GREEN STORMWATER INFRASTRUCTURE DECISION TREE FOR BROWNFIELD SITES: OVERVIEW AND INSTRUCTIONS

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NEW JERSEY INSTITUTE OF TECHNOLOGY – TECHNICAL ASSISTANCE TO BROWNFIELDS COMMUNITIES PROGRAM

(NJIT TAB)

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GREEN STORMWATER INFRASTRUCTURE DECISION TREE FOR BROWNFIELD SITES: OVERVIEW AND INSTRUCTIONS

The Green Stormwater Infrastructure Decision Tree for Brownfield Sites is a planning tool developed for organizations (i.e., communities, utility organizations, transit agencies) seeking to implement a Green Stormwater Infrastructure (GSI) program on contaminated or potentially contaminated sites (brownfields). The use of brownfield sites are sometimes quickly dismissed from GSI programs due to the fears of dealing with potential contamination and the associated costs. In many cases, the cost to remediate a site may outweigh the benefits of installing GSI. However, if the risks are mitigated by modifying the design of the GSI project (e.g., a rain garden with a liner and underdrain that directs excess water to an appropriate discharge point) GSI may still be constructed on brownfield sites with a positive benefit. On the other hand, if unexpected contamination is encountered during the construction of a GSI project, the site will likely need to be remediated; this is likely to be more costly than mitigation.

The Green Stormwater Infrastructure Decision Tree for Brownfield Sites (hereinafter referred to as the GSI Decision Tree) is a planning tool for assessing risk and managing the unknowns associated with brownfield sites. USEPA's "Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfields Sites" (July 2013) should be referenced when implementing this tool. Furthermore, this tool is designed to be applied by entities that are implementing or intend to implement a larger scale program consisting of numerous sites. Many entities charged with implementing a GSI program and high level decision making have an abundance of environmental data associated with brownfield sites but lack the necessary tools to quantify risks associated with placing GSI on such sites.

The Green Stormwater Infrastructure Decision Tree for Brownfield Sites includes the following components:

- A Workflow Diagram **(Figure 1)** that provides an overview of the parallel track development of the Environmental Planning Process and the Planning and Design Process as would progress through the Conceptual Site Model, Cost Benefit Analysis, and Risk Benefit Analysis.
- A Case Study of Site A – a hypothetical site that is used in illustrating the application of the Green Stormwater Infrastructure Decision Tree for Brownfield Sites.
- **Fact Sheets 1 – 4** that provide valuable information for each Step within the Work Flow, as well demonstrate the application of each Step for the Case Study.
- A Decision Tree **(Figure 2)** which illustrates potential decision options that might be made as one proceeds through the workflow process **(Figure 1)**.

The Workflow Diagram

Figure 1 presents the Work Flow Diagram. This GSI Decision Tree will inform decisions through an evaluation process that includes sites that have completed any of three levels of environmental investigation including: Tier 1 (desktop investigation/site inspection); Tier 2 (field screening); and Tier 3 (environmental site investigation). The evaluation process includes two tracks, an environmental planning process track and a planning/design track that run simultaneously through the evaluation process as depicted in the Work Flow Diagram. While the GSI Decision Tree focuses on the environmental planning process track, the planning/design track is included in the Workflow Diagram to illustrate the timing of the environmental planning process activities relative to the planning/decision activities undertaken to plan for GSI. These parallel tracks inform one another as each proceeds through three steps of evaluation. Step 1 includes data collection, analysis, and documentation; Step 2 includes a cost benefit analysis (CBA) comprised of a cost estimate and benefit estimate; and Step 3 includes the application of a risk-benefit analysis (RBA). At the conclusion of this three step process the user will have a quantifiable measure of the potential risks and benefits associated with the evaluated conceptual site model (CSM).

The Case Study

A brownfield site with hypothetical data is included in this tool as a means for illustrating the applicability of the tool. In each step of **GSI Decision Tree Site A** will be referenced with certain data and costs.

GSI Decision Tree Site A Map

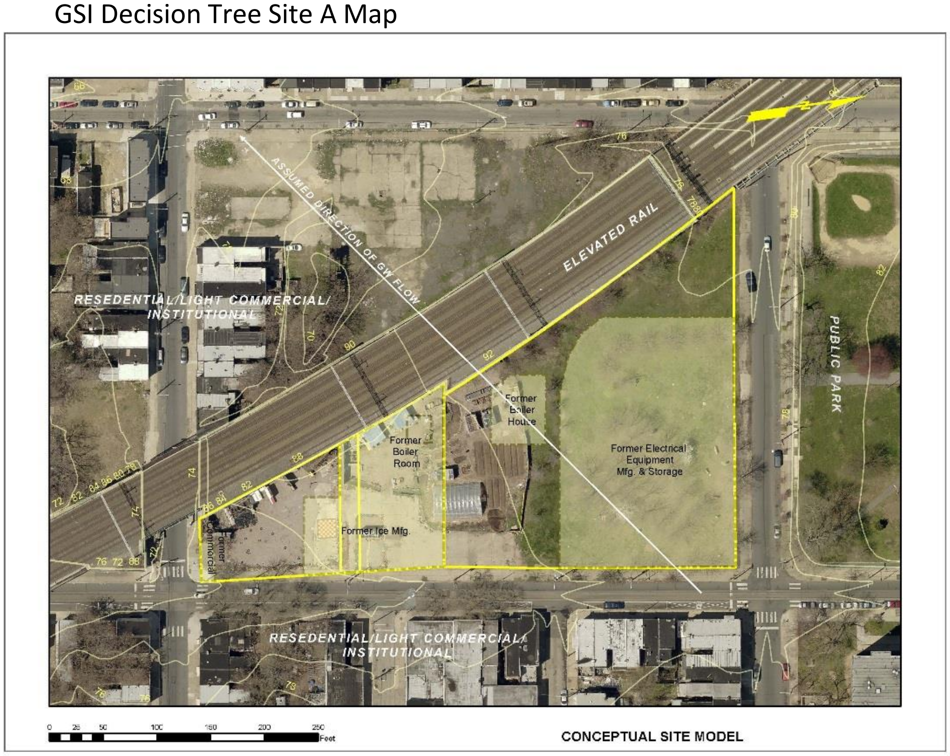
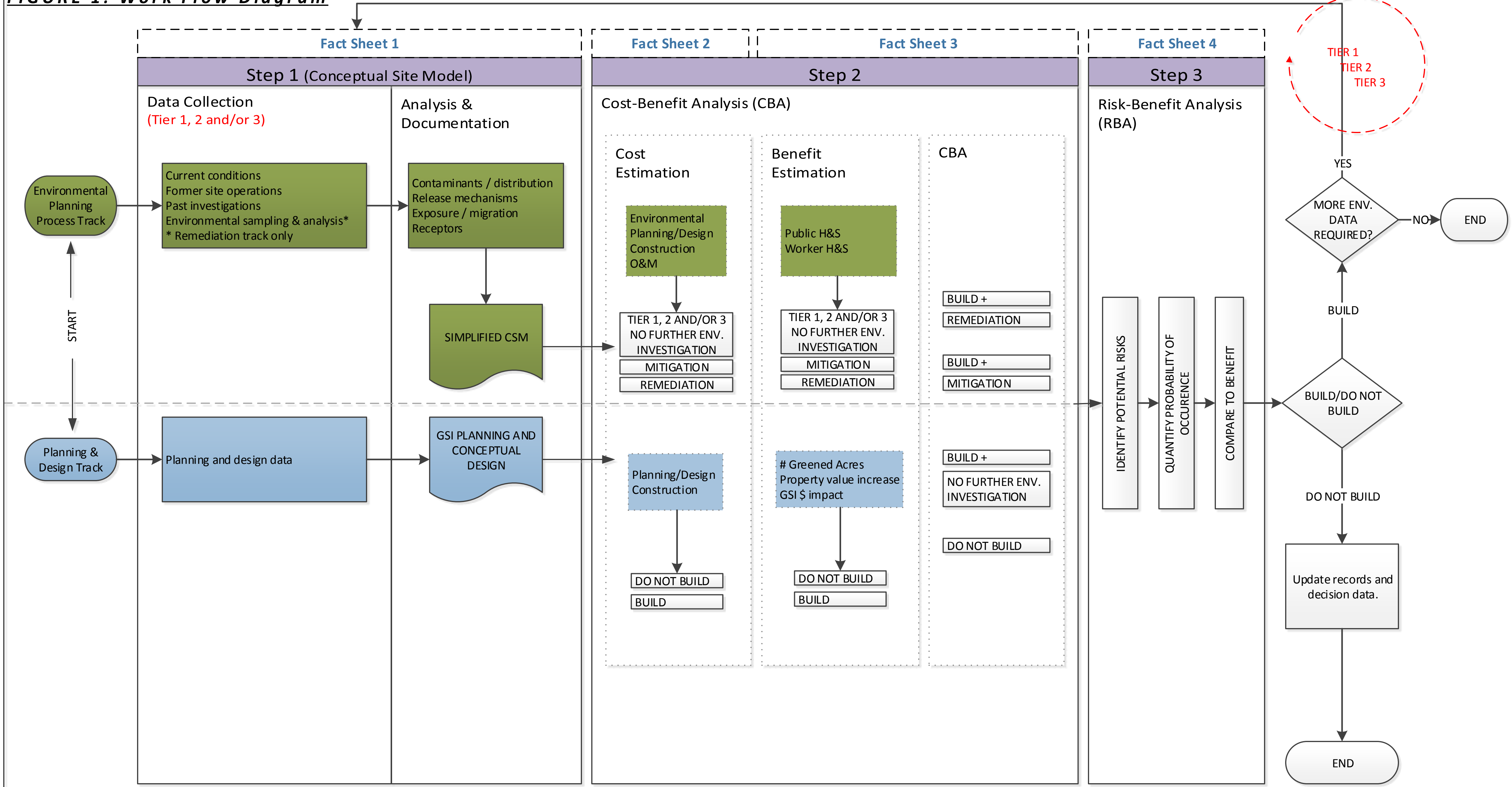


FIGURE 1: Work Flow Diagram



BRS inc	***GSI PLANNING AND DESIGN/ ENVIRONMENTAL ASSESSMENT WORKFLOW*** NJIT Brownfield Green Stormwater Infrastructure (GSI) Planning Project	**Comments/Revisions:** This diagram provides a high-level overview of the parallel track development of environmental risk assessment and GSI planning and design data including the application of a constrained, phased and iterative Conceptual Site Model (CSM) with subsequent application of Cost-Benefit Analysis (CBA) and Risk-Benefit Analysis (RBA).	**File No.:** 01 **Date:** 08.23.16 **Designer:** MB	**SHEET 1 OF 1**

Applying the Green Stormwater Infrastructure Decision Tree for Brownfield Sites

Provided below is an explanation of the steps to be taken in applying the GSI Decision Tree. Refer to **Figure 1: Workflow Diagram** as you read through these instructions.

Step 1 – Conceptual Site Model (CSM)

The first step in applying this tool is the development of a Conceptual Site Model (CSM) in accordance with ASTM standards. The CSM is a site summary that can include written and graphical/illustrative representations of the site conditions and processes that control the transport, migration, and potential impacts of contamination at a site in soil, air, ground water, surface water, and sediments to human and ecological receptors (see **Fact Sheet 1: Simplified Conceptual Site Model**). The goal of the CSM is to identify potential completed contaminant migration pathways whereby contamination may reach and harm human and ecological receptors. The iterative environmental data collection and analysis to develop a CSM can be categorized as one, two or three tiers (as needed) including:

- Tier 1 (Desktop research): Includes completion of a Phase 1 Environmental Site Assessment (or similar investigation and documentation) by a Qualified Environmental Professional or planning staff. The basic work includes desktop research (e.g. research and review historic mapping, file reviews, on-line database reports, etc.).
- Tier 2 (Field Screening): Includes in-field engineering, screening and inspection, including geo-hydrological investigation (e.g. borings/wells) and field screening (e.g. PID, XRF, etc.), but *no* collection and laboratory analysis of environmental samples in this phase.
- Tier 3 (Environmental Site Investigation): Includes collection and analysis of environmental samples.

1a. You should collect all pertinent environmental data related to the subject site. This data may include information such as: current site conditions, former site operations, past investigations, and/or prior environmental sampling and analysis.

Once you have gathered the environmental data and analyzed it, you can make a determination as to what Tier of environmental evaluation the data falls under: Tier 1, 2 or 3. The higher the Tier of environmental evaluation the data represents, directly affects the accuracy of the cost estimation that will be developed in Step 2 of the GSI Decision Tree process and ultimately the results of the risk-benefit analysis. It should be noted that some state regulatory programs require that if Tier 3 results indicate contamination, remediation would automatically be required; in other states that is not the case. It is your responsibility to determine the regulatory requirements of the state in which the brownfield site resides.

1b. Once all of the existing environmental data has been collected the CSM can be developed by documenting the collected data in a manner (e.g., spreadsheet) that illustrates: primary contaminant sources, contaminant types, primary release mechanisms, secondary contaminant sources, secondary release mechanisms, exposure routes, and receptors. **Fact Sheet 1: Simplified Conceptual Site Model** provides a discussion of CSMs. **Attachment 1 to Fact Sheet 1** provides a guide to common land uses and typical contaminants associated with such land uses. **Attachment 2** illustrates a simplified CSM for **Case Study Site A**.

Step 2 – Cost Benefit Analysis (CBA)

2a. Now that the environmental data has been gathered, analyzed, and documented, you can create a detailed cost estimate. The estimate would include costs associated, as applicable, with environmental investigation (Tiers 1, 2 & 3; mitigation; and remediation); planning, design and construction; and operations and maintenance. These estimates would be developed for four scenarios including:

1. No further environmental investigation/no build
2. No further environmental investigation/build
3. Mitigation/build
4. Remediation/build

2b. At this point in the process you would develop quantitative estimates associated with the four aforementioned scenarios with the exception of the "no build" scenario, as no quantifiable benefits would be realized from not building GSI. The types of benefits derived from the construction of GSI would depend on the particulars of each prospective site and would naturally vary as a result. These benefits may include health and safety improvements to both the public and workers, increased property values, number of greened acres, and/or grey infrastructure costs avoided. **Fact Sheet 2: Cost Estimation** provides information about estimating costs for each of the stages of the environmental stages of environmental investigation.

2c. Now that both the estimated costs and estimated benefits have been developed, a determination of net benefits can be made by comparing them against each other for each of the four scenarios (Refer to **Fact Sheet 3: Simplified Cost Benefit Analysis**). Typically, only projects that show a positive net benefit would be considered as feasible, with projects showing larger net benefits preferred over projects with lower net benefits. For purposes of this simplified methodology, discount factors are not used to derive a present-value analysis. At the level of analysis of this simplified approach, completing a present-value analysis will not expose significant differences between the alternatives. The example quantified net benefits shown on **Table 1 in Fact Sheet 3**, prior to the application of the Risk Benefit Analysis show the no further environmental investigation/build scenario as having the highest net benefit, however to properly assess the actual risk one more step must be taken.

Step 3 Risk-Benefit Analysis (RBA)

In order to properly assess the quantitative risks using the net benefits developed in Step 2, you need to make one additional calculation under the no further environmental investigation/build scenario. **Fact Sheet 4: Decision Tree** presents the use of the Decision Tree for assembling and viewing the information developed by the Conceptual Site Model, the Cost Estimate, and the Cost Benefit Analysis. A key feature of the Decision Tree is using Risk Analysis to assign probabilities to various decision points that are subject to significant unknown information. The no further environmental investigation/build scenario indicates that no significant environmental risk has been identified by the CSM and therefore the need to conduct additional investigation into environmental concerns is eliminated. The "build" qualification indicates that along with this no further environmental investigation decision, the decision is made to go forward with design and construction of the GSI project without gathering further environmental information. However, there is some probability that unknown environmental contamination may exist and will have to be remediated when encountered, for our example we assume a 50% probability.

3a. To correctly calculate the estimated payoff for the no further environmental investigation/build scenario, the expected value of the net benefit at each branch termination point must be calculated (see **Fact Sheet 4, Attachment 1: Risk Benefit Analysis Tree**). The calculation is the sum of the probability of each branch multiplied by the value of the net benefit at that decision branch. For example, if the expected value of the no further environmental investigation/build scenario is $74,255, and the expected value of the remediation scenario is -$281,050, the adjusted net benefit for this scenario would be calculated as follows:

0.5 * $74,255 + 0.5 * -$281,030 = -$103,388.

The -$103,388 represents the net value of the no further environmental investigation/build scenario by taking into account that there is a 50% probability that contamination may be found requiring remediation.

3b. You would place the net benefits, including the adjusted value for the no further environmental investigation/build scenario, in a comparison table similar to the one contained in **Fact Sheet 4**. The Risk Benefit Analysis Tree illustrates the decision making process used to compare the net benefits of each scenario. Using the example net benefit values on **Fact Sheet 4**, the alternative with the highest net benefit value is the "mitigation" scenario. Although the net benefit of the no further environmental investigation/build scenario is higher when observing the cost benefit analysis prior to application of the risk analysis, factoring the risk of encountering unknown contamination results in negative net benefits once the expected value is calculated. The "mitigation" scenario, because it is designed with the assumption of contamination, has no appreciable risk of failure.

It should be noted that this example is a very simplified and high level use of risk analysis. The application of risk and probability of various alternatives may be added at additional levels to develop a more detailed and comprehensive analysis.

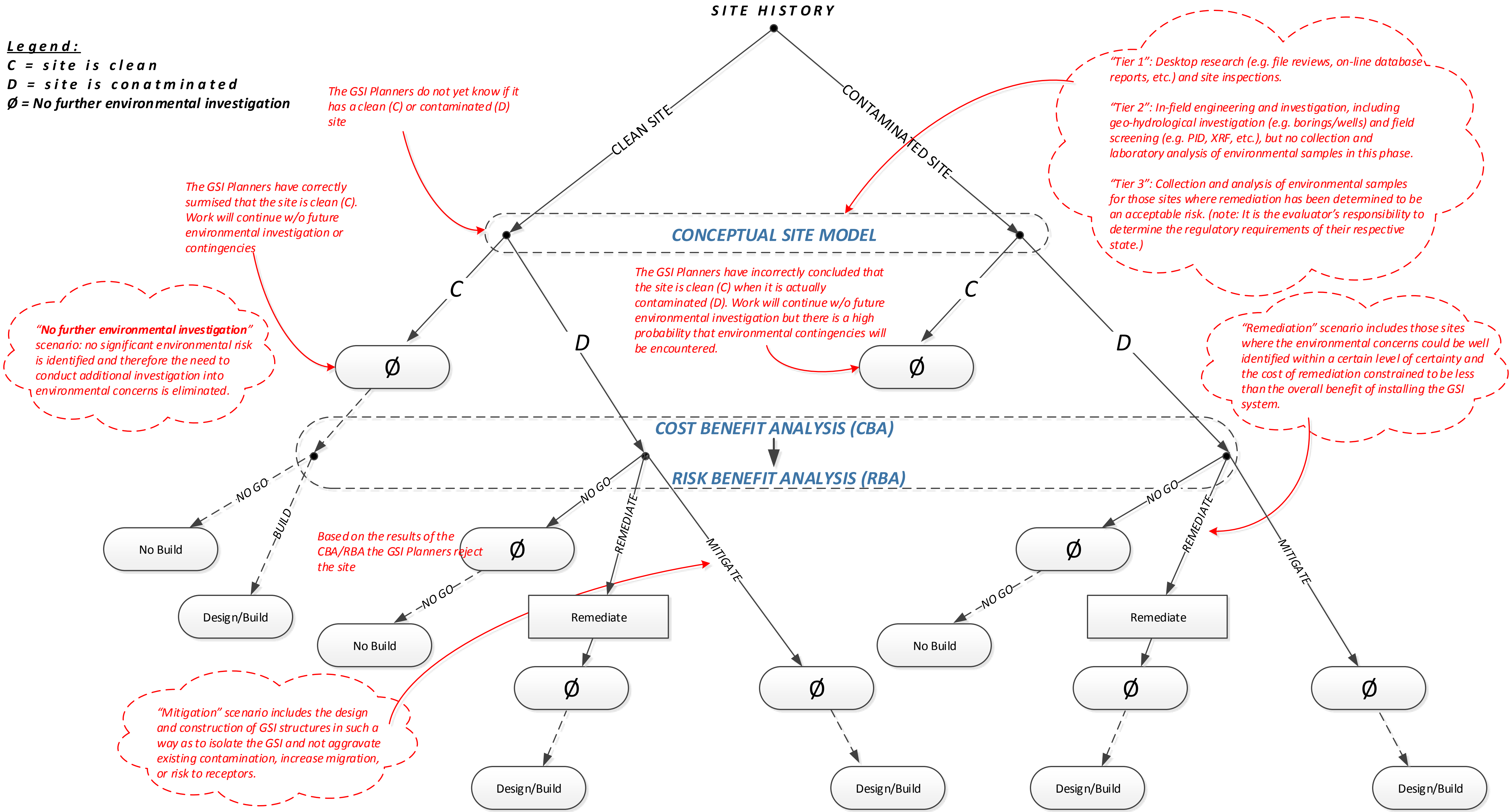
Decision Tree Process: Putting it All Together

The Work Flow Diagram illustrates the respective steps to be undertaken in using this tool. Figure 2: Decision Tree illustrates those steps as well as the decision points along the way.

You will prepare a CSM that reflects whether or not the site is clean or contaminated based on the level of environmental data available or Tier. Once the CSM is completed you will proceed to the CBA under the assumption that the site is either clean or contaminated. Once the CBA and RBA are completed you will decide which of the several scenarios to opt for including:

1. Site is determined to be clean, the evaluator decides no further environmental analysis is needed as no significant environmental risk has been identified, design/build.
2. Site is determined to be clean, the evaluator decides no further environmental analysis is needed as no significant environmental risk has been identified, site rejected no build.
3. Site is assumed clean but the environmental data reveals that it is likely contaminated, evaluator conducts CBA and RBA under that assumption, evaluator rejects site based on the RBA (no build).
4. Site is assumed clean but the environmental data reveals that it is likely contaminated, evaluator conducts CBA and RBA under that assumption, remediation option yields highest net benefits, evaluator opts for design/build.
5. Site is assumed clean but the environmental data reveals that it is likely contaminated, evaluator conducts CBA and RBA under that assumption, mitigation option yields highest net benefits, evaluator opts for design/build that will not aggravate existing contamination, increase migration, or risk to receptors.
6. Site is concluded to be clean, evaluator proceeds with design/build however site is actually contaminated. *Note: This scenario is illustrated in the Risk Benefit Analysis Tree that those that have to account for the 50% probability that the site, which was assumed clean, is actually contaminated and require an adjusted net benefit.*
7. Site is determined to be contaminated, evaluator conducts CBA and RBA, opts for no further environmental investigation, rejects site (no build).
8. Site is determined to be contaminated, evaluator conducts CBA and RBA, remediation option yields highest net benefits, evaluator opts for design/build.
9. Site is determined to be contaminated, evaluator conducts CBA and RBA, mitigation option yields highest net benefits, evaluator opts for design/build that will not aggravate existing contamination, increase migration, or risk to receptors.

FIGURE 2: Decision Tree



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FACT SHEETS

FACT SHEET 1: SIMPLIFIED CONCEPTUAL SITE MODEL (CSM)

The purpose of the Conceptual Site Model (CSM) in the GSI Environmental Planning process is to organize and present the most important components of the environmental risk assessment. The CSM is a is a written and illustrative representation of transport, migration, and potential impacts of contamination at a site in soil, air, ground water, surface water, and sediments to human and ecological receptors. The goal of the CSM is to identify potential *completed* contaminant migration pathways whereby contamination may reach and harm human and ecological receptors. The iterative environmental data collection and analysis to develop a CSM proceeds in one, two, or three tiers (as needed) including:

- Tier 1 (Desktop research and site inspections): Includes completion of a Phase 1 Environmental Site Assessment (or similar investigation and documentation) by a Qualified Environmental Professional or planning staff. The basic work includes desktop research (e.g. research and review historic mapping, file reviews, on-line database reports, etc.) and site inspections.
- Tier 2 (Field Investigation): Includes in-field engineering and investigation, including geo-hydrological investigation (e.g. borings/wells) and field screening (e.g. PID, XRF, etc.), but *no* collection and laboratory analysis of environmental samples in this phase.
- Tier 3 (Environmental Site Investigation): Includes collection and analysis of environmental samples for those sites where remediation has been determined to be an acceptable risk based on the risk assessment and analysis of the estimated costs and benefits.

The seven principle components of a CSM are the following:

1. Primary Sources: The origin of the contamination on the site. This may include aboveground or underground storage tanks for fuel oil, gasoline or other synthetic petroleum products; industrial or electrical equipment with PCB-contaminated cooling liquids; coatings such as lead-based paint, building materials such as asbestos, and materials used in manufacturing such as mercury. Prior agricultural uses such as orchids or dairies may have used pesticides, herbicides, fertilizers, nitrates that remain on the soil. There may also be natural sources of contamination such as arsenic in soil. A list of examples primary sources and contamination are provided in the Attachment to this Fact Sheet.
2. Contaminants: The residual contamination in soil and groundwater that may result from prior land use includes several broad classes of natural and man-made compounds including INORGANICS (e.g. metals, oxides, bases, acids and salts); SYNTHETIC ORGANIC COMPOUNDS or “SOC” (e.g. pesticides, PCBs, dioxin); POLYAROMATIC HYDROCARBONS or “PAH” (e.g. combustion by-products from fuel oil, coal, etc.); VOLATILE ORGANIC COMPOUNDS or “VOC” (organic compounds that easily evaporate at room temperature and low pressure, e.g. benzene, MTBE (gasoline additive), tetrachloroethylene, etc.). The type of contaminants that may be present are important in understanding potential toxicity and mobility of the uncontrolled compounds. Some prior uses, such as hospitals and laboratories may leave residual RADIOACTIVE or MICROBIAL contamination.
3. Primary Release Mechanism: This is the probable route that the contaminant followed from the primary source to the environment. For example, an underground storage tank may have corroded and leaked contamination directly to the subsurface, or a malfunctioning piece of machinery may have released PCBs. There is also intentional dumping that can cause releases of contamination to the environment.

4. Secondary Sources: Once the contamination has entered the environment, additional process may spread the contamination further to other environmental media. For example, the original release may have resulted in contamination of subsurface soil. In this case, the soil would be the secondary source of the contamination

5. Secondary Release Mechanism: These are the processes that spread uncontrolled contamination located in secondary sources to the broader environment. For example, stormwater may percolate through the soil profile bringing contamination in the subsurface unsaturated layers down deeper into groundwater aquifers; or wind may blow dried contaminated soil particles and dust off of site to adjoining areas.

6. Exposure Route: This is the way that a human or ecological receptor may come in contact with the uncontrolled contamination. For example, a fish may swim in a river or creek that has received contaminated groundwater and would absorb the contamination through its skin. Another example is humans coming in direct contact with contaminated soil through working in the subsurface or inhaling contaminated dust particles. Contaminated vapor may also travel through the subsurface into nearby residences or commercial buildings causing a threat to inhabitants or workers who may berate the accumulating contaminated fumes.

7. Receptors: These are the human or ecological receptors that are at risk of absorbing, ingesting, or inhaling contamination. The goal of the CSM is to identify potential completed contaminant migration pathways whereby contamination may reach and harm human and ecological receptors. It is also important to understand that there may be different classes of receptors. For example, there may be a child-care center near to a contaminated site and the young children would be much more susceptible to contamination then would, say, adult workers or adult residents in nearby house. Receptors may also include terrestrial and aquatic biota (animals and plants).

FACT SHEET 1 ATTACHMENT 1:
LAND USE HISTORY AND TYPICAL CONTAMINANTS

Land Use	Typical Contaminants	INORG	SOC	PAH	VOC	MICRO	RAD
Agriculture							
Crop and Fodder Production/ Specialty Crop Production/Nursery	Pesticides, herbicides, fertilizers, nitrates.	X	X		X		
Pasture (Grazing)/Confined Animal Feeding Operations/Aquaculture	Nutrients: nitrogen, ammonia, and phosphorus; organic matter; pathogens; parasites, bacteria, and viruses; solid matter; pesticides and hormones; antibiotics, metals	X				X	
Golf courses	Fertilizers; herbicides; pesticides for controlling mosquitoes, ticks, ants, gypsy moths, and other pests	X	X		X		
Chemical Processing / Storage							
Above/Below ground storage tanks	Heating oil; diesel fuel; gasoline; other chemicals	X	X	X	X		
Chemical/petroleum processing/storage	Hazardous chemicals; solvents; hydrocarbons; heavy metals; asphalt	X	X	X	X		
Coal Gasification Facility	Gas loss, leaching of residual products found in ash residue in the spent gasification cavity (calcium, sodium, sulfate, bicarbonate, metals), condensed liquids (BTEX, phenolic compounds, Polycyclic aromatic hydrocarbons (PAHs) and heterocyclic compounds.	X	X	X	X		
Pesticide / Herbicide / Fertilizer Manufacture / Distribution / Storage	Wide variety of hazardous and nonhazardous wastes depending on the nature of the facility.	X	X		X		
Plastics/synthetics producers	Solvents; oils; miscellaneous organic and inorganics (phenols, resins); paint wastes; cyanides; acids; alkalis; wastewater treatment sludges; cellulose esters; surfactant; glycols; phenols; formaldehyde; peroxides; etc.	X	X		X		
Commercial/Industrial							

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Land Use	Typical Contaminants	INORG	SOC	PAH	VOC	MICRO	RAD
Auction lots	Livestock sewage wastes; nitrates; phosphates; coliform and noncoliform bacteria; giardia, viruses; total dissolved solids	X					
Automotive Body shops/repair shops	Waste oils; solvents; acids; paints; automotive wastes; miscellaneous cutting oils						
Boat Services/repair/refinishing	Diesel fuels; oil; septage from boat waste disposal area; wood preservative and treatment chemicals; paints; waxes; varnishes; automotive wastes	X	X		X		
Car washes	Soaps; detergents, waxes; miscellaneous chemicals	X	X		X		
Cement / concrete plants	Diesel fuels; solvents; oils; miscellaneous wastes	X	X	X	X		
Dry cleaners	Solvents (perchloroethylene, petroleum solvents, Freon); spotting chemicals (trichloroethane, methyl chloroform, ammonia, peroxides, hydrochloric acid, rust removers, amyl acetate)				X		
Electrical/electronic manufacturing	Cyanides; metal sludges; caustic (chromic acid); solvents; oils; alkalis; acids; paints and paint sludges; calcium fluoride sludges; methylene chloride; perchloroethylene; trichloroethane; acetone; methanol; toluene; PCBs	X	X	X	X		
Food processing / Animal Slaughtering	Nitrates; salts; phosphorus; miscellaneous food wastes; chlorine; ammonia; ethylene glycol	X	X		X	X	
Funeral homes and Mortuaries	External corporeal wash water, internal body fluids, as well as residual arterial embalming chemicals (formaldehyde, phenol, and methanol	X	X		X	X	
Furniture repair/manufacturing	Paints; solvents; degreasing and solvent recovery sludges; lacquers; sealants	X	X		X		

FACT SHEET 1 ATTACHMENT 1: LAND USE HISTORY AND TYPICAL CONTAMINANTS

Land Use	Typical Contaminants	INORG	SOC	PAH	VOC	MICRO	RAD
Gas stations	oils; solvents; gasoline, diesel, miscellaneous wastes, lead	X	X	X	X		
Hardware/lumber/parts stores	Hazardous chemical products in inventories; heating oil and fork lift fuel from storage tanks; wood-staining and treating products such as creosote; paints; thinners; lacquers; varnishes	X	X	X	X		
Home manufacturing	Solvents; paints; glues and other adhesives; waste insulation; lacquers; tars; sealants; epoxy wastes; miscellaneous chemical wastes	X	X		X		
Hospitals/Research laboratories	X-ray developers and fixers; infectious wastes; radiological biological wastes, disinfectants; asbestos; beryllium; solvents; infectious materials; drugs; disinfectants; (quaternary ammonia, hexachlorophene, peroxides, chlorhexidine, bleach); and miscellaneous chemical wastes.	X	X		X	X	X
Junk/scrap/salvage yards	Automotive wastes; PCB contaminated wastes; any wastes from businesses and households; oils; lead	X	X	X	X		
Machine shops	Solvents; metals; miscellaneous organics; sludges; oily metal shavings; lubricant and cutting oils; degreasers (tetrachloroethylene); metal marking fluids; mold-release agents	X	X	X	X		
Medical/vet offices	X-ray developers and fixers; infectious wastes; radiological wastes; biological wastes; disinfectants; asbestos; beryllium; dental acids; variable miscellaneous chemicals	X	X		X	X	X
Metal plating/finishing/ fabricating	Sodium and hydrogen cyanide; metallic salts; hydrochloric acid; sulfuric acid; chromic acid; boric acid; paint wastes; heavy metals; plating wastes; oils; solvents	X	X		X		
Military installations	Wide variety of hazardous and nonhazardous wastes depending on the nature of the facility and operation; diesel fuels; jet fuels; solvents; paints; waste oils; heavy metals; radioactive wastes	X	X		X		X

FACT SHEET 1 ATTACHMENT 1:
LAND USE HISTORY AND TYPICAL CONTAMINANTS

Land Use	Typical Contaminants	INORG	SOC	PAH	VOC	MICRO	RAD
Office buildings/complexes	Building wastes; lawn and garden maintenance chemicals ; gasoline; motor oil	X	X		X		
Parking lots/malls	Hydrocarbons; heavy metals; building wastes	X	X		X		
Pharmaceutical	TSS, oil & grease, fecal coliform, volatile organic compounds, nonconventional pollutants.	X	X		X		
Photo processing, print shop	Ethanol, isopropanol, ethylene glycol, xylene, toluene, cyclohexanone, petroleum products, volatile organic compounds, lead, chromium, silver, cadmium, and barium,	X	X		X		
Textiles	Scouring alkali waste, oils, surfactants, lubricants, dye, bleaching (hydrogen peroxide, sodium hypochlorite, sodium chlorite, sulfur dioxide), caustic soda, salts	X	X	X			
Wood preserving/treating	Wood preservatives; creosote, pentachlorophenol, arsenic, dioxin.	X	X	X			
Wood/pulp/paper processing and mills	Metals; acids; minerals; sulfides; other hazardous and nonhazardous chemicals; organic sludges; sodium hydroxide; chlorine; hypochlorite; chlorine dioxide; hydrogen peroxide; treated wood residue (copper quinolate, mercury, sodium azide); tanner gas; paint sludges; solvents; creosote; coating and gluing wastes, dioxin.	X	X	X			
Disposal							
Hazardous Waste Recovery Facility / Waste Transfer / Storage / Disposal and Superfund Sites	Wide variety of contaminants depending on historical use.	X	X	X	X	X	X

FACT SHEET 1 ATTACHMENT 1:
LAND USE HISTORY AND TYPICAL CONTAMINANTS

Land Use	Typical Contaminants	INORG	SOC	PAH	VOC	MICRO	RAD
Solid Waste Collection / Transfer Site	Wide variety of contaminants depending on the historical use. Anthropogenic waste (toxic metals, hydrocarbons, chlorinated hydrocarbons, surfactant-derived compounds, phthalates, pharmaceutical chemicals. Biological waste (ammonia, dissolved organic carbon, aliphatic compounds, phenols, derivates of abietic acid)	X	X	X	X	X	
Land Disposal							
Cemetery	Microbiological contaminants including *Staphylococcus spp., Bacillus spp., Enterobacteriaceae spp.,* fecal streptococci, *Clostridium spp., Helicobacter pylori,* enteroviruses, rotavirus, calicivirus; arsenic, mercury, formaldehyde, copper, lead, zinc.	X	X			X	
Injection wells/drywells/sumps	Stormwater runoff; spilled liquids; used oils; antifreeze; gasoline; solvents; other petroleum products; pesticides; and a wide variety	X	X		X	X	X
Landfills/dumps (active and closed)	Leachate; organic and inorganic chemical contaminants; waste from households and businesses; nitrates; oils; metals; solvents; sludge	X	X	X	X	X	
Septic systems	Nitrates; septage; Cryptosporidium; Giardia; coliform and noncoliform bacteria; viruses; drain cleaners; solvents; heavy metals; synthetic detergents; cooking and motor oils; bleach; pesticides; , paints; paint thinner; swimming pool chemicals; septic tank/cesspool cleaner chemicals ; elevated levels of chloride, sulfate, calcium, magnesium, potassium, and phosphate; other household hazardous wastes	X				X	
Resource Extraction							
Mines/gravel pits	Mine spills or tailings that often contain metals; acids; highly corrosive mineralized waters; metal sulfides; metals; acids; minerals sulfides; other hazardous and nonhazardous chemicals	X			X		X

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Land Use	Typical Contaminants	INORG	SOC	PAH	VOC	MICRO	RAD
Shale Gas extraction / Coalbed methane extractions / Tight sands hydraulic fracturing	Total dissolved solids, fracturing fluid additives: acids, biocides, gel agents, clay stabilizers, corrosion inhibitors, pH adjusting agents, scale inhibitors, surfactants; metals, naturally occurring radioactive materials.	X	X	X	X		X
Transportation							
Airports (maintenance/fueling areas)	Jet fuels; deicers; diesel fuel; chlorinated solvents; automotive wastes; * heating oil; building wastes			X	X		
Barge and Vessel Traffic	Fuel, miscellaneous wastes; oil; variable transported materials	X	X	X	X	X	X
Boat ramps and marinas	Gasoline, diesel, miscellaneous wastes, lead, waste oil; solvents; gasoline and diesel fuel from vehicles and storage tanks; fuel oil; other automotive wastes; deicing products; variable transported materials	X	X	X	X		
Fleet / trucking / bus terminals	Waste oil; solvents; gasoline and diesel fuel from vehicles and storage tanks; fuel oil; other automotive wastes	X	X	X	X		
Primary Roadways / Truck Terminals	Gasoline, diesel, miscellaneous wastes, lead, waste oil; solvents; gasoline and diesel fuel from vehicles and storage tanks; fuel oil; other automotive wastes; deicing products; variable transported materials	X	X	X	X	X	X
Railroad tracks / yards / maintenance / fueling areas	Diesel fuel; herbicides for rights-of-way ; creosote from preserving wood ties; solvents; paints; waste oils	X	X	X	X	X	X
Utilities							
Urban stormwater management infrastructure	TSS, pesticides and fertilizers, animal waste, metals, oil and grease/hydrocarbons, bacteria and viruses, nitrogen and phosphorus ,	X	X	X	X	X	

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LAND USE HISTORY AND TYPICAL CONTAMINANTS

Land Use	Typical Contaminants	INORG	SOC	PAH	VOC	MICRO	RAD
Utility stations/maintenance areas	PCBs from transformers and capacitors; oils; solvents; sludges; acid solution; metal plating solutions (chromium, nickel, cadmium); herbicides from utility rights-of-way		X	X			
Wastewater treatment facilities	Municipal wastewater; sludge; treatment chemicals; nitrates; heavy metals; coliform and noncoliform bacteria; nonhazardous wastes	X	X	X	X	X	

Source: Virginia Department of Health, Office of Drinking Water Source Water Assessment Program Typical Contaminants Compendium (Rev. December 2015)

Legend:

INORG = INORGANICS (e.g. metals, oxides, bases, acids and salts)
SOC = SYNTHETIC ORGANIC COMPOUNDS (e.g. pesticides, PCBs, dioxin)
PAH = POLYAROMATIC HYDROCARBONS (e.g. combustion by-products from fuel oil, coal, etc.)
VOC = VOLATILE ORGANIC COMPOUNDS (organic compounds that easily evaporate at room temperature and low pressure, e.g. benzene, MTBE (gasoline additive), tetrachloroethylene, etc.)
MICRO = MICROBIAL contamination
RAD = RADIOACTIVE contamination

FACT SHEET 1 ATTACHMENT 2: Simplified CSM for Case Study Site A

Potential Primary Sources	Potential Contaminants	Primary Release Mechanism	Potential Secondary Sources	Secondary Release Mechanism	Exposure	Receptors
Underground storage tanks and piping	Heavy petroleum hydrocarbons (PAHs)	Spills/Leaks	Soil	Migration vis saturated zone	Inhalation of fugitive dust	Area residents or commercial/ institutional buildings
Subsurface demolition debris	Inorganics (Mercury/Lead) SOCs	Infiltration/Percolation		Migration vis unsaturated zone	Inhalation of vapors	Site visitors/workers
Former industrial operations	VOCs			Stormwater runoff	Ingestion of soil and dust	Biota aqautic
				Dust or volatile emissions	Dermal contact soil and dust	Biota terrestrial

Less mobile: direct contact concern

Highly mobile: vapor/gw concern

Mainly concern for Area 2 only since Area 1 is capped.

Not likely due to distance from rivers

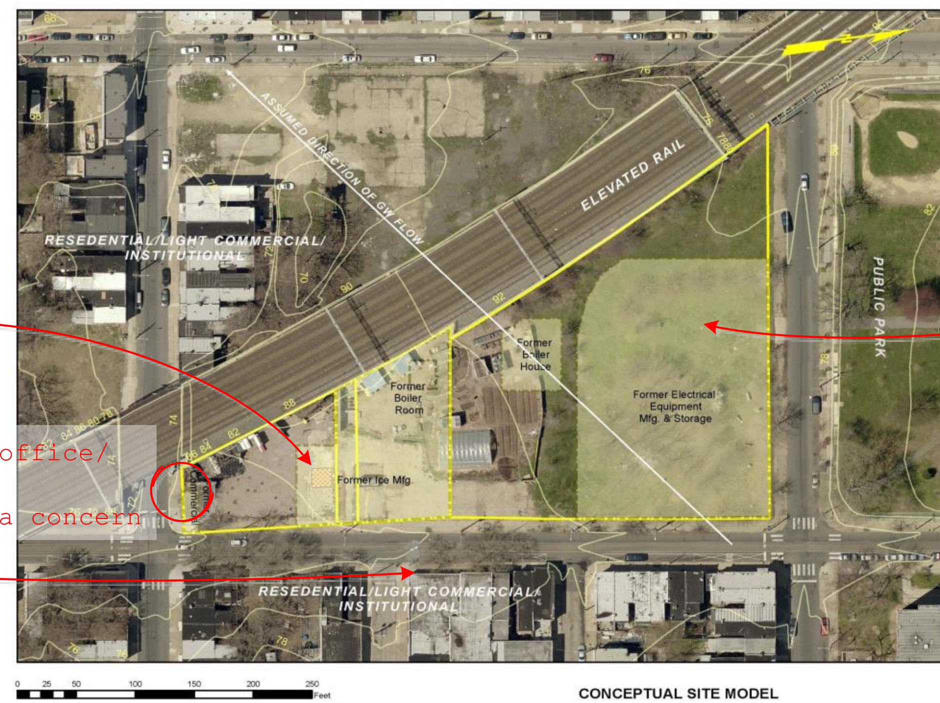
Main concern is former manufacturing operations at electrical equipment warehouse. Boilers existed at the electrical equipment co. and the ice manufacturing company, which indicates possibility for USTs and piping. Demolition debris in the subsurface is also of concern.

Area 1: Capped

Area 2: Unpaved

Former small office/ commercial building not a concern

Active store-front Church



CONCEPTUAL SITE MODEL

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EXAMPLE CASE STUDY SITE A: CONCEPTUAL SITE MODEL

NJIT Brownfield Green Stormwater Infrastructure (GSI) Planning Project

File No.: 01	SHEET 1 OF 1
Date: 08.23.16	
Designer: MB	

FACT SHEET 2: COST ESTIMATION

This Fact Sheet provides information about estimating costs for each of the three stages of the environmental planning process. The cost estimates are based on a range of sites between 0.10 acre and 2.5 acres (5,000 – 100,000 sq. ft. (approx.). These costs are merely estimates. Actual costs may vary.

The Attachment to this fact sheet provides a cost estimate for each of the Stages for the Example Case Study.

Tier 1 (Desktop Investigation/Site Inspection): $2,000 - $5,000.

Desktop research (e.g. file reviews, on-line database reports, etc.) and site inspections. Includes completion of a Phase 1 Environmental Site Assessment (or similar investigation and documentation) by a Qualified Environmental Professional or planning staff. The basic work includes desktop research (e.g. research and review historic mapping, file reviews, on-line database reports, etc.) and site inspections.

Tier 2 (Field Investigation): $20,000 - $100,000.

In-field engineering and investigation, including geo-hydrological investigation (e.g. borings/wells) and field screening (e.g. PID, XRF, etc.), but no collection and laboratory analysis of environmental samples in this phase.

The price will vary based on the area that must be investigated and the intensity of investigation based on knowledge of site conditions.

The Case Study attached to this Fact Sheet includes unit costs and a prepared cost estimate for a Field Investigation at Site A. The site is 2.25 acres (approx.) however, only half of the site appears to have had land use history that may have resulted in significant subsurface contamination. The cost estimate for the Tier 2 Field Investigation Case Study Site A is $65,745.00

Tier 3 (Environmental Site Investigation): $20,000 - $100,000.

Collection and analysis of environmental samples for those sites where remediation has been determined to be an acceptable risk based on the risk assessment and analysis of the estimated costs and benefits. This includes geophysical investigation and use of Geoprobe to collect subsurface soil samples and install temporary well points for collection of groundwater samples. The price will vary based on the area that must be investigated and the intensity of investigation based on knowledge of site conditions.

The Case Study attached to this Fact Sheet includes unit costs and a prepared cost estimate for an Environmental Site Investigation at Site A. The site is 2.25 acres (approx.) however, only half of the site appears to have had land use history that may have resulted in significant subsurface contamination. The cost estimate for the Stage 3 Environmental Site Investigation Case Study is $67,335.00.

Environmental Remediation: $50,000 - $500,000

Although environmental remediation is outside (and subsequent to) the environmental planning process, remediation unit costs and a prepared cost estimate for remediation of the Case Study Site A. The Case Study remediation includes the closure of two (2) 10,000-15,000 gallon USTs, the excavation and disposal of 750 tons of non-hazardous contaminated soil (approx., 1,000 sq. ft. to a depth of 15-feet below grade), and construction of a 6-inch stone cap. The cost estimate for the remediation of the Case Study is $287,950.00.

FACTSHEET 2 ATTACHMENT 2: Sample Cost Estimate

Example Case Study

Assumptions:

Investigation area of 2.25 acres (approx.) including permeable and impermeable surfaces.

Remediation includes the closure of 2 10,000-15,000 Gal. USTs, the excavation and disposal of 750 tons of non-hazardous contaminated soil (approx., 1,000 sq. ft. to a depth of 15-feet below grade), and construction of a 6-inch stone cap.

			Tier 2/Field Investigation		Tier 3/Site Investigation		Remediation	
Description	**Unit**	**Unit Price**	**Bid Quantity**	**Total Cost**	**Bid Quantity**	**Total Cost**	**Bid Quantity**	**Total Cost**
Professional Services								
Project Control and Management	LS	$ 5,000.00	1	$ 5,000.00	1	$ 5,000.00	2	$ 10,000.00
Regulatory Coordination	HR	$ 120.00	0	$ -	0	$ -	36	$ 4,320.00
Review of Environmental Case Files	LS	$ 2,500.00	1	$ 2,500.00	1	$ 2,500.00	1	$ 2,500.00
Permits, Forms and Certifications	LS	$ 2,000.00	1	$ 2,000.00	1	$ 2,000.00	1	$ 2,000.00
QAPP	LS	$ 2,500.00	0	$ -	1	$ 2,500.00	1	$ 2,500.00
HASP	LS	$ 1,200.00	1	$ 1,200.00	1	$ 1,200.00	1	$ 1,200.00
Public Notification	LS	$ 850.00	0	$ -	1	$ 850.00	1	$ 850.00
Receptor Evaluation	LS	$ 2,500.00	0	$ -	1	$ 2,500.00	1	$ 2,500.00
Blended Labor Rate (Professional Services)	HR	$ 100.00	60	$ 6,000.00	60	$ 6,000.00	180	$ 18,000.00
Phase II Investigation Report	LS	$ 3,500.00	1	$ 3,500.00	1	$ 3,500.00	0	$ -
Remedial Investigation Workplan	LS	$ 4,500.00	0	$ -	0	$ -	1	$ 4,500.00
Remedial Investigation Report	LS	$ 5,500.00	0	$ -	0	$ -	1	$ 5,500.00
Remedial Action Report	LS	$ 6,500.00	0	$ -	0	$ -	1	$ 6,500.00
Environmental Closure	LS	$ 4,000.00	0	$ -	0	$ -	1	$ 4,000.00
		Subtotal:		**$ 20,200.00**		**$ 26,050.00**		**$ 64,370.00**
Subcontractors								
Geophysical Survey (half-day)	LS	$ 1,250.00	1	$ 1,250.00	1	$ 1,250.00	0	$ -
UST Closure: < 5,000 Gal.	EA	$ 7,800.00	0	$ -	0	$ -	0	$ -
UST Closure: 5,000 - 10,000 Gal.	EA	$ 13,800.00	0	$ -	0	$ -	0	$ -
UST Closure: 10,000-15,000 Gal.	EA	$ 18,000.00	0	$ -	0	$ -	2	$ 36,000.00
UST Closure: 15,000-20,000 Gal.	EA	$ 24,000.00	0	$ -	0	$ -	0	$ -
Geoprobe and operator	DAYS	$ 2,400.00	2	$ 4,800.00	3	$ 7,200.00	0	$ -
Temporary groundwater sampling points	FEET	$ 8.50	0	$ -	450	$ 3,825.00	0	$ -
Installation of 2 inch monitoring/test wells (50-ft.)	EA	$ 4,500.00	3	$ 13,500.00	0	$ -	3	$ 13,500.00
Groundwater monitoring events	EA	$ 2,500.00	2	$ 5,000.00	0	$ -	2	$ 5,000.00
Loader and operator	DAYS	$ 1,860.00	2	$ 3,720.00	1	$ 1,860.00	3	$ 5,580.00
Excavator with jackhammer and operator (excavation and select demolition)	DAYS	$ 2,575.00	2	$ 5,150.00	1	$ 2,575.00	3	$ 7,725.00
Laborer	DAYS	$ 800.00	2	$ 1,600.00	1	$ 800.00	3	$ 2,400.00
Field screening (e.g. PID, XRF, etc.)	DAYS	$ 350.00	2	$ 700.00				
Disposal of construction and demolition waste	TONS	$ 175.00	15	$ 2,625.00	15	$ 2,625.00	125	$ 21,875.00
Off-site recycling or disposal of concrete and masonry debris	TONS	$ 55.00	60	$ 3,300.00	60	$ 3,300.00	180	$ 9,900.00
Disposal of non-hazardous liquid waste	GALS.	$ 1.75	1,200	$ 2,100.00	1,200	$ 2,100.00	4,800	$ 8,400.00
Disposal of Unsuitable Materials and IDW (20 CY Roll-Off)	EA	$ 1,800.00	1	$ 1,800.00	1	$ 1,800.00	4	$ 7,200.00
Remedial Excavation: Excavated and stockpiled material	CY	$ 8.00	0	$ -	0	$ -	750	$ 6,000.00
Remedial Excavation: Excavated material screened, loaded, transported and disposed off-site at a licensed and approved solid waste disposal facility.	TON	$ 65.00	0	$ -	0	$ -	750	$ 48,750.00
Remedial Excavation: Certified clean backfill emplaced and compacted.	TON	$ 35.00	0	$ -	0	$ -	750	$ 26,250.00
Soil Cap Construction	CY	$ 5.50	0	$ -	0	$ -	0	$ -
Stone Cap Construction	CY	$ 30.00	0	$ -	0	$ -	20	$ 600.00
Chain Link Fence and Gates	FT	$ 5.00	0	$ -	0	$ -	250	$ 1,250.00
		Subtotal:		**$ 45,545.00**		**$ 27,335.00**		**$ 200,430.00**
Laboratory Analysis								
Concrete and masonry sample analysis	EA	$ 850.00	0	$ -	0	$ -	5	$ 4,250.00
PCB Analysis	EA	$ 75.00	0	$ -	2	$ 150.00	4	$ 300.00
Target Compound List+ 30 /Target Analyte List (TCL+30/TAL) Analytical Parameters.	EA	$ 550.00	0	$ -	20	$ 11,000.00	30	$ 16,500.00
Groundwater samples analyzed for VO+TIC's and SVO+TIC's	EA	$ 350.00	0	$ -	8	$ 2,800.00	6	$ 2,100.00
		Subtotal:		$ -		**$ 13,950.00**		**$ 23,150.00**
		Total:		**$ 65,745.00**		**$ 67,335.00**		**$ 287,950.00**

Vapor Intrusion Investigation								
Vapor Intrusion Investigation	LS	$ 5,000.00		$ -	1	$ 5,000.00	4	$ 20,000.00
Sub-slab soil gas: 1 liter summa canisters analyzed using USEPA Method TO-15	EA	$ 350.00		$ -	5	$ 1,750.00	16	$ 5,600.00
Indoor air: 1 liter summa canisters analyzed using USEPA Method TO-15	EA	$ 350.00		$ -	5	$ 1,750.00	16	$ 5,600.00
		Total:		$ -		**$ 8,500.00**		**$ 31,200.00**
LNAPL Recovery and Interim Remedial Measures								
LNAPL Recovery	EA	$ 1,500.00		$ -	3	$ 4,500.00	9	$ 40,500.00
LNAPL Recovery Reporting and Regulatory Coordination	EA	$ 3,500.00		$ -	3	$ 10,500.00	9	$ 94,500.00
		Total:		$ -		**$ 15,000.00**		**$ 135,000.00**

FACT SHEET 3: SIMPLIFIED COST BENEFIT ANALYSIS

This Fact Sheet provides information on the use of a Simplified Cost-Benefit Analysis (CBA) methodology that may be used in the environmental planning process to compare projects under different scenarios. Typically, only projects that show a positive net benefit would be considered as feasible, with projects showing larger net benefits preferred over projects with lower net benefits. For purposes of this simplified methodology, discount factors are not used to derive a present-value analysis. At the level of analysis of this simplified approach, completing a present-value analysis will not expose significant differences between the alternatives.

The environmental planning process and development of the Conceptual Site Model (CSM) described in Fact Sheet 1 includes an iterative (staged) process consisting of collection and interpretation of data, analysis of costs and benefits and risk assessment under the three following environmental planning scenarios:

- Do-nothing: No significant environmental risk is identified and therefore the need to conduct additional investigation into environmental concerns is eliminated.
- Mitigation: Uses the design and construction of GSI structures in such a way as to isolate the GSI and not aggravate any existing contamination, increase migration, or risk to receptors.
- Remediation: Used on those sites where the environmental concerns may be well identified within a certain level of certainty and the cost of remediation constrained to be less than the overall benefit of installing the GSI system.

A sample CBA for the Case Study Site A is provided in Table 1. The estimated costs for the three tiers of environmental planning are taken from the Case Study cost estimates developed in Fact Sheet 2. For purposes of this analysis, the planning, design and construction costs of the GSI project are assumed to be $70,000 on a clean or remediated site. The same project is conservatively estimated to cost 25% more ($87,500) to build on a site that is assumed to be contaminated under the "Mitigation" scenario.

Table 1: Case Study Cost-Benefit Analysis

	Scenario			
	Do-Nothing (NO GO)	**Do-Nothing (GO)**	**Mitigation[1]**	**Remediation**
Costs				
Environmental Planning				
Tier 1: Desktop Investigation/Site Inspection	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00
Tier 2: Field Investigation	$ 65,745.00	$ 65,745.00	$ 65,745.00	$ 65,745.00
Tier 3: Environmental Site Investigation	$ -	$ -	$ -	$ 67,335.00
Remediation	$ -	$ -	$ -	$ 287,950.00
Planning, Design and Construction	$ -	$ 70,000.00	$ 87,500.00	$ 70,000.00
O&M (10 Yr.)	$ -	$ 35,000.00	$ 43,750.00	$ 35,000.00
Total Costs:	**$ 70,745.00**	**$ 175,745.00**	**$ 201,995.00**	**$ 531,030.00**
Benefits				
Increased environmental services	$ -	$ -	$ -	$ -
Improved public and worker health and safety	$ -	$ -	$ -	$ -
Increase in property value	$ -	$ -	$ -	$ -
# of new Greened Acres	$ -	$ 250,000.00	$ 250,000.00	$ 250,000.00
Grey infrastructure costs avoided	$ -	$ -	$ -	$ -
Total Benefits:	**$ -**	**$ 250,000.00**	**$ 250,000.00**	**$ 250,000.00**
Net Benefits:	**$ (70,745.00)**	**$ 74,255.00**	**$ 48,005.00**	**$ (281,030.00)**

[1] Construction and O&M costs for the mitigation scenario are assumed to be 25% higher than on a clean site.

FACT SHEET 3: SIMPLIFIED COST BENEFIT ANALYSIS

The results of the CBA indicates that the Do-Nothing (GO)[1] scenario has the highest net benefits, followed by the Mitigation scenario, which has incurred higher design and construction costs to mitigate the suspected environmental risk. Both the Do-Nothing (NO GO) scenario and the Remediation scenario show negative net benefits. The negative net benefits associated with the Do-Nothing (NO GO) scenario are only avoidable if no investigation is done at all at the site and could be reduced if a decision is made not to continue on to Tier 2 investigation if the results of the Tier 1 investigation are highly prohibitive. This result demonstrates that some sites where environmental planning costs are incurred will not be developed with GSI, indicating an unavoidable net loss that should be considered in the overall budgeting and planning process.

As will be seen in Fact Sheet 4 that introduces Risk Analysis into the environmental planning process, although the Do-Nothing (GO) scenario has higher net benefits than the Mitigation scenario, when the considerable risks associated with the unknown conditions are factored in, the expected value of the benefits of the Mitigation scenario may in fact be higher than the Do-Nothing (GO) scenario.

Some of the potential quantifiable benefits of the GSI installation are listed in the table and include increased environmental services (e.g. more open green space in the neighborhood, or less surface water pollution); increased public and worker health and safety; increase in the property value of the site; and the costs of grey infrastructure avoided. For purposes of this Case Study analysis, the benefit of the project is summarized in the # of Greened Acres, which is assumed to be $250,000/acre and that one new Greened Acre will be created for this project.

[1] The GO/NO GO indicator reference a decision to build a GSI system or not at the site. Although the environmental planning process plays a role in the GO/NO GO decision to build, it is not the only consideration that will drive this decision. Other factors may include the cost to build, the availability of better sites in the vicinity, neighborhood concerns, or a competing higher use of the site.

FACT SHEET 4: DECISION TREE

This Fact Sheet presents the use of the Decision Tree for assembling and viewing the information developed by the Conceptual Site Model (Fact Sheet 1), the Cost Estimate (Fact Sheet 2), and the Cost-Benefit Analysis (Fact Sheet 3).

A key feature of the Decision Tree is using Risk Analysis to assign probabilities to various decision points that are subject to significant unknown information. For example, the Do Nothing (GO) scenario indicates that no significant environmental risk has been identified by the CSM and therefore the need to conduct additional investigation into environmental concerns is eliminated. The “GO” qualification indicates that along with this Do Nothing decision, the decision is made to go forward with design and construction of the GSI project without gathering further environmental information.[1] However, there is some probability that unknown environmental contamination may exist and will have to be remediated when encountered.

A Decision Tree for the Case Study at 2316-50 N. 11th Street is attached to this Fact Sheet. For purposes of this analysis, the two branches of the tree following the decision point following the selection of the Do Nothing (GO) alternative have each been assigned a probability of 50% of occurrence. In other words, a probability of 50% has been assigned to the possibility that environmental contamination may be encountered. To correctly calculate the payoff for this Do Noting (GO) scenario, the expected value of the net benefit at each branch termination point must be calculated. The calculation is the sum of the probability of each branch multiplied by the value of the net benefit at that branch. For this example, the expected value of the Do Nothing (GO) scenario is 0.5 * $74,255 + 0.5 * -$281,030 = -$103,388.

The decision tree can then be used to compare the net benefit of each scenario. In this case the net benefit of each scenario is presented in the table below. As may be seen, the alternative with the highest net benefit value if the Mitigation scenario. Although the net benefit of the Do-Nothing (GO) scenario is higher when observing the cost benefit analysis prior to application of the risk analysis, factoring the risk of encountering unknown contamination results in negative net benefits once the expected value is calculated. The Mitigation scenario, because it is designed with the assumption of contamination, has no appreciable risk of failure.

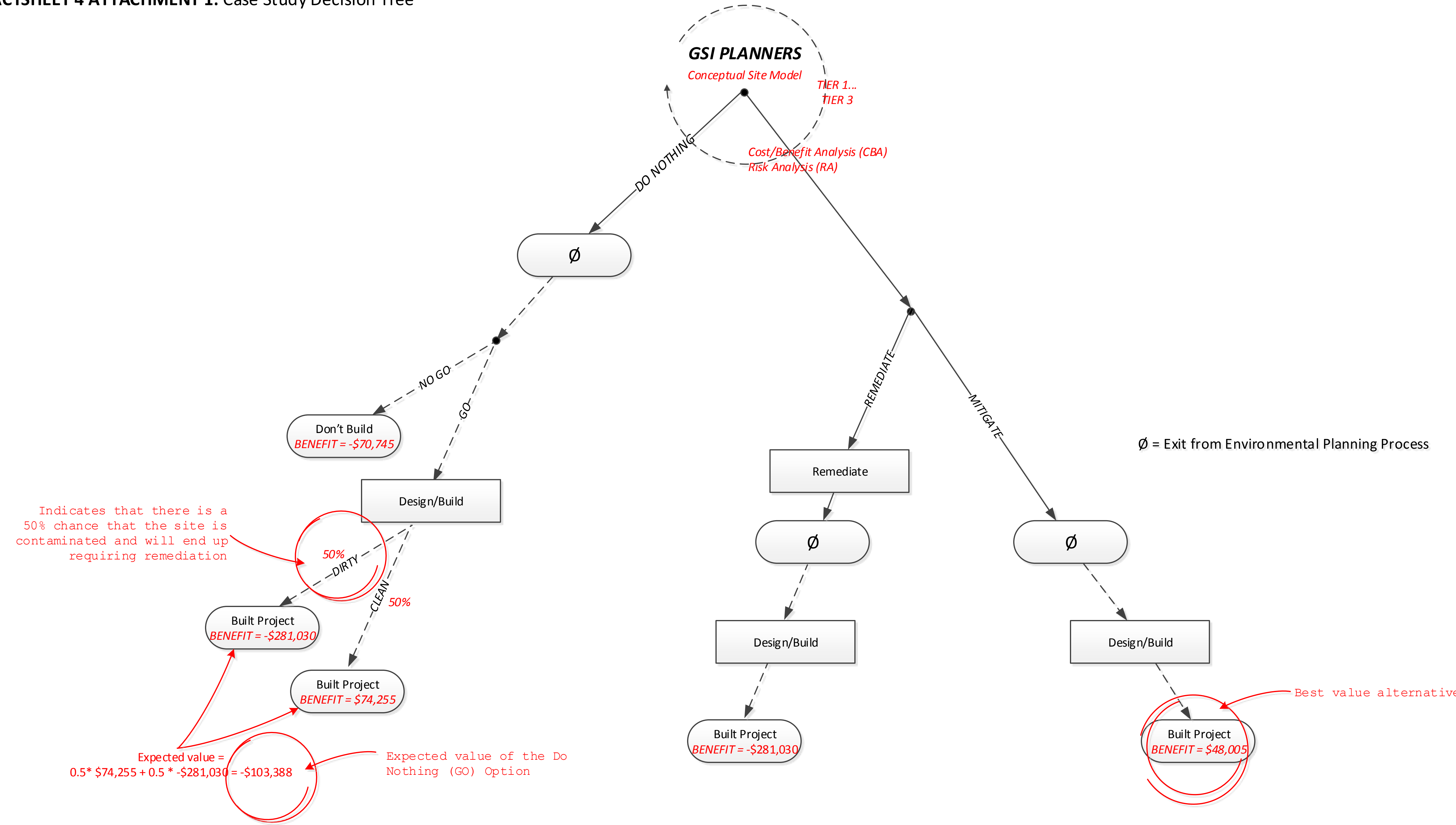
It should be noted that this presentation is a very simplified and high level use of risk analysis. The application of risk and probability of various alternatives may be added at additional levels to develop a more detailed and comprehensive analysis.

Table 1: Net Benefits

Scenario	Net Benefit	
Do-Nothing (NO GO)	$	(70,745.00)
Do-Nothing (GO)	$	(103,387.50)
Mitigation	$	48,005.00
Remediation	$	(281,030.00)

[1] To gather more environmental information at this point (Tier 2) would be to select the Remediation scenario and proceed to Tier 3.

FACTSHEET 4 ATTACHMENT 1: Case Study Decision Tree



BRS inc	***GSI PLANNING AND DESIGN/ DECISION TREE*** NJIT Brownfield Green Stormwater Infrastructure (GSI) Planning Project	**Comments/Revisions:** This diagram provides a high-level overview of the parallel track development of environmental risk assessment and GSI planning and design data including the application of a constrained, phased and iterative Conceptual Site Model (CSM) with subsequent application of Cost-Benefit Analysis (CBA) and Risk Analysis (RA).	**File No.:** 01 **Date:** 08.23.16 **Designer:** MB	**SHEET 1 OF 1**