



HOW TO PLAN AND IMPLEMENT A SUCCESSFUL INJECTION PROJECT

TODD HANNA
LEGACY REMEDIATION, INC.

SUCCESSFUL INJECTION PROJECT PHASES

1

Remediation
Design &
Characterization

2

Bidding and
Injection
Contractor
Selection

3

Remediation
Compound
Ordering,
Delivery and
Storage

4

Injection
Contractor
Pre-Project
Planning

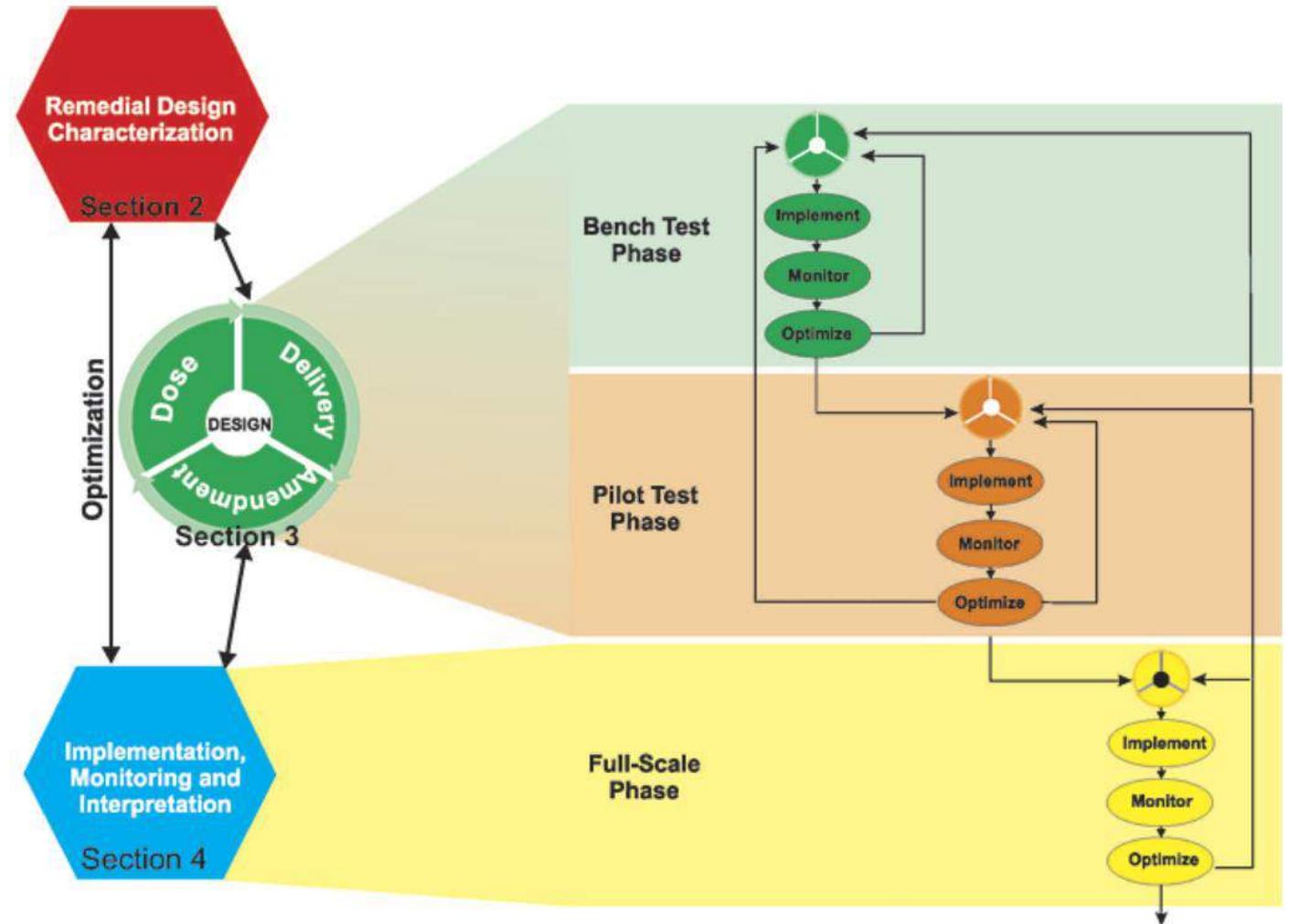
5

Injection of
Remedial
Amendments

THE INJECTION FIELD WORK IS EQUALLY IMPORTANT AS ADEQUATELY CHARACTERIZING THE SITE,
SELECTING THE CORRECT CHEMISTRY, AND SELECTING THE CORRECT DELIVERY APPROACH

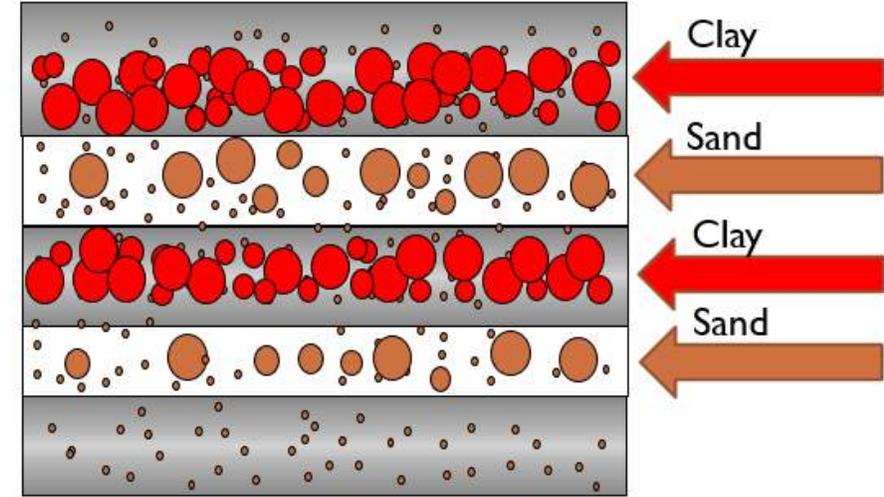
I. SITE CHARACTERIZATION & DESIGN OPTIMIZATION

- Remediation Design
- Treatability Study
- Amendment Delivery Method
- Pilot Test Injection
- Adjustments and Optimization
- Full-Scale Injection



REMEDIATION DESIGN

- A sound Remediation Design needs to be based on a good understanding of the Contaminant Mass Distribution and a good Conceptual Site Model (CSM).
- The appropriate chemistry based on contaminants, geochemistry, delivery approach, site hydraulics, and kinetics.



TREATABILITY STUDY

- Treatability Study results select a respective chemistry based on the best COC remediation.
 - Keep in mind the ability to effectively and cost efficiently deliver the chemistry into the target lithology also needs to be considered.
 - The amendment amount may need to be done up into multiple events
 - Certain amendments may not be good for tight lithology, etc.

AMENDMENT DELIVERY METHOD

- Selected delivery approach needs to make contact based on-site lithology in the target treatment interval(s).
 - Direct Push Injection
 - Well Injection (Vertical or Horizontal Wells)
 - In-Situ Mixing



PILOT TEST INJECTION

- Ability to reach target depth
- Ability of the lithology to accept the target volume and amendment amount
- Establish full scale injection flowrate and injection pressure
- Evaluate Radius of Influence (ROI)

ADJUSTMENTS AND OPTIMIZATION

- Injection Point or Injection Well layout adjustment based on achievable ROI
- Adjust Full Scale Injection Project Duration based on achievable flowrate (gpm)



FULL-SCALE INJECTION

- Delivery approaches to make contact based on-site lithology of target intervals.
- Chemistry dosing also based on residence time versus the amount of contaminant mass sorbed to soil or in the NAPL phase.

2. BIDDING AND CONTRACTOR SELECTION

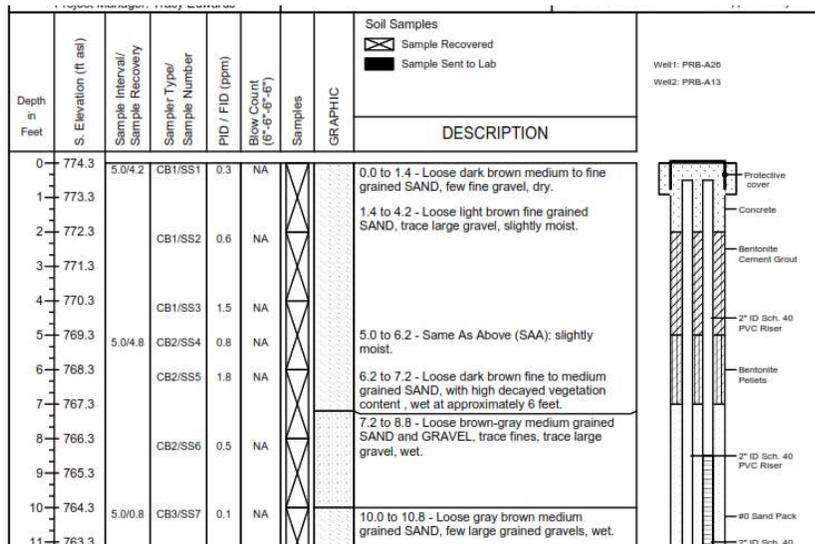
- Scope of Work Details
- Project Site Details
- PSI/GPM Limitations / Assumptions
- Ability to Manifold
- Contractor Selection Decisions
 - Experience/Safety
 - Equipment



SCOPE OF WORK DETAILS (MORE INFO THE BETTER)

- Quantity of DPT Points or Injection Wells
- Treatment Interval Length
- Injection Volume per Point or Interval
 - Project Price is generally volume (gallon) driven

DPT Location	Target Monitoring Well	Intervals per Location	Vertical Injection Interval Depth (ft bTOC)	Target Injection Volume (gallons)
19-DPT-01	19-MW-17A/B	4	9-13	120
			13-17	120
			20-24	850
			24-28	850
19-DPT-02	19-MW-17A/B	4	9-13	120
			13-17	120
			20-24	850
			24-28	850
SD019-DPT-3	19-MW-17A/B	4	9-13	120
			13-17	120
			20-24	850
			24-28	850
SD019-DPT-4	19-MW-17A/B	4	9-13	120
			13-17	120



PROJECT SITE DETAILS

- Site Maps
- Soil Boring or Well Construction Logs
- Limited Access Concerns
- Water Source Location and estimated production rate

PSI/GPM LIMITATIONS / ASSUMPTIONS

- Are there Injection Pressure Limitations / Assumptions?
- Are there Injection Flowrate Limitations / Assumptions?
- If there are pressure limitations, what if the pressure limitation is reached before flowrate assumption is reached?



ABILITY TO MANIFOLD

- This can greatly reduce time onsite and overall project cost.
- How close are the Wells or Injection Points to Mixing Area?
- How close are the Wells or Injection Points from each other?
- Do onsite operations limit access to multiple locations?

Note: I determine manifold capacity based on how long each injection tool is in a specific interval (volume / flowrate)

CONTRACTOR SELECTION - EXPERIENCE/SAFETY

- Experienced with Reagent Transfer & Handling?
- Familiar with Reagent Specific Hazards?
- Experienced with Reagent Specific Mixing & Pumping Procedures?
- Provide Accurate Record Keeping & Reporting?



CONTRACTOR SELECTION - EQUIPMENT

- Do they have purpose-built equipment?
 - Safety Features Incorporated
 - Spill and Secondary Containment Incorporated
 - Chemically Compatible & Pressure Rated
 - Accurate Totalizers, Flowmeters and Pressure Gauges
 - Performance Based (Mixers/Pumps/Multi-Point Manifold)
 - Proper Injection Tools designed for Lateral Injection

POLL QUESTION NUMBER 1

- What has been your biggest deciding factor when selecting an Injection Contractor?
 - a. Price
 - b. Project Experience
 - c. Injection Experience

3. REMEDIATION COMPOUND ORDERING, DELIVERY AND STORAGE

- Remediation Compound Delivery
- Delivery Location
- Onsite Staging & Storage
- Fencing & Security



REMEDIATION COMPOUND DELIVERY

- Less-Than-Truckload (LTL) freight can take up to 2 weeks
- Specify Pallet Jack if required
- Specify Liftgate if required



DELIVERY LOCATION

- Deliver to Job Site?
- Delivery to Contractors Yard?
- Daily Hazmat delivery?

ONSITE STAGING & STORAGE

- Will Plastic be needed to lay under the Skids?
- Will Full Secondary Liquid Containment be needed?
- Will a collapsible style containment berm work?
- Will Incompatible Reagents need to be stored separately?
- How will the skids be removed from the berm?



FENCING & SECURITY

- Will Temporary Fencing be needed?
 - With or without Privacy Screen
 - Wind Concern (Sandbags on T Stands, Smiles Cut in Fabric, etc.)
- Will Storage Container be needed?
 - How to position and remove skids in container

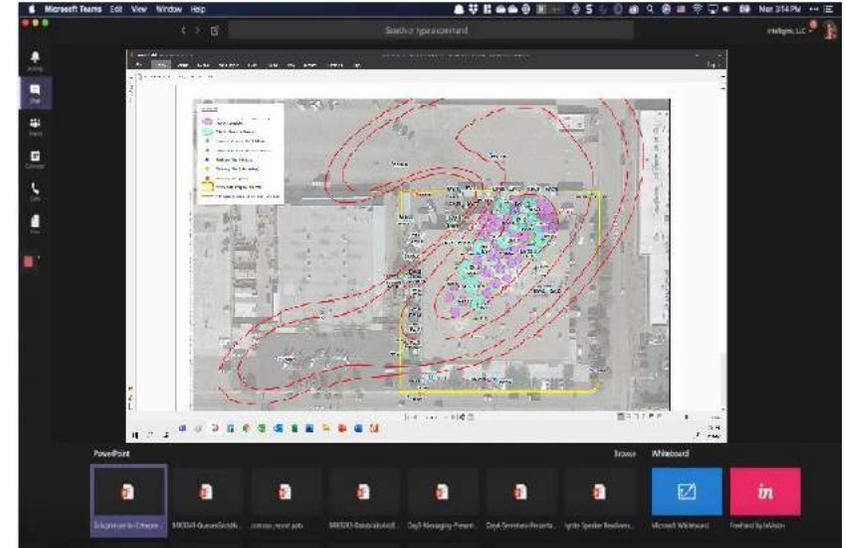
4. INJECTION CONTRACTOR PRE- PROJECT PLANNING

- Pre-Project Call or Web Meeting
- Laydown Area/Exclusion Zone
- Onsite Logistics
- Make-up Water Source/Logistics
- Boring Abandonment & Patching
- End of Day Staging/Clean-up



PRE-PROJECT CALL OR WEB MEETING

- Review SOW, Site Figures, etc.
- Safety Concerns
- Identify Responsibilities
- Planned Work Hours
- Remediation Compound Delivery Schedule
- Empty Remediation Compound Container Disposal



LAYDOWN AREA/EXCLUSION ZONE

- Exclusion Zone needs → Caution Tape, Cones, Delineators?
- Site Security needs → None, Temp Fencing, Guard Service
- Proximity to Water Source
- Proximity to Remediation Compounds
- Proximity to Storm Drains

ONSITE LOGISTICS

- Restroom and Wash Station location?
- Traffic Control, Lane Closures, flag men
- Working around existing tenant operations
- Use of Hose Crossover Ramps
- Onsite operation Safety Concerns



MAKE-UP WATER SOURCE/LOGISTICS

- Onsite Hose Spigot => will it keep up with injection rate?
- Fire Hydrant => who is coordinating with local municipality?
- Building Fire Line => fire department notification needed?
- Extracted Groundwater => treatment/storage requirement?
- Water Truck/Trailer transport to work area?

BORING ABANDONMENT & PATCHING

- Bentonite Chip backfill then hydrate
- Cement/Bentonite Slurry
- Tremmie Pipe Install
- Match Existing Surface Top Soil / Asphalt / Concrete
- Concrete Patch with Black Dye



END OF DAY STAGING/CLEAN-UP

- Equipment:
 - Tighten up, but leave all equipment onsite at the end of each day
 - Pack-up and demobilize all equipment each day
- Direct Push Tooling:
 - Leave in place & identify hazard with Cones & Delineators
 - Leave in place but leave tool joint just below ground surface

POLL QUESTION NUMBER 2

- What type of services are you wanting from your Injection Contractor?
 - a. Field Services only
 - b. Remediation Design and Field Services
 - c. Remediation Design, Remediation Compounds, and Field Services

5. INJECTION OF REMEDIAL AMENDMENTS

- Mobilization & Safety Meeting
- Off Load & Set up Equipment
- Amendment Handling
- Water Preparation
- Borehole Clearance
- Coring
- Injection Tool Considerations
- Advance Injection Tooling
- Injection Point Connection
- Injection Well Connection
- Test Systems with Water
- Mixing Considerations
- Pumping Consideration
- Injection Pressure and Flowrate
- Troubleshooting:
 - Overcoming Refusal
 - Managing Surfacing



MOBILIZATION & SAFETY MEETING

- Onsite Tailgate Safety Meeting
 - Discuss Project & Site-Specific Safety Concerns
 - Review Scope of Work, Reagent Dosing, Site Figure
 - Review H&SP and PPE
 - Review Safety Data Sheets (SDS)
 - Review Job Safety Analysis (JSA) Forms for specific Job Tasks



OFF LOAD & SET UP EQUIPMENT

- Set-up Exclusion Zone
- Off-load Equipment
- Receive Rental Equipment (Storage Tanks, Forklift, etc.)
- Set-up Secondary Containment
- Set-up Spill Response Equipment

AMENDMENT HANDLING

- Receive Amendment Delivery
- Verify Inventory & enter total into Mass Balance Tracking table
- Bring Amendments to the Mixing Area
- Place Amendments into secondary containment as needed
- Prepare scales for Dry Amendment weighing
- Connect Liquid Amendments to Transfer Pumps as needed



WATER PREPARATION

- Connect to Water Source
 - Hydrant, Hose Bib, etc.
- Run Water to the Mixing Area
 - Hydrant Hose or Water Hose
 - Water Truck / Water Trailer
- Prepare Anaerobic Flush Water for Bioaugmentation

BORE HOLE CLEARANCE

- Must notify Underground Service Alert 2-3 workdays prior
- Private Utility Locating – optional
- Hand Clearance – upper 5 feet minimum
 - 3” Hand Auger
 - Air Vac Clearance



CORING

- Electric Core Drill
- Geoprobe with 4” Auger Bit (asphalt)
- Geoprobe with 4” Concrete Bit (concrete)

INJECTION TOOL CONSIDERATIONS

- Remediation Amendment Characteristics
 - Chemical Compatibility, Viscosity, Liquids, Suspended Solids
- Target Depth & Lithology
- Treatment Interval Length
- Top-down or Bottom-up (top-down is generally the best)
- Pressure and Flowrate Limitations or Targets



ADVANCE INJECTION TOOLING

- A liberal amt of Teflon Thread Tape must be used on all joints
- Advancement Methods
 - Direct Push Rig (all sizes)
 - CPT Truck
 - Sonic Rig
 - Auger Rig

INJECTION POINT CONNECTION

- Direct Push Injection Tooling Top Connection
 - Injection Cap with Pressure Relief Valve
 - Injection Pull Cap
- Inner Hose Connection
 - Hose strung through rods & connected directly to injection tool



INJECTION WELL CONNECTION

- Slip Style Well Head Connection → outside of well casing
 - Held down with ratchet strap to well box bolt lugs
- Inflatable Pneumatic Packer → inside well casing
- Mechanical Packer → inside well casing
 - Fixed size or expandable
- Note: Packers cannot isolate a portion of a well screen

TEST SYSTEMS WITH WATER

- Test injection with water prior to mixing/injecting chemicals
- Test proper system operation
- Test there aren't any system leaks
- Verify Tooling hasn't gotten plugged during advancement

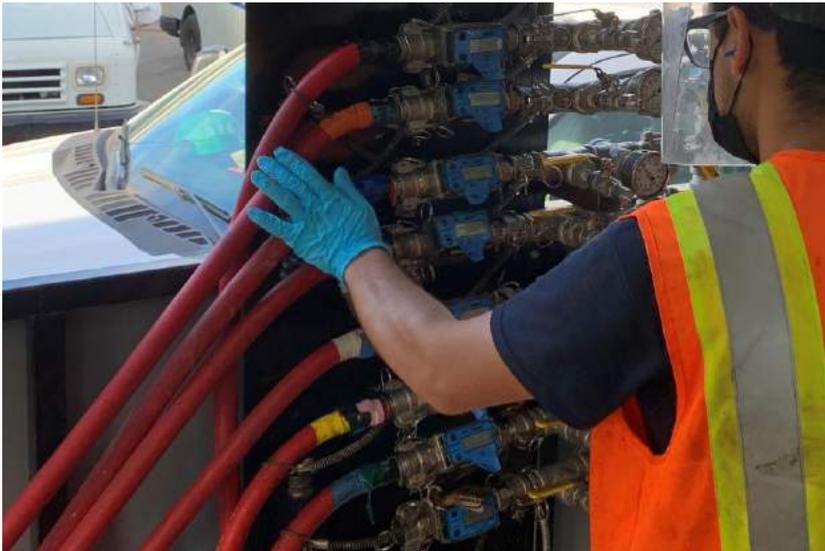


MIXING CONSIDERATIONS

- All or partial crew may need to upgrade to Level C
- Batch Mixing:
 - What size batches?
- In-Line Mixing:
 - Dosing Pumps, Static Mixers
- Will filtering be required?critical for Well Injections

PUMPING CONSIDERATIONS

- Pump Type → Remediation Amendment Characteristics
 - Chemical Compatibility, Viscosity, Liquids, Suspended Solids
- Target Pressure and Flowrate per Point?
- Combined Flowrate needed to support manifolding?



INJECTION PRESSURE AND FLOWRATE

- Direct Push Points will generally require more pressure than an Injection Well on the same site.
- With soluble mixtures, it is generally best to inject below fracture pressure.
- With solid mixtures, higher pressure and flowrates are generally needed to get good distribution.

TROUBLESHOOTING – OVERCOMING REFUSAL

- More Powerful Rig
- Smaller Diameter Tooling
- Friction Reducer
- Pre-Drilling



TROUBLESHOOTING – MANAGING SURFACING

- Reduce Pressure
- Reduce Flowrate
- Seal up old borings with Bentonite Packing Method
- Skip Treatment Interval
- Step out to and adjacent location



COURSE CODE: L R T H

QUESTIONS?

TODD HANNA

LEGACY REMEDIATION, INC.

3035 S. HALLADAY ST; SUITE B

SANTA ANA, CA 92705

(P) 714-494-6609

THANNA@LEGACYREMEDIAITON.COM

WWW.LEGACYREMEDIAITON.COM



[LINKEDIN.COM/IN/TODDWHANNA](https://www.linkedin.com/in/toddwhanna)



A SERVICE-DISABLED VETERAN-OWNED SMALL BUSINESS (SDVOSB)