[Form 2 (to be reported to Committee on Countermeasures for Contaminated Water Treatment and to be disclosed to public)

Technology Information	
Area	5 (Select the number from “Areas of Technologies Requested”)
Title	Groundwater Management using Barrier Wall Systems; Surface Covers and Re-directing Surface Water Flows; and *In-Situ* Strontium Immobilization.
Submitted by	Geosyntec Consultants, Inc.

1 Overview of Technologies (features, specification, functions, owners, etc.)

Our groundwater management measures consist of following core technologies:

1.1 Barrier Wall Systems

- Upgradient Impermeable Wall

  Between 10 m to 25 m deep based on available site information and filled with impermeable backfill (the backfill material would be selected based on consideration of geotechnical conditions and site water chemistry).

- Downgradient Permeable Reactive Barrier (PRB)

  A funnel and gate (F&G) may be a more feasible configuration for a PRB than a continuous PRB. *In-situ* reactive vessels may be used in lieu of gates.

- Microbially-Induced Calcite Precipitation (MICP)

  The MICP process tightly binds soil particles together, forming a sandstone-like material. The binding agent consists of calcite, microorganisms, and biopolymers. The MICP technique can be induced and controlled using the naturally occurring, nonpathogenic microbial culture *Sporoscarcina pastuerii*, or by stimulating the growth and activity of native bacteria at the Site.

1.2 Cover Systems and Re-directing Surface Water Flows

Selection from conventional compacted clay system, an evapotranspirative cover system with a capillary barrier, spray-applied foam and cementatious products, and MICP.

Stormwater collection and conveyance systems will be designed by guidance manuals we have prepared for US EPA, US Federal Highway Administration, National Cooperative Highway Research Program, and Water Environment Research Foundation (WERF).

1.3 *In-situ* Strontium Immobilization

In-situ methods may be more cost-effective for treating the large volumes of contaminated groundwater generated at the Site. These methods include apatite sequestration (Bostick et al., 2003; Thompson et al., 2009), and MICP (DeJong et al., 2013). Preformed apatite media such as Apatite II (PIMS™ NW, Inc.) effectively adsorb and coprecipitate numerous metals and radionuclides including uranium, with a moderate capacity to remove strontium (Bostick et al., 2003). The MICP technology summarized above (Section 1.1) has the

potential to immobilize Sr-90 directly by coprecipitation in biogenic calcite and indirectly by decreasing soil permeability through pore space occlusion (DeJong et al., 2013).

For details, please see Appendix.

2 Notes (Please provide following information if possible)

- Technology readiness level (including cases of application, not limited to nuclear industry, time line for application)

Our experience in providing engineering services for groundwater and waste management spans the US, Canada, Europe, and Asia and involves more than 600 sites. Geosyntec is applying experience and lessons learned from these projects at other radiological facility decontamination & decommissioning and waste management projects in the US, including US DOE Portsmouth Gaseous Diffusion Plant, Paducah Gaseous Diffusion Plant, Savannah River, and West Valley sites; a mid-Atlantic US Army Corp of Engineers FUSRAP site and several commercial nuclear power sites.

Technology readiness level and cases of application for individual core technologies are as follows.

✓ Barrier Wall Systems

Upgradient Impermeable Wall and Downgradient PRB:

Geosyntec has extensive experience with analysis and design software, including finite element analysis software for design and performance evaluations and proprietary construction quality control software that has been adopted by the US Army Corps of Engineers.

Microbially-Induced Calcite Precipitation (MICP):

Geosyntec is working with leading researchers at ASU and the University of California, Davis to develop MICP technology for ground improvement, impervious barriers, and radionuclide sequestration applications.

✓ Cover Systems and Re-directing Surface Water Flows

Geosyntec has performed hundreds of cover system and surface water flow management applications.

Cover system: Author of US EPA guidance manual “Technical Guidance for RCRA/CERCLA Final Cover Systems.” (USEPA 2004),

Re-directing surface water flows: Author of guidance manuals for US EPA, US Federal Highway Administration etc.

✓ *In-situ* Strontium Immobilization

Geosyntec is currently leading bench and field tests of Apatite II (a medium known to

sequester strontium), in collaboration with a university partner, for *in-situ* immobilization of uranium in groundwater at the Nuclear Metals, Inc. (NMI) Superfund Site. Geosyntec has also achieved target groundwater clean-up levels for strontium using zeolite reactive zones associated with a soil bentonite impermeable wall.

For details, please see Appendix.

- Challenges

  Any technology for *in-situ* control of strontium at the Site will require development of a detailed conceptual site model that incorporates all of the important hydrogeological and geochemical parameters that could potentially impact performance.

- Others (referential information on patent if any)