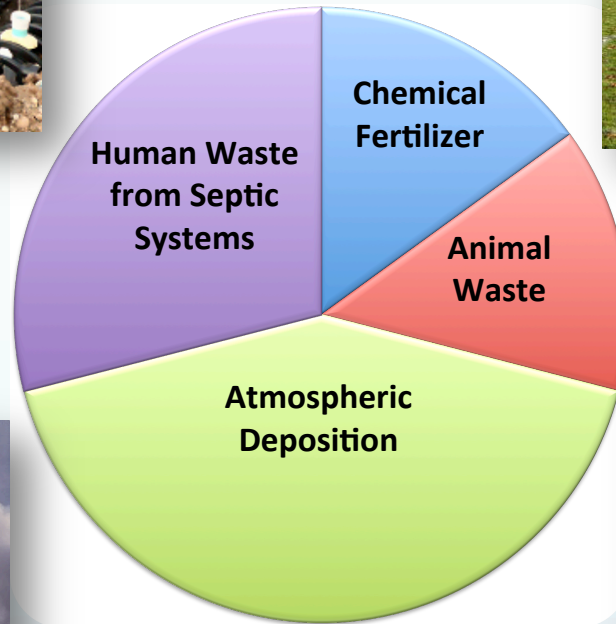
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Major sources of nitrate in groundwater



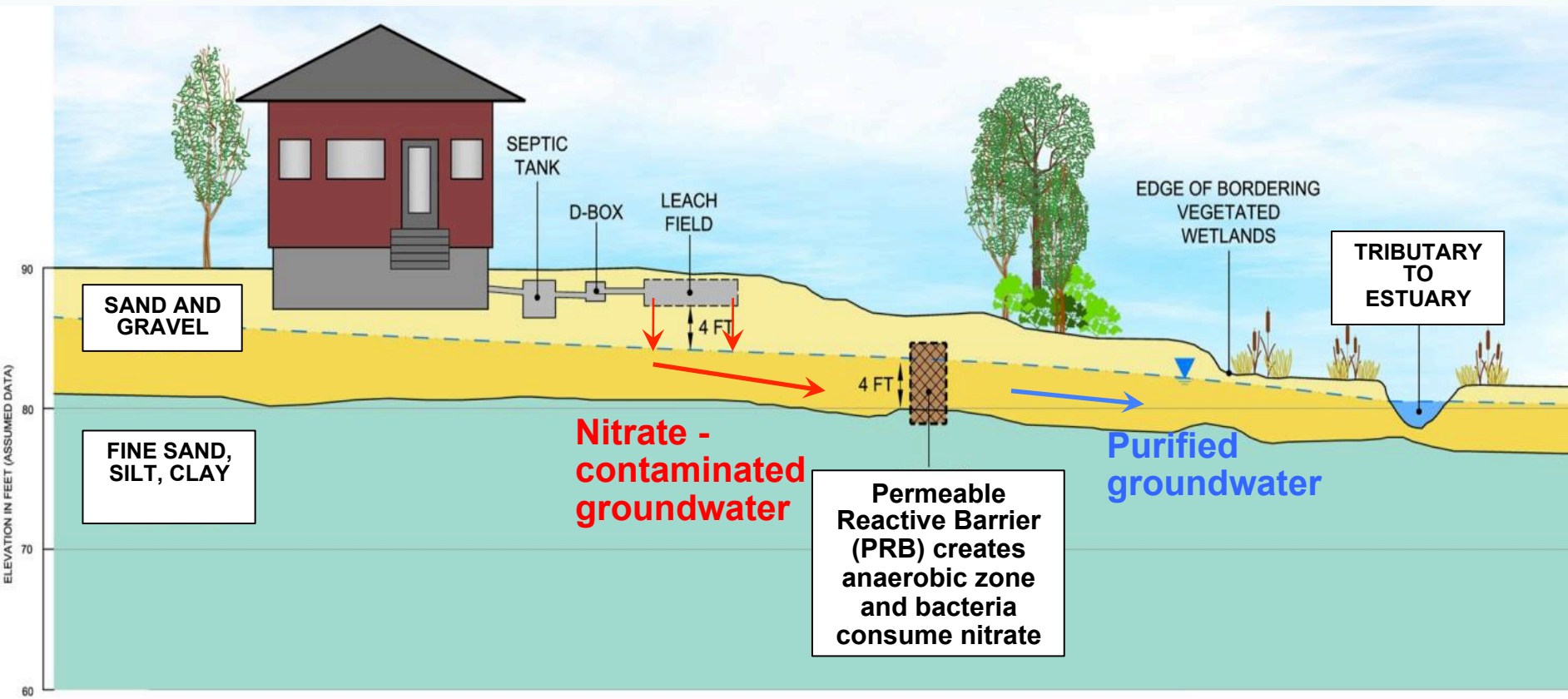
Why is nitrate a problem?

- Degradation of coastal water quality and habitat from excess nitrate discharge
- Excessive nitrate in drinking water can be harmful to health

What is a Permeable Reactive Barrier (PRB)

- Sustainable infrastructure that will reduce nitrate concentrations in groundwater
- A subsurface treatment process that improves water quality as groundwater passes through a bioreactor or treated zone
- Proven technology for toxic chemical clean up that has been modified for nitrate removal
- A practice used in agricultural areas to improve water quality

How does a PRB work?



Nitrate contaminated groundwater passes through the PRB and nitrate is converted to nitrogen gas

Wood Chip Bioreactor PRBs

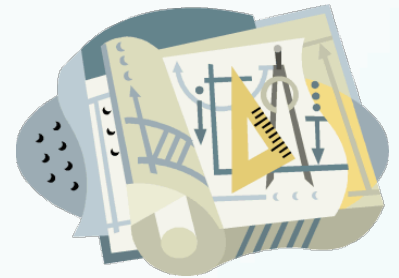
- Trench or zone with a low cost carbon source (wood chips) for denitrification
- Creates environment for naturally occurring anaerobic bacteria to thrive and transform nitrate to nitrogen gas
- Shallow reactive barriers can be simple to install and maintain



Bioreactor wood chips similar to wood chips used for playgrounds

What information is needed for proper design and installation?

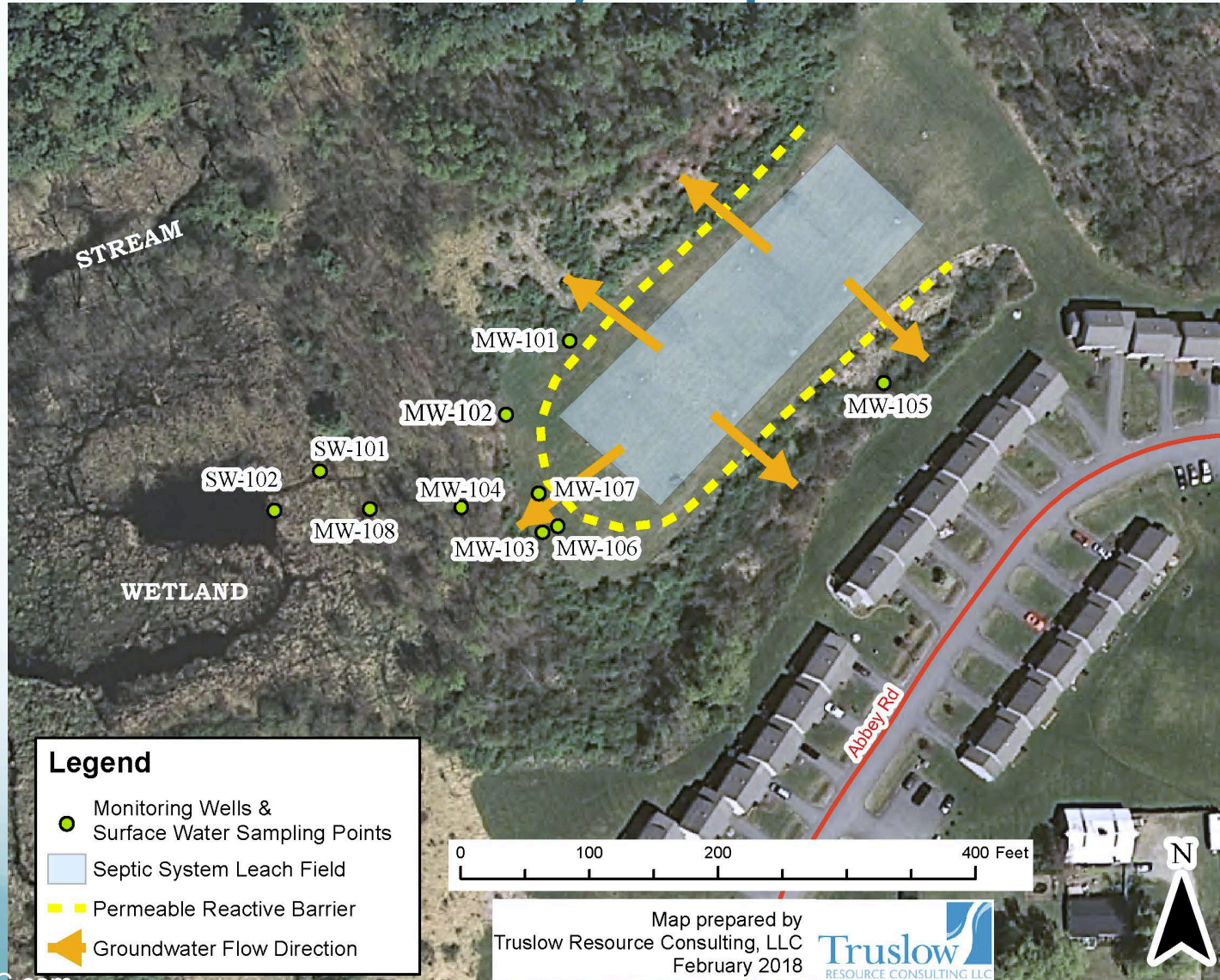
- Subsurface geology
- Concentration of nitrate in groundwater
- Potential/actual depth of nitrate impact
- Direction of groundwater flow from source
- Groundwater flow rate
- Annual groundwater level fluctuation
- Basic groundwater geochemistry



Optimal settings for PRB use in New England

- Development near sensitive areas – can treat combined septic system discharges
- To supplement a traditional septic system to treat nitrate to standard at property line
- Surrounding a community septic field for protection of sensitive area (water supply, stream, etc..)
- Near a water supply well – to remediate or prevent elevated nitrate
- Site where hydrogeologic study completed or required

Typical PRB Layout – Community Septic Field



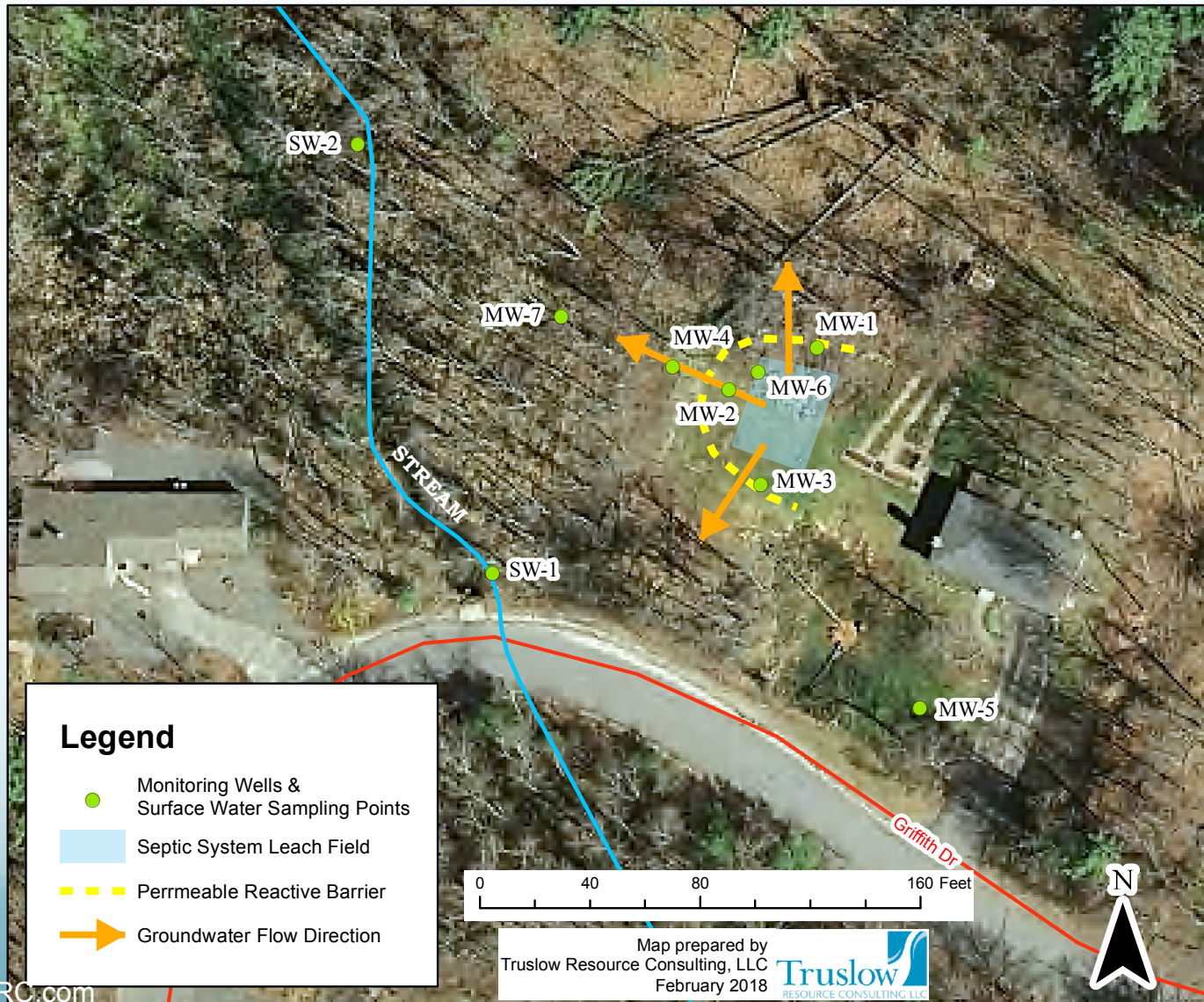
PRB Installation – Community Septic Field



PRB Placement and Site Restoration



Typical PRB Layout – Domestic Septic Field



PRB at Single Residence Septic Field



Advantages of PRBs

- Wood chips for trench are locally available and low cost
- Wood chips are safe, plant based materials
- Can provide significant nitrate reduction
- Can be sited to treat multiple source areas
- Passive treatment – no mechanical systems to maintain
- Minor maintenance required once trench installed
- Expected lifetime – 20+ years

Examples of successful PRB installations

- Midwest and Canada – Agricultural applications – woodchip bioreactors
 - <https://jbioleng.biomedcentral.com/articles/10.1186/s13036-017-0057-4>
 - www.tidescanada.org/.../D-1-9LauraChristiansonD-enitrificationWood-chipBioreactor..
 - <https://engineering.purdue.edu/watersheds/conservationdrainage/bioreactors.html>
- Brentwood, NH and Durham, NH – Pilot woodchip bioreactor trenches
 - <http://www.rockinghamccd.org/presentations/nitrogen-septic-systems-great-bay-and-why-it-matters/>
- Orleans, MA – Injected Emulsified Oil PRB – ongoing pilot study
 - https://www.town.orleans.ma.us/sites/orleansma/files/file/file/owqap_prb_breakout_group_presentation_final_0.pdf

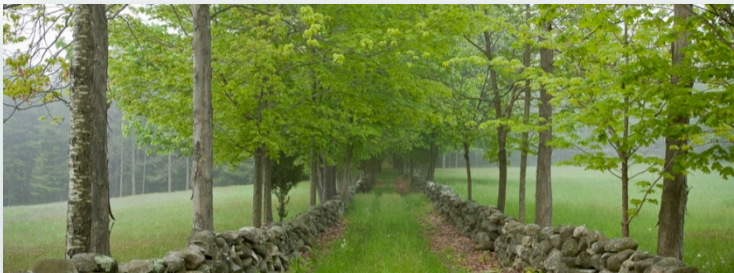
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