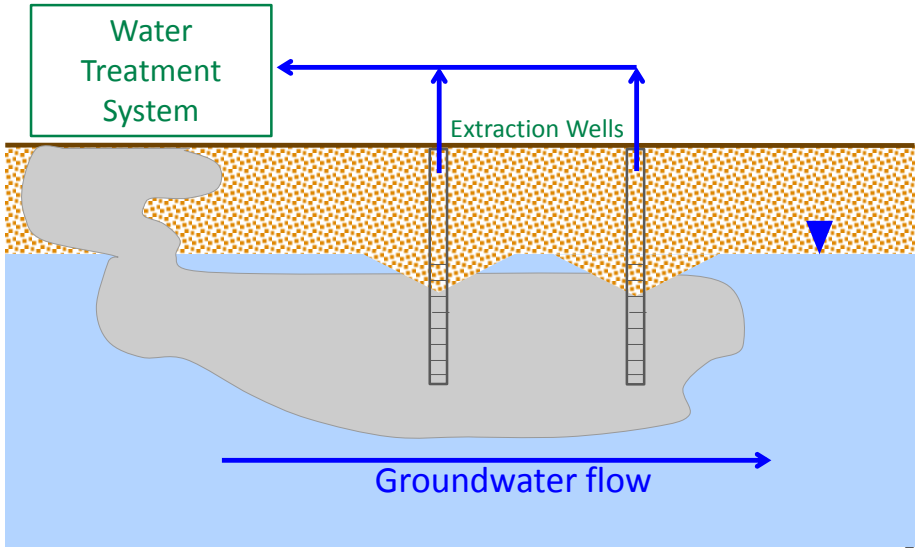
DISCUSSION: REMEDIATION OF POLY- AND PERFLUOROALKYL SUBSTANCES (PFAS)

May 23, 2016

1

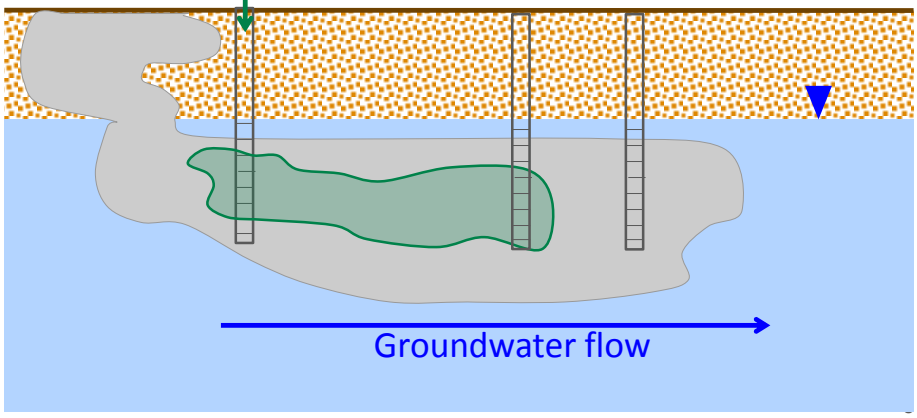
REMEDIATION OVERVIEW



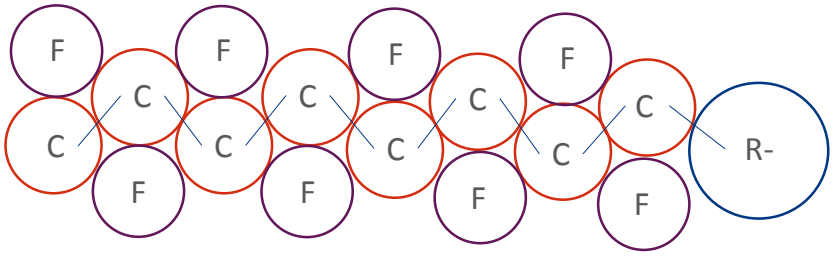
REMEDIATION OVERVIEW

Injection Well
- In situ chem. ox.
- Air Sparge
- Etc.

Monitoring Wells



WHY IS PFAS REMEDIATION DIFFICULT?

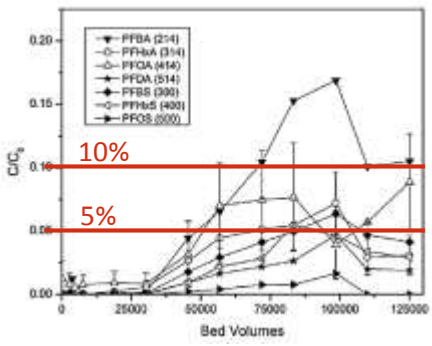


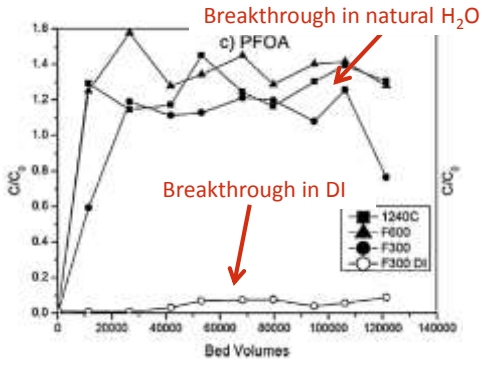
Properties
- Strong C-F bond
- No aromatic features
- No double bonds
- Electron withdrawing functional groups
- No H atoms to withdraw
- Low vapor pressure

= Poor Candidate for
- Hydrolysis
- Photolysis
- Oxidation
- Microbial deg.
- Air stripping

4

CHALLENGES WITH PUMP AND TREAT + GAC[1]





- Chain length-dependent breakthrough
- E.g. PFBA breakthrough occurs early, requires GAC replacement

- DOM increases breakthrough
- Not all GACs perform equally
- Kinetic effects?
- What about smaller compounds?

5

NOVEL TECHNIQUES: LITERATURE

Technology	Degradation/removal	Less/no degradation/removal	Reference
Nanofiltration	PFBA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFBS, PFHxS, PFOS	--	1
Sonolysis (aqueous pyrolysis)	PFOA, PFOS, PFHxA, PFHxS	PFBS, PFBA	2,3
Electrochemical treatment with Ti/RuO_2 anode	PFHpA, PFOA, PFHxS, PFHpS, PFOA	PFBA, PFPeA, PFHxA, PFBS	4
UV-photon-induced degradation	PFBA, PFPeA, PFOA	PFBS, PFOS	5
UV Photolysis (reduction)	PFOS	PFBA, PFHxA, PFOA, PFBS, PFHxS	6,7
Heat activated persulfate oxidation	PFBA, PFPeA, PFHxA, PFHpA, PFOA, 6:2 FTS	PFOS	8

6

NOVEL TECHNIQUES: PATENTS

- Combined in-situ oxidation/reduction techniques: e.g. Arcadis patent US 2013/0200303 A1 for SCISOR
- Immobilization techniques: e.g. Tersus Environmental patent US 8,940,958 B2 for RemBind
- Oxidation with hydroperoxide coated, oxygen/ozone bubble: e.g. Kerfoot Technologies patent US20140246366A1
- Oxidant combinations: e.g. Enchem patent US 7,667,087 B2 for OxyZone with new application to PFAS

7

QUESTIONS FOR DISCUSSION

1. Is anyone closely considering or piloting any of the novel techniques presented or others?
2. What types of methods are being used?
3. Which compounds are targeted?
4. What are the removal efficiencies?
5. For GAC systems:
   - Issues with early breakthrough?
   - Issues with GAC longevity?
6. Any other thoughts on technologies presented or others that should be investigated?

8

REFERENCES CITED

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9