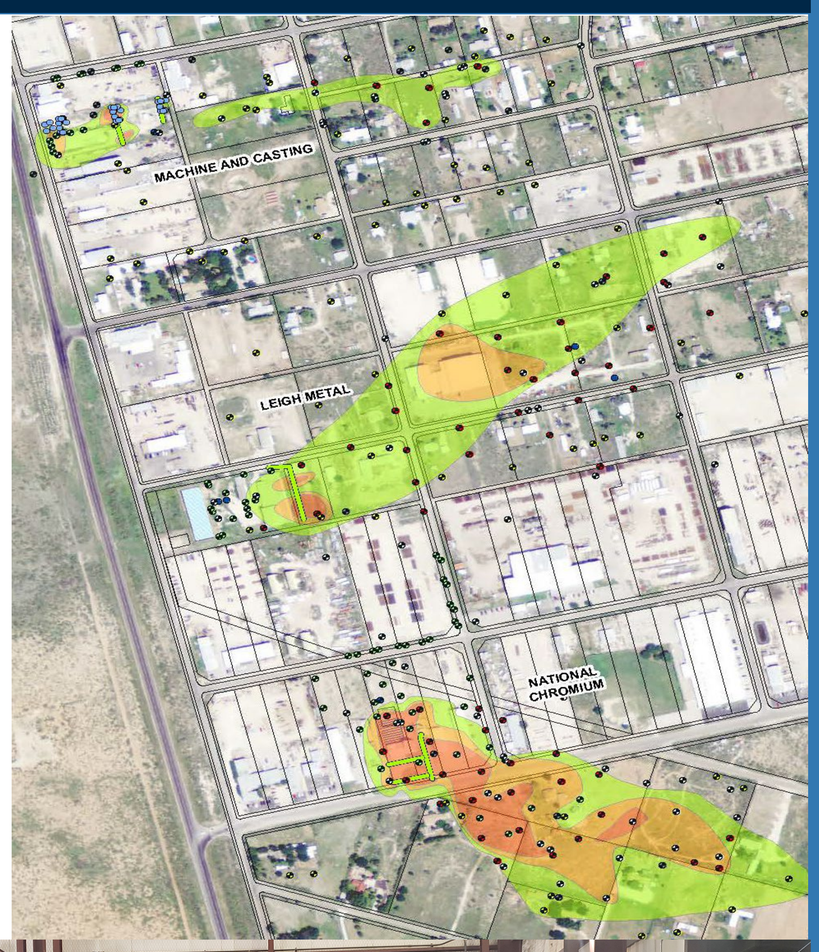
BACKGROUND

- The site consists of three abandoned metal plating facilities located within 1 mile of each other.
  - Leigh Metal Plating Inc. (LM), a 3.6-acre facility
  - National Chromium Corporation (NCC), a 2.5-acre facility
  - Machine and Casting, Inc. (M&C), a 2-acre facility
- Previous electroplating activities at these facilities released chromium (Cr) to the groundwater and resulted in three separate groundwater plumes, consolidated into the Sprague Road Groundwater Plume Superfund Site.
- The Cr plumes cover approximately 47 acres in the Edwards Trinity Aquifer, which is the sole-source drinking water supply for many area residents with private water wells.
- A pump-and-treat system has been operated since 2003 and different treatment media have been used, from an old ion exchange resin, an ultraviolet-activated catalyst system to a new weak base anion resin.
  - One central unit and two satellite treatment units
  - More than 100 recovery and injection wells
  - One infiltration gallery
- Residential well pumping overcame system recovering rate, pulling plumes to residential wells and causing plume expanding.



REMEDIAL OBJECTIVES AND STRATEGY

EPA Record of Decision established remedial objectives and remedial goals:

- Prevent exposure to contaminated groundwater above acceptable risk levels
- Prevent or minimize further migration of the groundwater contaminant plumes
- Prevent or minimize further migration of contaminants from source materials to groundwater
- Return groundwaters to their expected beneficial uses wherever practicable.
- Remedial goal for chromium is 100 µg/L

REMEDIAL STRATEGY: Due to the limitation and excessive cost of the pump-and-treat system, in situ remedy was introduced to treat the cores of the groundwater plumes while the pump-and-treat system captures/contains/treats the plumes.

PILOT STUDY AND REMEDIAL DESIGN

PILOT STUDY: An in situ treatment pilot study was conducted through three locations between 2010 and 2014 at M&C using three amendments, all of which were expected to reduce the groundwater oxidation reduction potential (ORP) and reduce hexavalent Cr to trivalent Cr.

- Regenesis 3DMe™ and MRC®
- Terra System SRS-M ®
- Adventus EHC-F ®
- SRS-M® was selected due to its better performance
- Temporarily increased dissolved metal concentrations over a short distance from injection points

REMEDIAL DESIGN:

- Used the *Substrate Estimating Tool for Enhanced Anaerobic Bioremediation of Chlorinated Solvents, Version 1.2* (Parsons 2010)
- A total of 99 wells to be injected
- 60% SRS-M® solution (256,000 gallons) and sodium bicarbonate (171,000 gallons)

Bioremediation of Chromium Contaminated Groundwater in Complex and Large Plume

Beth Liu
EA Engineering, Science, and Technology, Inc., PBC

BIOREMEDIATION IMPLEMENTATION

WELL INSTALLATION (July–August 2020)

A total of 100 wells (92 injection wells + 8 monitoring wells)

- M&C – 27 wells
- LM – 38 wells
- NCC – 35 wells
- Wells' spacing – 15 ft (NCC); 20 ft (M&C and LM)
- Injection wells – 4-inch (diameter) Schedule 80 PVC flush thread-joined casing; 10-20 ft screen
- Geophysical logging to determine screen intervals

AMENDMENT INJECTION (September–October 2020)

- SRS-M10® and sodium bicarbonate
- Average flow rate – 7-15 gpm (LM and NCC)
- Average pressure – 5-10 psi
- Injection under gravity but flow rates were low in M&C due to tight formation, flow rates up to 3 gpm
- A total of 170,000 gallons of SRS-M10® and 103,000 gallons of sodium bicarbonate solution injected at 73 wells
- Not all designed amount injected due to the tight formation

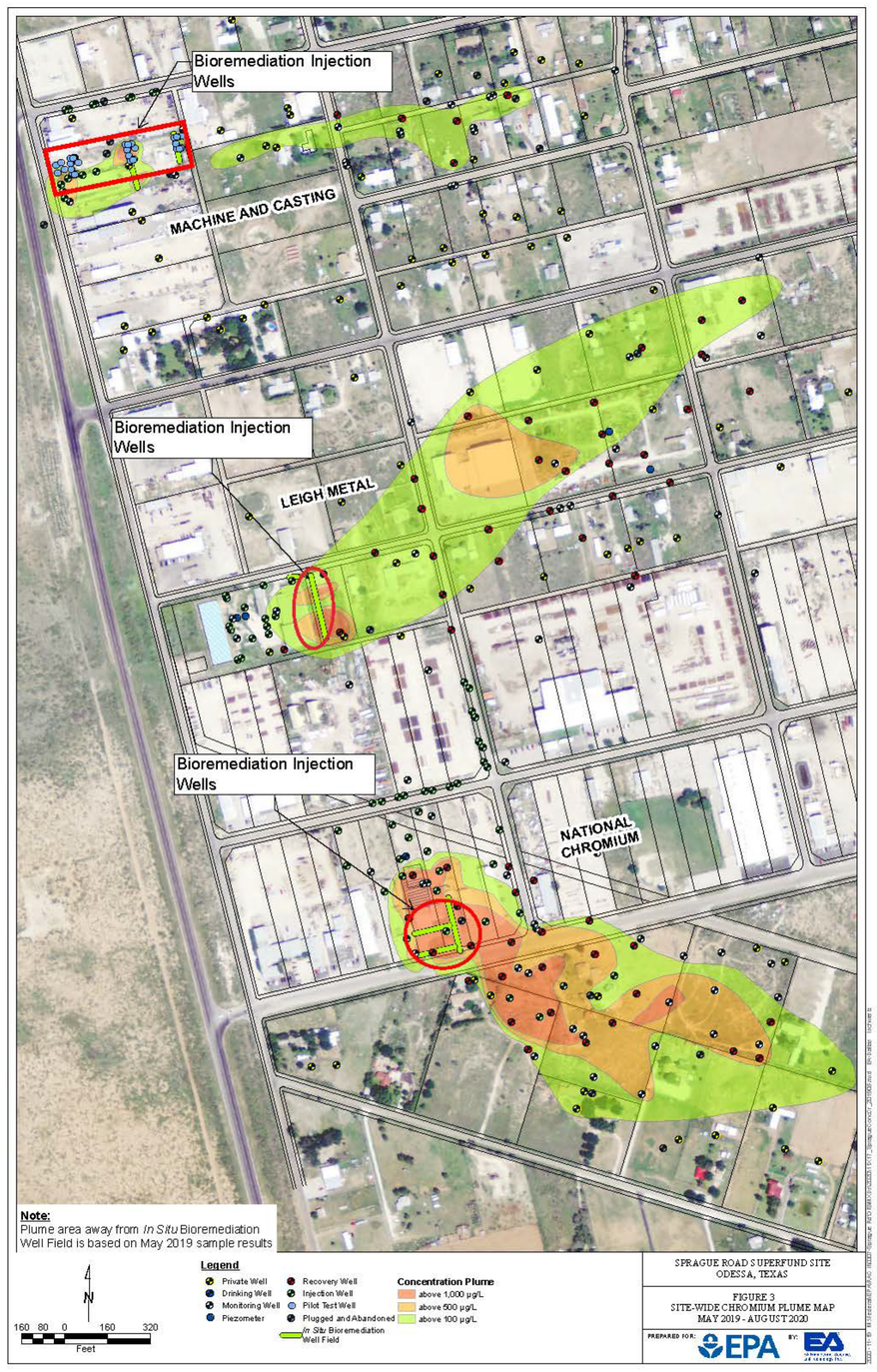
Area		Number of Wells Injected	SRS-M10 Solution (gallons)	Sodium Bicarbonate Solution + Chase Water (gallons)
NCC	Design	35	77,000	51,555
	Actual		77,000	51,925
	Deficit		0	-370
LM	Design	16	46,656	31,248
	Actual		46,665	32,879
	Deficit		-9	-1,631
M&C	Design – B&C Lines	15	38,154	25,560
	Actual – B&C Lines		24,502	9,838
	Deficit – B&C Lines		13,652	15,722
M&C	Design – A Line	7	27,216	18,228
	Actual – A Line		21,832	8,457
	Deficit – A Line		5,384	9,771
M&C	*M&C Design Total*	*22*	*65,370*	*43,788*
	M&C Actual Total		*46,334*	*18,295*
	M&C Deficit Total		*19,036*	*25,493*
Total	**Grand Design Total**	**73**	**189,026**	**126,591**
	Grand Actual Total		**169,999**	**103,099**
	Grand Total Deficit		**19,027**	**23,492**

Group 2

BIOREMEDIATION RESULTS

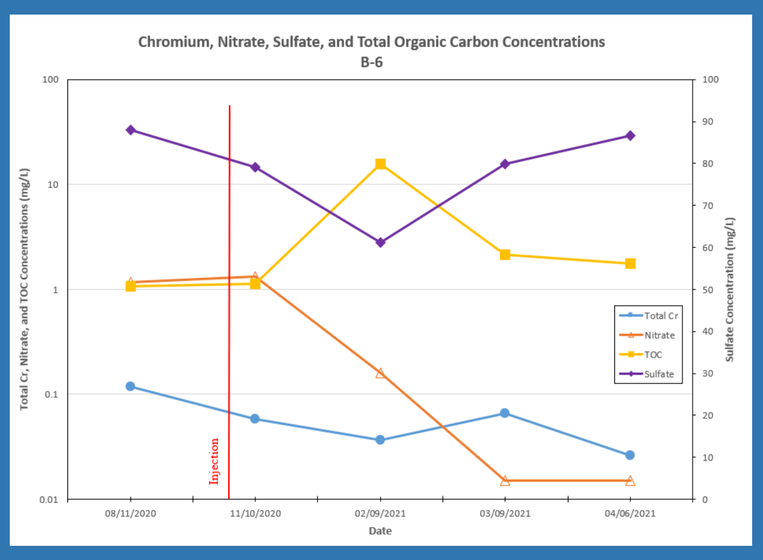
Baseline and post-injection sampling was conducted to evaluate the performance of in situ bioremediation.

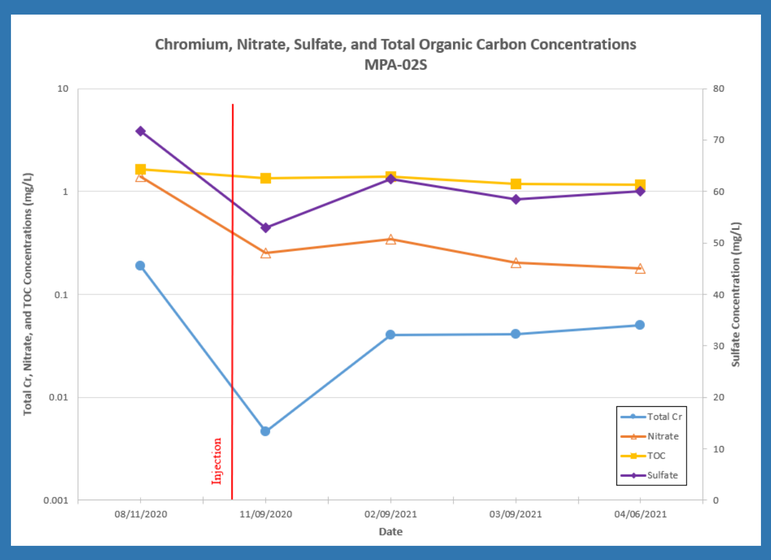
- Four post-injection sampling events.
- Groundwater samples analyzed for Cr, nitrate, sulfate, TOC, and ferrous iron.
- 70-99% reduction of Cr in M&C and LM and lower in NCC 6 months after injection.
- LM performed the best, followed by M&C, and then NCC.
- Concentrations of TOC, iron, and manganese increased and ORP and nitrate decreased in the wells with Cr reduction, indicating anaerobic microbial activities stimulated by the amendments.
- Low impact of amendment injection at NCC due to monitoring wells' far distances from injection wells, higher concentrations of Cr than the other two plumes, and potential loss of the amendments from accidental operations of the nearby recovery wells in the injection areas.

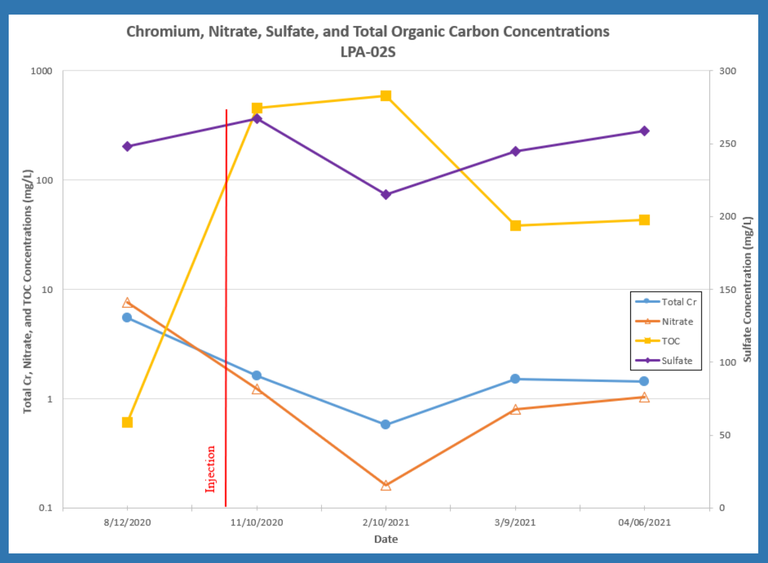


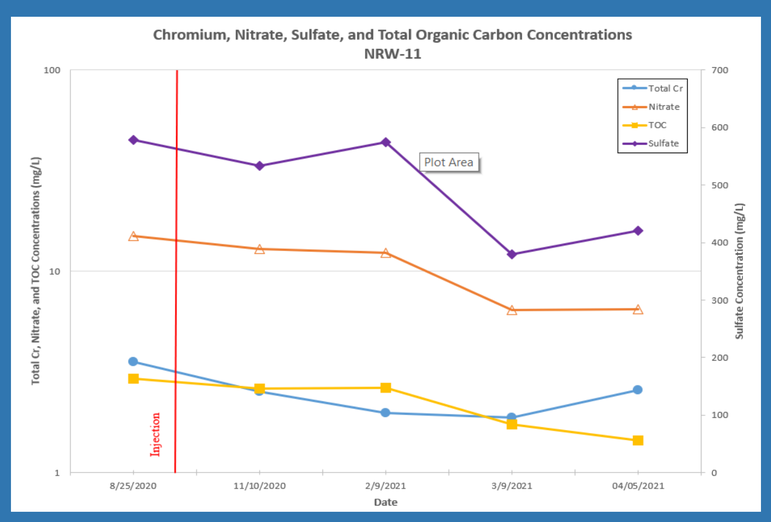
LESSONS LEARNED

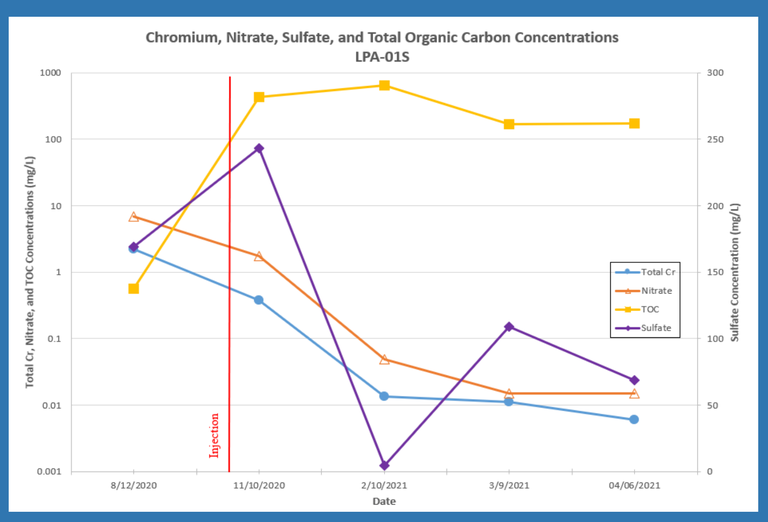
- Rehabilitate old injection wells prior to a new injection event, and evaluation of remaining capacity is important.
- Incorporate hydrogeologic data into the design, but actual capacity of formation for amendments is hard to predict. Therefore, a contingency plan is needed in case (i.e., to inject leftover amendments in other areas or ship amendments in batch to prevent leftover amendments from being wasted).
- Potentially add microorganisms into the subsurface to further create reducing condition for Cr reduction, but impact of high concentrations of Cr on microbes is to be evaluated through bench or pilot scale study.
- Ensure pump-and-treat system is off and remains off until injected amendments dissipate.











ACKNOWLEDGEMENTS

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