MICROTUNNEL INSTALLATION:

Microtunneling is a remotely controlled, guided, pipe-jacking process that provides continuous positive control of earth and groundwater pressures at the face of the excavation. The microtunneling machine (MTBM) and jacking pipes are pushed into the ground from a jacking shaft to a reception shaft on opposite sides of a crossing. The carrier or product pipe may be jacked directly or installed inside an oversized casing in a separate operation. Pipe materials that can be jacked directly into place are similar to those used for open-shield pipe-jacking and include steel casing pipe (SCP), reinforced concrete pipe (RCP), polymer concrete pipe (PCP), vitrified clay pipe (VCP), and centrifugally cast fiberglass reinforced polymer mortar pipe (CCF RPM).

For this application, Vadnais will be utilizing the sacrificial case-and-displace method with steel casing pipe to install the 24″ steel gas pipe, as specified.

The proposed elevation of the top of the pipeline at the microtunnel crossing beneath San Francisquito Creek is at approximately Elevation -10.00. This provides a minimum depth of cover of 10 feet below the creek bottom and 14 feet of cover on the East side and 21 feet of cover on the West side. The length of the proposed crossing is 300 lineal feet. Based on soil borings on either side of the Creek, performed by Kleinfelder in 2014, the crossing will be bored through primarily favorable soil conditions consisting of silty sand and sandy lean clay beneath the groundwater table. The anticipated soil conditions are well-suited to the Iseki TCC500 (24-inch OD) microtunnel boring machine that will be utilized for the crossing.

We anticipate approximately 7 days of tunneling in order to complete the crossing, followed by an additional 3 days to install the gas pipeline. A microtunnel schedule is attached at the end of this plan.

The excavation and construction of the tunnel will proceed generally by:

- Excavate, shore and dewater the launching shaft to the size required to accommodate the Microtunnel Boring Machine (MTBM) and the pipe sections to be jacked.
- Excavate, shore, and dewater the reception shaft at the tunnel terminus.
- In the launching shaft, set-up the jacking frame and tunnel entry portal with a watertight entrance ring. No dewatering is required along the tunnel route for the microtunneling process.
- The MTBM is an earth pressure balance machine, which insures that the tunneling face is stable throughout the excavation process. The end result is the tunnel will be installed with no subsidence to structures or utilities above the tunnel horizon. The machine is remotely controlled in a control center above the ground surface. Barring unforeseen obstructions, the operation will install the tunnel within inches of its designed grade and alignment.
• The MTBM will be installed into the jacking shaft. Once the system is pretested, the MTBM will be launched through the entrance seal and begin tunneling.

• The removal of soils is accomplished via slurry. The excavated material is transported to the surface through slurry pipes in the tunnel. The slurry is processed in a slurry separation plant on the surface. At the separation plant, the solids are removed and loaded in a drier condition directly into dump trucks to be removed from the site. The clean slurry is returned to the tunnel and completes the slurry loop.

• As the advancement of the MTBM continues, sections of sacrificial steel casing tunnel pipe are set and installed behind the MTBM. The sections are hydraulically jacked behind the advancing MTBM and the process repeats itself until the tunnel reaches its terminus, at the reception shaft. Once “holed-out” at the reception shaft, the MTBM is removed and sections of 24" steel Gas Pipe are placed one at a time in the Launch Shaft. As each section of gas main is welded together and pushed forward, with the same jacking frame that initially installed the tunnel, the sacrificial casing is displaced into the reception and removed to the surface. This process continues until all sacrificial casing has been removed and the final, fully welded, coated and x-rayed gas main completes the crossing.

MICROTUNNEL OPERATION:

Vadnais Trenchless Services, Inc. (VTS) will perform the microtunnel for this project. VTS is extremely familiar with this type of work and has been performing microtunneling projects for the past 23 years. VTS will work a 6 day a week, 10-hour per day schedule to install the microtunnelled portion of the project. Due to the nature of the work, VTS may often exceed a 10 hour day due to unforeseen issues in excavation rate, separation processing, or other items that may prevent the completion of a given joint of pipe during the shift.

We will take care to plan safe routes for material and equipment delivery to our set-up area (jacking shaft) and minimize public and environmental impact. Management staff will be onsite and we will utilize a standard crew of operators and laborers to complete the micro tunneling portion of the L-101 San Francisquito Creek Pipeline Relocation Project. Personnel and equipment may be added and removed as needed.

Project staff will consist of:

(1) Project Manager       Brian McCahon (916) 416-6616
(1) Superintendent / Monitor    Jeff Rager (308) 995-1000
(1) Foreman
(1) MTBM Operator
(1) Equipment Operator
(4) Laborers

Equipment:
1. Tool Sheds
2. Isoki TCC500 (24") MTBM
3. Microtunnel Control Cabin
4. Slurry Separation Plant
5. Generator
6. Light Plants
7. Pickup Trucks
8. 1-Ton Truck
9. Air Compressor
10. Crane
11. Loader

VTS's equipment fleet is 100% tier 3 compliant and certified by the California EPA Air Resources Board. We continue to upgrade the fleet to meet future requirements prior to any regulatory mandates.
The Microtunnel Work Plan will proceed as follows:

**SECTION 1 – MICRO TUNNELING METHODS**
The construction of a pipe installation using the microtunnel method proceeds in the following order:

1) The jacking shaft is constructed together with a concrete base slab. The size of the jacking shaft will be determined by the pipe length and the jacking rig to be used. Then a concrete or steel thrust block is built for transmitting and dispersing the jacking reaction force to the ground in the jacking shaft. A pump will be provided at the bottom of the shaft in order to sump out any groundwater that may have gathered in the shaft and to remove the water that escapes from the slurry lines during pipe changes. If required, the ground at the exit eye will be stabilized to allow for the exit of the MTBM.

2) The jacking equipment, the laser, the pit by-pass unit, and the discharge pump are set up in the jacking shaft.

3) An entrance ring with a rubber seal is fitted to the inside of the shaft wall around each bore location to form a seal against both groundwater, if present, and slurry ingress into the shaft.

4) The slurry separation plant is installed near the jacking shaft on the surface. The slurry system is a closed-loop system where the water is used over and over again to transport the spoils. The spoil is separated from the slurry at the separation plant using a combination of shaker screens, and hydrocyclones. All of this material is conveyed out of the separation plant into end dumps, or another type of containment device, to be disposed of at an approved location. Piping from the separation plant to the jacking shaft is placed to form a slurry circuit.

5) The control cabin containing the operation board of the MTBM and the distribution board for the electrical equipment is set up, and power and control cables are connected to the operation board, the main power supply, and other ancillary equipment.

6) Hydraulic hoses between the power pack and the jacking equipment are connected.

7) The MTBM is lowered into the jacking shaft and set on the guide rails. The MTBM is checked to make sure it is positioned correctly on line and grade utilizing the survey points provided by the general contractor.

8) Flexible slurry lines are connected to the MTBM from the pit by-pass unit, the power and control cables are connected to the machine, and the separation plant is filled with water and any admixture required in the slurry. We DO NOT anticipate the need for any slurry additives on this project. However, if conditions dictate, bentonite may be added to the slurry. Information on the proposed bentonite is located within the Spill Response Plan.

9) The functions of the system are then tested to ensure that the whole system is ready for operation.

10) Proper soil stabilization is confirmed outside the shaft, and the interfering portion of the shaft wall is removed.

11) The hydraulic jacks are engaged to push the MTBM close to the work face through the rubber entrance seal.

12) The pit by-pass unit and the slurry pumps are operated to circulate the slurry between the MTBM and the separation plant.
13) The cutter head of the MTBM is rotated, and the jacks extend to push it forward and start the excavation.

14) During the installation process, the MTBM operator controls the jacking speed, the torque of the cutter head, the slurry flow rate, the slurry pressure at the work face, the earth pressure, and the inclination of the MTBM. The operation board contains the gauges for the discharge and charge pumps. These gauges allow the MTBM operator to balance earth pressure/groundwater pressure with the slurry pressure. The charge and discharge pumps are monitored by sensors located in the slurry chamber (face pressure) and in the slurry line (charge pressure) and kept as equal as possible.

15) After the MTBM is driven into the ground, the operation of the machine and slurry pumps is stopped and the jacks are retracted. The electric cables, control cables and the slurry lines are disconnected in the jacking shaft to allow the placement of the first pipe (or lubrication pipe if applicable) onto the guide rails.

16) The hydraulic jacks are extended to push the pipe forward until it fits to the tail of the MTBM.

17) After making sure that the pipe is joined properly to the tail of the MTBM, the electric cables, control cables, and the slurry lines are reconnected.

18) The slurry pumps are restarted, the pit by-pass unit operated, the cutter head of the MTBM is rotated and the hydraulic jacks extend to resume the micro tunneling operation.

19) The micro tunneling operation is repeated as a cycle to jack the pipes one after another into the ground.

20) While the pipe jacking operation is carried out, a lubricant is pumped continuously to the periphery of the jacking pipe to reduce the jacking friction. The lubricant is a mixture of water and bentonite or polymer.

21) Before the micro tunneling operation starts, the reception shaft is also constructed for the recovery of the MTBM upon completion of each drive.

22) When the MTBM is about 12 inches away from the reception shaft, the jacking operation is stopped. A small hole is cut through the shaft wall of the receiving pit in order to confirm the position of the machine, and to confirm proper soil stabilization.

23) The exit ring and rubber seal are attached to the shaft wall and the guide rails are set to receive the MTBM.

24) The interfering portion of the reception shaft wall is cut and the jacking operation is resumed to push the MTBM into the reception shaft.

25) After it is completely driven into the reception shaft, the MTBM is removed and lifted to the surface.

26) At the completion of the jacking operation the shield is cleaned, checked and returned to the jacking shaft to start the next drive (if applicable). The slurry lines control and power cables are removed and prepared for reuse on the next drive.

For this project we are using an Iseki TCC 500. General dimensions of this machine have been provided on the following page. This machine is capable of balancing the anticipated hydrostatic and earth pressures anticipated on this project in order to minimize ground movement, and
prevent inadvertent return of slurry.

<table>
<thead>
<tr>
<th>Iseki TCC 500</th>
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<tbody>
<tr>
<td>Excavation Diameter</td>
</tr>
<tr>
<td>Length</td>
</tr>
<tr>
<td>Weight</td>
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</tbody>
</table>

SECTION 2 – ALIGNMENT CONTROL SYSTEM

The Iseki TCC 500 has an articulated steering head controlled by a set of three hydraulic positioning jacks. A laser securely mounted in the jacking shaft sends a beam through the jacking pipe to the target mounted in the tail of the MTBM. A camera located in the MTBM shows the laser's position on the target. The operator uses this information to continuously steer the shield on line and grade within the required tolerances. When the excavation is observed to be off line or grade, all corrections will be made at a rate of not more than 1 inch per 25 feet until it has been returned to design line and grade.

The laser will be mounted on a laser stand that will be installed independently inside the jacking shaft so movements of the jacking equipment or other objects don’t affect the accuracy of the laser. Survey marks will be provided on both sides of the jacking shaft to allow a string line to be set up with vertical plumb bobs to align the laser beam reference accurately.

SECTION 3 – JACKING EQUIPMENT

The jacking equipment we will be using for this project has a compact design utilizing two-piece construction for fast set-up and handling along with a 3-stage mechanic lock push system and curved back plate to minimize required shaft dimensions. The jacking equipment also features a bolted, interchangeable push ring for simple adaptation to different pipe diameters, and individually controlled hydraulic cylinders for frame alignment. Additional information regarding the jacking equipment is listed below.

<table>
<thead>
<tr>
<th>Iseki TCC 500 Jacking Frame</th>
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</thead>
<tbody>
<tr>
<td>Length (without frame extension)</td>
</tr>
<tr>
<td>Width</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td>Maximum Jacking Force</td>
</tr>
</tbody>
</table>

Jacking Equipment Set-Up - Typically, the entire assembly is erected at the ground surface and hoisted into the shaft in one piece, when ample space is available. It is just as easy to assemble in the shaft once the shaft floor has been poured, and elevations are checked. Given the elevation of the floor, we utilize several reference points on the jacking frame to set it to proper line and grade. Line is easily achieved by landing the frame in the proper location. Fine-tuning of grade at the various reference points is accomplished via adjustable screw jacks.
SECTION 4 – SLURRY HANDLING

As the micro tunnel boring machine (MTBM) excavates the spoil, the dirt is mixed with water, forming slurry. By the use of two or three pumps, the slurry is transported via steel slurry lines from the MTBM to separation equipment on the surface where the dirt (spoil) is removed and the water is returned to the MTBM to form more slurry. The separation equipment includes mechanical shakers, and hydrocyclones. The primary shaker screens the larger particles from the slurry. Further separation occurs in the hydrocyclones, and the secondary shaker that remove the smaller particles. Photos of the separation equipment are included on the following page. All spoils are conveyed from the separation plant directly into dump trucks, or another type of containment device, that will be taken to an approved location for disposal. At the conclusion of tunneling operations, the remaining slurry water will be pumped from the separation plant into vacuum / pump trucks to be disposed of at an approved location off-site.

Quantity of Excavation - Given a 26.00” excavation, based on a 24.00” OD steel casing pipe with an allowable 1-inch overcut measured radially:

\[ A = \pi r^2, \quad r = d/2, \quad \text{and} \quad 1 \text{ cy} = 27 \text{ cf} \]
\[ r = 26.00” / 2 = 13.00” \quad \text{or} \quad r = 1.083’ \text{ for the excavation} \]
\[ \text{Area of Excavation} = \pi (1.083’)^2 = 3.69 \text{ sf} \times 1 \text{ If} = 3.69 \text{ cf} \]
\[ 3.69 \text{ cf} / (27 \text{ cf} / \text{ cy}) = 0.137 \text{ cy} / \text{linear foot of tunnel} \]
Assuming fluffing of the soil (25%), .28 cy / If x 1.25 = 0.17 cy / If
MICROTUNNEL CONTINGENCY PLANS

Machine Unable To Advance:

- **Possible Obstructions** – Our machines are designed to chew up items that are fairly large in size. The largest possible sized object that will fit in the cutting wheel is approximately 30% of the diameter of the machine. However, if an obstruction was encountered larger than 30% of the diameter of the machine and was unable to be broken up and swallowed by the microtunnel machine, we would slightly pull the face back and allow the material to be slowly chipped at until fully ingested. Finally, if the machine were indeed unable to break-up and ingest such an object, pulling back or retrieving the machine (911 shaft) would be our only alternative. Should an obstruction require a pull-back, or a 911 shaft, further discussions will be required by all stakeholders and plans will be developed and submitted for approval at that time. In the event that an obstruction was hit beneath San Francisquito Creek that we were not able to pass, pulling back the MTBM into the jacking shaft would be our only option. We would utilize the attachment points on the rear of the MTBM and run pull-back rods back through the pipeline into the jacking shaft. The pull-back rods would then be attached to the jacking frame (or specifically designed hydraulic cylinder), and an attempt to pull the machine back would be made. The void created by removing the MTBM and steel casing would be filled with a thickened bentonite mixture.

- **Insufficient Jacking** – We have little reason to believe that this scenario will occur. Previous tunnels in similar ground conditions have shown relatively low jacking loads. For this project we will have an allowable jacking force of approximately 300 tons. In the event that jacking pressures start to rise at a level greater than we were anticipating, we will add a soil support polymer to the lubrication. If that doesn’t stabilize the jacking pressures, we can provide additional lubrication at injection ports throughout the tunnel alignment.

- **Machine Malfunction** – Immediately, upon any evidence of machine malfunction, the jacking operation will cease. The technician and crew will troubleshoot the problem, seek assistance from a factory representative if necessary, and perform the required repairs. When all functions of the machine test-out successfully, the jacking operation will continue.

- **Soil Unable to Support the MTBM** – Based on the information provided in the geotechnical report, it’s unlikely that we will run into this problem on this project. However, if this problem does arise, jet grouting or other means of ground improvement to allow the machine to be supported by the soil would be required.

- **MTBM “Freezes”** – If after implementing the contingency plans listed above, we were still unable to advance the machine, we would have to pull the MTBM back into the jacking shaft.
**Settlement & Subsidence:**

- **Surveyed Surface Deformations** – If heave is encountered, tunnel advancement will be slowed or slurry pressure and earth pressure decreased. Typically, heave occurs during a change in material (i.e. from stiff clay to loose sand). If settlement occurs, tunnel advancement would be increased or slurry pressure and earth pressure increased. The slurry could also be thickened to add additional support at the face of the tunnel.

- **Excess Excavated Volume** – When excavated volumes exceed calculated volumes the tunnel progress will be increased. A slow advancement rate and high slurry pressure typically cause over-excavation. Thickening of the slurry can help to counter such an occurrence.

- **Sudden Face Pressure Decrease** – If we observe a sudden decrease in face pressure while tunneling we would immediately activate the slurry bypass mode and check the surface for signs of a frac-out. If slurry was being lost at the surface we would definitely see a drop in face pressure. If no signs of a frac-out are visible we would check the separation plant for a change in the material being excavated to look for sign of unstable material. A change in material conditions from rock to sand could cause a sudden face pressure decrease. If the drop in face pressure was due to a change in the type of material we are excavating we thicken up the slurry by adding bentonite. We would also increase the advancement rate and decrease the slurry pressure to balance the pressures at the tunnel face.

**Slurry Separation Problems:**

- **Excavated Material not Separated at Separation Plant** – If the separation plant is not providing adequate separation of the excavated material from the slurry we would check the following: proper screens on the primary and secondary shakers, hydrocyclones functioning properly, centrifuge functioning properly, proper flocculant injection rate.

- **Excavated Material Sets Out in Slurry Lines** – If the excavated material settles out in the slurry lines, the lines will be disconnected and cleaned or flushed out. This will typically occur at the booster pump raising the slurry out of the shaft. If the problem persists, bentonite will be added to the slurry to keep the excavated material suspended in the slurry.

- **Accumulation of Material in Separation Plant Tanks** – If we observe an accumulation of material in the separation plant tanks we would trouble shoot the paddle mixers in the tank to make sure they are functioning properly. If the mixers are working we would make changes to the screens, or flocculant injection rate to make sure we are removing as much material from the slurry as possible. If required, we would have a vacuum truck remove the material from the tanks.
**Slurry Losses:**
- Slurry losses from the tank will be minimized. Slurry water that escapes will be contained within the separation plant containment berm and returned to the separation plant. In the unlikely event of an inadvertent slurry return during tunneling, we will follow our Spill Response Plan (attached).

**Groundwater Inflows to Shaft:**
- The entrance seals will prevent much of any groundwater inflows. Any water and/or fines that do enter the shaft will be removed via a submersible sump pump that stays at the bottom of the shaft. If flows are excessive, chemical grouting will be performed through ports around the entrance ring to cut-off the inflow.

**Steering Difficulties:**
- Steering and alignment of both line and grade are closely watched and corrected at all times by the tunnel technician. Any corrections to line or grade will be done at a return rate of not more than 1-inch per 10 feet. Advancement rates will be slowed if it is found that steering is difficult.

**Laser Distortion:**
- **Due to Heat & Humidity** - If we observe laser distortion due to temperature or moisture levels in the shaft or tunnel we would troubleshoot our ventilation system to make sure it is functioning properly. We would also check to make sure that the laser is kept out of the direct sunlight. Temperature and moisture levels would be checked between the laser and the target to check for variations. If variations are found additional ventilation equipment may be required. If the laser is still moving while adequate ventilation and protection of the laser is provided we would have the operator closely monitor the movement and use the average reading as the center. If the movement is severe enough that we are not confident that we know the exact location of the MTBM at all times we would have to use a qualified surveyor to provide our exact location every morning.

- **Due to Physical Disturbance** - If we observe laser distortion due to a physical disturbance we would have to perform a laser check to be sure the laser is set to the design line.

**Damaged Pipe:**
- Pipe to be found out of compliance prior to installation would be brought to the owner/engineer’s attention. A decision would be made as to the acceptability of the product prior to us handling it. A similar discussion would take place if damage occurred during installation. If the pipe were damaged after installation, another conference would be held to discuss repair procedures and feasibility of repair. If it is determined that the pipe cannot be fixed in place it would have to be cycled out through the reception shaft, or the MTBM and pipe would have to be pulled back into the jacking shaft.
**Thrust Block Deformation:**
- The design of the jacking shaft and thrust block should provide sufficient bearing to handle the anticipated jacking loads, and due to the low anticipated maximum jacking loads, there should not be a problem with thrust block deformation. In the event that we are experiencing thrust block deformation it is usually possible to observe it visually. If required, thrust block deformation can be verified using a fixed point located in the shaft, and taking measurements to see if it has moved. If thrust block deformation is observed the soil behind the thrust block would have to be stabilized.

**Possible Shaft Flooding:**
- If floods were predicted, all power cables and the laser would be removed from the shaft and stored in a safe, dry location at the surface. The rear of the microtunnel machine will be bulk-headed off to prevent water damage to the electronics inside the MTBM. When floodwaters subside, the shaft as well as all installed pipe will be dewatered, the bulkhead will be removed, all electrical connections will be re-established and the tunneling process will continue.

**Loss of Control Signal:**
- If, for any reason, the control signal is lost during the advancement of a drive, the forward progress will be immediately stopped. An investigation into the cause for the loss of signal will commence and repairs will be made to restore the signal. The drive will then re-commence. Under no circumstances will the tunnel drive continue to advance without a solid control signal in the operations center.

**Excessive Pipe Separation at Joints or Pipe String Movement:**
- If, for any reason, we encounter excessive pipe separation or pipe string movement when the jacks are retracted we will have to carefully restrain the pipe using a chain and a come-a-long to apply pressure to the pipe until the next section of pipe has been installed.

**Presence of Contaminated Ground:**
- If the presence of contaminated ground is observed we stop all activities and determine the exact nature of the contamination. Once all crewmembers are made aware of the hazards associated with the contaminant(s), we would make sure all crewmembers that are required to be near the contaminated soil are equipped with gas detection equipment, and the proper PPE. We would also make sure that all work areas are properly ventilated to prevent the accumulation of harmful gasses. Atmospheric testing would be administered prior to and during any hot work activities that could potentially provide a source of ignition.
SPILL RESPONSE PLAN

For the pipeline installation required on this project, a slurry microtunnel boring machine (MTBM) will be utilized. A slurry MTBM utilizes fluid (occasionally containing bentonite) that is mixed with the soils as the cutterhead excavates the soils away from the tunnel face. In the event that bentonite needs to be added to the slurry, the Data Sheet and SDS for Baroid Bore-Gel have been attached following this plan. The slurry provides two important functions: (1) Pressure Balance – the slurry provides a positive hydraulic pressure to the face of the tunnel that balances the in-situ soil and groundwater pressures; and (2) Spoil Transportation – the slurry allows the excavated soils to remain in a fluid-state to facilitate pumping away from the head back to a separation plant. The function of Pressure Balance is one of the many tremendous benefits of microtunneling as it eliminates the need for dewatering, which is extremely beneficial in environmentally sensitive areas.

A potential disadvantage to this method is that slurry pressure applied to the tunnel face could (if excessive pressures are applied) release slurry to a waterway/roadway by fracturing the soil. Realistically, slurry releases can occur anywhere along the microtunnel alignment; however, most releases occur where the vertical cover above the MTBM is at its least.

With our highly experienced crew, well-trained in all aspects of microtunneling, we greatly decrease the potential for inadvertent return of slurry. Nevertheless, unforeseen conditions and circumstances can lead to situations where inadvertent returns and/or surface spills may occur. To this end, VTS has developed a plan to control inadvertent slurry releases during microtunneling. The specific objectives of this plan are:

- Minimize the potential for slurry releases.
- Monitor all activities to detect slurry releases in a timely manner.
- Protect all environmentally sensitive areas.
- Ensure an organized, quick response to any releases.
- Contain any releases to the smallest possible area.
- Ensure that any required notifications and reports are completed.

The following pages provide specifics for VTS’ Spill Response Plan.

1. Microtunneling “Rules”
   A) All tunnel sites will have an on-site monitor of the tunneling operations.
   B) The monitor will be equipped with a radio/cell phone to remain in contact with all equipment operators on the site.
   C) At no time shall tunnel cuttings, mud, and/or materials or water contaminated with bentonite or other substances be allowed to enter the stream/water body/roadway or be placed where they may be washed into a stream/water body/roadway.
D) In the unlikely event of spills or inadvertent returns, the monitor shall immediately notify the Owner, the Engineer and the Project Manager and request that the problem be addressed. All work shall stop, and will not resume until the cleanup is completed.

E) Any inadvertent return that may occur will be immediately contained, cleaned up and all recovered material will be disposed of off-site.

2. On-Site Response Equipment: At a minimum, the following equipment will be available at, or near, the tunnel site:
   A) At least 50 heavy weight sealable sand bags (to be filled with gravel).
   B) Two large rolls of heavy weight plastic sheeting.
   C) Several 5-gallon hard plastic pails.
   D) Three heavy-duty push brooms.
   E) Three flat-blade shovels.
   F) T-posts and enough silt fence to encapsulate the work area.
   G) Absorbent pads.
   H) Vacuum Trailer.

3. Best Management Practices (BMPs) for Microtunnel Operations: The following sets of BMPs have been established by VTS to prevent tunneling operations from releasing tunnel fluids to the environment. The on-site monitor shall inspect and request repairs or replacement of the materials used to meet these BMPs throughout the tunnel process.
   A) A containment unit, fiber roll, straw wattle or silt fence will be installed between the Separation Plant and any water body/roadway. This protection is meant to prevent seepage occurring outside of the work area from reaching any water body/roadway. Excess supplies of containment materials, as listed above as Response Equipment, (i.e. silt fence, shovels, etc.) will be available for use as needed. A vacuum trailer of sufficient size, at least 2000 gallons, will be readily available in the unlikely event that a spill or inadvertent return occurs.

   B) In the event that an inadvertent return does occur, the response sequence will be to:
      i) Immediately stop all microtunneling operations and make the proper notifications.
      ii) The face pressure at the head of the MTBM will be reduced to avoid further discharges of slurry.
      iii) Determine the source or cause of the inadvertent return and coordinate with the microtunneling machine operator to eliminate or minimize further discharges, as feasible.
      iv) Completely contain the inadvertent return.
      v) Clean up the inadvertent return. If required, the vacuum trailer should immediately begin recovering the tunneling fluid.
      vi) Divert all tunneling fluids from entering any water body/roadway.
      vii) The cause of the inadvertent return will be corrected.
viii) Microtunneling will resume in accordance with this contingency plan and the personnel will continue to closely monitor the water body/roadway.

4. **Clean-up of Inadvertent Returns:** Any cleaning activity will be done with the approval of the Owner/Engineer/Contractor. When the inadvertent return clean-up activities have been completed, the collected material shall be properly disposed of off-site. The clean-up effort shall include removal of all materials, rubbish and construction debris.

5. **Upon Completion of Microtunneling Operations:**
   
   A) The launching and receiving shafts will be backfilled and returned to natural grade after completion of the tie-ins by the Prime Contractor.
   
   B) All tunneling fluids will be removed from the construction area and properly disposed of at an accepting off-site location.
   
   C) All protective measures (containment units, silt fence, plastic sheeting, etc.) will be removed unless otherwise recommended by the Owner/Engineer. In the event that the protective measures are left in place after microtunneling operations have ceased, provisions shall be made by the Owner/Engineer for their removal.
BORE-GEL®

Boring Fluid System – U.S. Patent Number 5,723,416

Description
BORE-GEL® single sack, boring fluid system is specially formulated for use in horizontal directional drilling (HDD) applications. BORE-GEL fluid system is a proprietary blended product using high-quality Wyoming sodium bentonite. When BORE-GEL system is mixed with fresh water, it develops an easy-to-pump slurry with desirable fluid properties for HDD.

Applications/Function
- Provide optimum gel strength with minimum viscosity for cuttings suspension and transport
- Improve borehole stability in poorly consolidated/cemented sands and gravel formations
- Reduce filtration by forming a thin filter cake with low permeability
- Lubricate pipe in microtunneling operations
- Produce a pumpable slurry with maximum amount of reactive solids for borehole stability

Advantages
- Minimizes the number of boring fluid products required
- Easy to mix and fast to yield
- Low viscosity minimizes pump pressures
- Provides lubricity for pulling product line
- NSF/ANSI Standard 60 certified
- Can be used in Water Wells in unconsolidated formations or when additional gel strengths are required to compensate for low annular velocity

Typical Properties
- Appearance: Tan to gray powder
- pH (4% slurry or 15 lb/bbl): 10.2
- Bulk density, lb/ft³: 68 to 72 (compacted)
**Recommended Treatment**

Add slowly and uniformly through a high-shear, jet-type mixer over one or more cycles of the volume of slurry. Continue to circulate and agitate the slurry until all unyielded bentonite is dispersed.

**Recommended application amounts**

<table>
<thead>
<tr>
<th>Boring Application</th>
<th>lb/100 gal</th>
<th>kg/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal boring conditions</td>
<td>25 – 35</td>
<td>30 – 42</td>
</tr>
<tr>
<td>Poorly consolidated sand/gravel</td>
<td>35 – 60</td>
<td>42 – 72</td>
</tr>
<tr>
<td>Lubrication fluid for microtunneling</td>
<td>50 – 60</td>
<td>60 – 72</td>
</tr>
</tbody>
</table>

**Packaging**

BORE-GEL fluid system is packaged in a 50-lb (22.7-kg) multiwall paper bag. The bag is sturdy, moisture resistant and easy to handle, store and transport.

**Availability**

BORE-GEL fluid system can be purchased through any Baroid Industrial Drilling Products Retailer. To locate the Baroid IDP retailer nearest you contact the Customer Service Department in Houston or your area IDP Sales Representative.

**Baroid Industrial Drilling Products**

**Product Service Line, Halliburton**

3000 N. Sam Houston Pkwy. E.
Houston, TX 77032

**Customer Service**  (800) 735-6075 Toll Free  (281) 871-4612

**Technical Service**  (877) 379-7412 Toll Free  (281) 871-4613
1. Identification

1.1. Product Identifier
Product Trade Name: BORE-GEL®
Synonyms: None
Chemical Family: Mineral
Internal ID Code: HM003576

1.2 Recommended use and restrictions on use
Application: Viscosifier
Uses Advised Against: No information available

1.3 Manufacturer’s Name and Contact Details
Manufacturer/Supplier: Baroid Fluid Services
Product Service Line of Halliburton
P.O. Box 1675
Houston, TX 77251
Telephone: (281) 871-4000
Emergency Telephone: (281) 575-5000

Prepared By: Chemical Stewardship
Telephone: 1-580-251-4335
e-mail: fdunexchem@halliburton.com

1.4. Emergency telephone number
Emergency Telephone Number: (281) 575-5000

2. Hazard(s) Identification

2.1 Classification in accordance with paragraph (d) of §1910.1200

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A - H350</td>
<td>Carcinogenicity</td>
</tr>
<tr>
<td>1 - H372</td>
<td>Specific Target Organ Toxicity - (Repeated Exposure)</td>
</tr>
</tbody>
</table>

2.2. Label Elements

Hazard Pictograms

Signal Word: Danger

Hazard Statements: H350 - May cause cancer
H372 - Causes damage to organs through prolonged or repeated exposure
Precautionary Statements

Prevention
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P260 - Do not breathe dust/fume/gas/mist/vapors/spray
P264 - Wash face, hands and any exposed skin thoroughly after handling
P270 - Do not eat, drink or smoke when using this product
P280 - Wear protective gloves/protective clothing/eye protection/face protection

Response
P308 + P313 - IF exposed or concerned: Get medical advice/attention
P314 - Get medical attention/advice if you feel unwell

Storage
P405 - Store locked up

Disposal
P501 - Dispose of contents/container in accordance with local/regional/national/international regulations

Contains

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
</tr>
</tbody>
</table>

2.3 Hazards not otherwise classified
None known

3. Composition/information on Ingredients

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>PERCENT (w/w)</th>
<th>GHS Classification - US</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>1 - 5%</td>
<td>Eye Irrit. 2 (H319)</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>1 - 5%</td>
<td>Carc. 1A (H350) STOT RE 1 (H372)</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>0.1 - 1%</td>
<td>Carc. 1A (H350) STOT RE 1 (H372)</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>0.1 - 1%</td>
<td></td>
</tr>
</tbody>
</table>

The exact percentage (concentration) of the composition has been withheld as proprietary.

4. First-Aid Measures

4.1. Description of first aid measures
Inhalation
If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Eyes
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention if irritation persists.

Skin
Wash with soap and water. Get medical attention if irritation persists.

Ingestion
Under normal conditions, first aid procedures are not required.

4.2 Most important symptoms/effects, acute and delayed
Breathing crystalline silica can cause lung disease, including silicosis and lung cancer. Crystalline silica has also been associated with scleroderma and kidney disease.

4.3. Indication of any immediate medical attention and special treatment needed
Notes to Physician: Treat symptomatically.

5. Fire-fighting measures
5.1. Extinguishing media
Suitable Extinguishing Media:
All standard fire fighting media
Extinguishing media which must not be used for safety reasons:
None known.

5.2. Specific hazards arising from the substance or mixture
Special Exposure Hazards:
None anticipated.

5.3. Special protective equipment and precautions for fire-fighters
Special Protective Equipment for Fire-Fighters:
Full protective clothing and approved self-contained breathing apparatus required for fire fighting personnel.

6. Accidental release measures
6.1. Personal precautions, protective equipment and emergency procedures
Use appropriate protective equipment. Avoid creating and breathing dust.
See Section 8 for additional information.

6.2. Environmental precautions
Prevent from entering sewers, waterways, or low areas.

6.3. Methods and material for containment and cleaning up
Collect using dustless method and hold for appropriate disposal. Consider possible toxic or fire hazards associated with contaminating substances and use appropriate methods for collection, storage and disposal.

7. Handling and storage
7.1. Precautions for Safe Handling
Handling Precautions:
This product contains quartz, cristobalite, and/or tridymite which may become airborne without a visible cloud. Avoid breathing dust. Avoid creating dusty conditions. Use only with adequate ventilation to keep exposure below recommended exposure limits. Wear a NIOSH certified, European Standard En 149, or equivalent respirator when using this product. Material is slippery when wet.

Hygiene Measures:
Handle in accordance with good industrial hygiene and safety practice.

7.2. Conditions for safe storage, including any incompatibilities
Storage Information:
Use good housekeeping in storage and work areas to prevent accumulation of dust. Close container when not in use. Do not reuse empty container. Product has a shelf life of 12 months.

8. Exposure Controls/Personal Protection
8.1. Occupational Exposure Limits:

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>OSHA PEL-TWA</th>
<th>ACGIH TLV-TWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>
8.2 Appropriate engineering controls

Engineering Controls Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits.

8.3 Individual protection measures, such as personal protective equipment

Personal Protective Equipment If engineering controls and work practices cannot prevent excessive exposures, the selection and proper use of personal protective equipment should be determined by an industrial hygienist or other qualified professional based on the specific application of this product.

Respiratory Protection Not normally needed. But if significant exposures are possible then the following respirator is recommended:

- Dust/mist respirator. (N95, P2/P3)

Hand Protection Normal work gloves.

Skin Protection Wear clothing appropriate for the work environment. Dusty clothing should be laundered before reuse. Use precautionary measures to avoid creating dust when removing or laundering clothing.

Eye Protection Wear safety glasses or goggles to protect against exposure.

Other Precautions None known.

9. Physical and Chemical Properties

9.1. Information on basic physical and chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical State: Powder</td>
<td>Color: Light brown or Gray</td>
</tr>
<tr>
<td>Odor:</td>
<td>Odor: No information available</td>
</tr>
<tr>
<td>pH</td>
<td>8-10</td>
</tr>
<tr>
<td>Freezing Point/Range</td>
<td>No information available</td>
</tr>
<tr>
<td>Melting Point/Range</td>
<td>No data available</td>
</tr>
<tr>
<td>Boiling Point/Range</td>
<td>No data available</td>
</tr>
<tr>
<td>Flash Point</td>
<td>No data available</td>
</tr>
<tr>
<td>Flammability (solid, gas)</td>
<td>No data available</td>
</tr>
<tr>
<td>upper flammability limit</td>
<td>No data available</td>
</tr>
<tr>
<td>lower flammability limit</td>
<td>No data available</td>
</tr>
<tr>
<td>Evaporation rate</td>
<td>No data available</td>
</tr>
<tr>
<td>Vapor Pressure</td>
<td>No data available</td>
</tr>
<tr>
<td>Vapor Density</td>
<td>No data available</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>2.5</td>
</tr>
<tr>
<td>Water Solubility</td>
<td>Partly soluble</td>
</tr>
<tr>
<td>Solubility in other solvents</td>
<td>No data available</td>
</tr>
<tr>
<td>Partition coefficient: n-octanol/water</td>
<td>No data available</td>
</tr>
<tr>
<td>Autoignition Temperature</td>
<td>No data available</td>
</tr>
<tr>
<td>Decomposition Temperature</td>
<td>No data available</td>
</tr>
<tr>
<td>Viscosity</td>
<td>No data available</td>
</tr>
<tr>
<td>Explosive Properties</td>
<td>No information available</td>
</tr>
</tbody>
</table>
10. Stability and Reactivity

10.1. Reactivity
Not expected to be reactive.

10.2. Chemical Stability
Stable

10.3. Possibility of Hazardous Reactions
Will Not Occur

10.4. Conditions to Avoid
None anticipated

10.5. Incompatible Materials
Hydrofluoric acid.

10.6. Hazardous Decomposition Products
Amorphous silica may transform at elevated temperatures to tridymite (870 °C) or cristobalite (1470 °C).

11. Toxicological Information

11.1. Information on likely routes of exposure
Principle Route of Exposure: Eye or skin contact, inhalation.

11.2. Symptoms related to the physical, chemical and toxicological characteristics

Acute Toxicity
Inhalation: Inhaled crystalline silica in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (IARC, Group 1). There is sufficient evidence in experimental animals for the carcinogenicity of tridymite (IARC, Group 2A).

Breathing silica dust may cause irritation of the nose, throat, and respiratory passages. Breathing silica dust may not cause noticeable injury or illness even though permanent lung damage may be occurring. Inhalation of dust may also have serious chronic health effects (See "Chronic Effects/Carcinogenicity" subsection below).

Eye Contact: May cause mechanical irritation to eye.
Skin Contact: May cause mechanical skin irritation.
Ingestion: None known
Chronic Effects/Carcinogenicity

Silicosis: Excessive inhalation of respirable crystalline silica dust may cause a progressive, disabling, and sometimes-fatal lung disease called silicosis. Symptoms include cough, shortness of breath, wheezing, non-specific chest illness, and reduced pulmonary function. This disease is exacerbated by smoking. Individuals with silicosis are predisposed to develop tuberculosis.

Cancer Status: The International Agency for Research on Cancer (IARC) has determined that crystalline silica inhaled in the form of quartz or cristobalite from occupational sources can cause lung cancer in humans (Group 1 - carcinogenic to humans) and has determined that there is sufficient evidence in experimental animals for the carcinogenicity of tridymite (Group 2A - possible carcinogen to humans). Refer to IARC Monograph 68, Silica, Some Silicates and Organic Fibres (June 1997) in conjunction with the use of these minerals. The National Toxicology Program classifies respirable crystalline silica as "Known to be a human carcinogen". Refer to the 9th Report on Carcinogens (2000). The American Conference of Governmental Industrial Hygienists (ACGIH) classifies crystalline silica, quartz, as a suspected human carcinogen (A2).

There is some evidence that breathing respirable crystalline silica or the disease silicosis is associated with an increased incidence of significant disease endpoints such as scleroderma (an immune system disorder manifested by scarring of the lungs, skin, and other internal organs) and kidney disease.

11.3 Toxicity data

Toxicology data for the components

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>LD50 Oral</th>
<th>LD50 Dermal</th>
<th>LC50 Inhalation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>4090 mg/kg (Rat)</td>
<td>2210 mg/kg (Mouse)</td>
<td>2.3 mg/l (Rat) 2h</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>500 mg/kg (Rat)</td>
<td>&gt;2000 mg/kg (Rabbit)</td>
<td>No data available</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>500 mg/kg (Rat)</td>
<td>No data available</td>
<td>No data available</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>500 mg/kg (Rat)</td>
<td>No data available</td>
<td>No data available</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Skin corrosion/irritation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>Non-irritating to the skin</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>Non-irritating to the skin</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>Non-irritating to the skin</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>Non-irritating to the skin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Eye damage/irritation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>Irritating to eyes</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>Mechanical irritation of the eyes is possible.</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>Mechanical irritation of the eyes is possible.</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>Mechanical irritation of the eyes is possible.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Skin Sensitization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>Not classified</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>Not regarded as a sensitizer.</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>Not regarded as a sensitizer.</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>Not regarded as a sensitizer.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Respiratory Sensitization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>No information available</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>No information available</td>
</tr>
</tbody>
</table>
### Substances

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Mutagenic Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>In vivo tests did not show mutagenic effects.</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>Not regarded as mutagenic.</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>Not regarded as mutagenic.</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>Not regarded as mutagenic.</td>
</tr>
</tbody>
</table>

### Substances

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Carcinogenic Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>Not regarded as carcinogenic.</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>Contains crystalline silica which may cause silicosis, a delayed and progressive lung disease. The IARC and NTP have determined there is sufficient evidence in humans of the carcinogenicity of crystalline silica with repeated respiratory exposure. Based on available scientific evidence, this substance is a threshold carcinogen with a mode of action involving indirect genotoxicity secondary to lung injury.</td>
</tr>
</tbody>
</table>

### Substances

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Reproductive toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>Did not show teratogenic effects in animal experiments.</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>No information available</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>No information available</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>No information available</td>
</tr>
</tbody>
</table>

### Substances

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>STOT - single exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>None under normal use conditions</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>No significant toxicity observed in animal studies at concentration requiring classification.</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>No significant toxicity observed in animal studies at concentration requiring classification.</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>No significant toxicity observed in animal studies at concentration requiring classification.</td>
</tr>
</tbody>
</table>

### Substances

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>STOT - repeated exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>No information available</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>Causes damage to organs through prolonged or repeated exposure if inhaled: (Lungs)</td>
</tr>
</tbody>
</table>

### Substances

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Aspiration hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

### 12. Ecological Information

#### 12.1. Toxicity

#### Ecotoxicity Effects

**Product Ecotoxicity Data**

No data available
### Substance Ecotoxicity Data

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Toxicity to Algae</th>
<th>Toxicity to Fish</th>
<th>Toxicity to Microorganisms</th>
<th>Toxicity to Invertebrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>EC50 242 mg/L (Nitzschia)</td>
<td>TLM24 385 mg/L (Lepomis macrochirus)</td>
<td>No information available</td>
<td>EC50 265 mg/L (Daphnia magna)</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>No information available</td>
<td>LL0 (96h) 10,000 mg/L (Danio rerio)</td>
<td>No information available</td>
<td>LL50 (24h) &gt; 10,000 mg/L (Danio rerio)</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>No information available</td>
<td>LL0 (96h) 10,000 mg/L (Danio rerio)</td>
<td>No information available</td>
<td>LL50 (24h) &gt; 10,000 mg/L (Daphnia magna)</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>No information available</td>
<td>LL0 (96h) 10,000 mg/L (Danio rerio)</td>
<td>No information available</td>
<td>LL50 (24h) &gt; 10,000 mg/L (Daphnia magna)</td>
</tr>
</tbody>
</table>

### 12.2. Persistence and degradability

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Persistence and Degradability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>The methods for determining biodegradability are not applicable to inorganic substances.</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>The methods for determining biodegradability are not applicable to inorganic substances.</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>The methods for determining biodegradability are not applicable to inorganic substances.</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>The methods for determining biodegradability are not applicable to inorganic substances.</td>
</tr>
</tbody>
</table>

### 12.3. Bioaccumulative potential

<table>
<thead>
<tr>
<th>Substances</th>
<th>CAS Number</th>
<th>Log Pow</th>
<th>Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>497-19-8</td>
<td>No info</td>
<td>No information available</td>
</tr>
<tr>
<td>Crystalline silica, quartz</td>
<td>14808-60-7</td>
<td>No info</td>
<td>No information available</td>
</tr>
<tr>
<td>Crystalline silica, cristobalite</td>
<td>14464-46-1</td>
<td>No info</td>
<td>No information available</td>
</tr>
<tr>
<td>Crystalline silica, tridymite</td>
<td>15468-32-3</td>
<td>No info</td>
<td>No information available</td>
</tr>
</tbody>
</table>

### 12.4. Mobility in soil

<table>
<thead>
<tr>
<th>Substances</th>
<th>Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium carbonate</td>
<td>No info</td>
</tr>
</tbody>
</table>

### 12.5 Other adverse effects

No information available

### 13. Disposal Considerations

#### 13.1. Waste treatment methods

**Disposal Method**
If practical, recover and reclaim, recycle, or reuse by the guidelines of an approved local reuse program. Should contaminated product become a waste, dispose of in a licensed industrial landfill according to federal, state, and local regulations.

**Contaminated Packaging**
Follow all applicable national or local regulations.

### 14. Transport Information

**US DOT**
UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

US DOT Bulk
DOT (Bulk) Not applicable

Canadian TDG
UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

IMDG/IMO
UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

IATA/ICAO
UN Number: Not restricted
UN Proper Shipping Name: Not restricted
Transport Hazard Class(es): Not applicable
Packing Group: Not applicable
Environmental Hazards: Not applicable

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code: Not applicable
Special Precautions for User: None

15. Regulatory Information

US Regulations

US TSCA Inventory All components listed on inventory or are exempt.

EPA SARA Title III Extremely Hazardous Substances Not applicable

EPA SARA (311,312) Hazard Class Chronic Health Hazard

EPA SARA (313) Chemicals This product does not contain a toxic chemical for routine annual "Toxic Chemical Release Reporting" under Section 313 (40 CFR 372).

EPA CERCLA/Superfund Reportable Spill Quantity Not applicable.

EPA RCRA Hazardous Waste Classification If product becomes a waste, it does NOT meet the criteria of a hazardous waste as defined by the US EPA.

California Proposition 65 The California Proposition 65 regulations apply to this product.
MA Right-to-Know Law  One or more components listed.
NJ Right-to-Know Law  One or more components listed.
PA Right-to-Know Law  One or more components listed.

Canadian Regulations
Canadian DSL Inventory  All components listed on inventory or are exempt.

16. Other information

Preparation Information
Prepared By  Chemical Stewardship
Telephone:  1-580-251-4335
e-mail: fdinexchem@halliburton.com

Revision Date:  02-Apr-2015
Reason for Revision  Update to Format SECTION: 2

Additional information
For additional information on the use of this product, contact your local Halliburton representative.

For questions about the Safety Data Sheet for this or other Halliburton products, contact Chemical Stewardship at 1-580-251-4335.

Key or legend to abbreviations and acronyms
bw – body weight
CAS – Chemical Abstracts Service
EC50 – Effective Concentration 50%
Erc50 – Effective Concentration growth rate 50%
LC50 – Lethal Concentration 50%
LD50 – Lethal Dose 50%
LL50 – Lethal Loading 50%
mg/kg – milligram/kilogram
mg/L – milligram/liter
NIOSH – National Institute for Occupational Safety and Health
NTP – National Toxicology Program
OEL – Occupational Exposure Limit
PEL – Permissible Exposure Limit
ppm – parts per million
STEL – Short Term Exposure Limit
TWA – Time-Weighted Average
UN – United Nations
h – hour
mg/m³ – milligram/cubic meter
mm – millimeter
mmHg – millimeter mercury
w/w – weight/weight
d – day

Key literature references and sources for data
www.ChemADVISOR.com/
Disclaimer Statement
This information is furnished without warranty, expressed or implied, as to accuracy or completeness. The information is obtained from various sources including the manufacturer and other third party sources. The information may not be valid under all conditions nor if this material is used in combination with other materials or in any process. Final determination of suitability of any material is the sole responsibility of the user.

End of Safety Data Sheet
<table>
<thead>
<tr>
<th>ID</th>
<th>Task Mode</th>
<th>Task Name</th>
<th>Duration</th>
<th>Start</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>PGE L-101 San Francisco Creek (10 hrs/day - 6 days/week)</td>
<td>28 days</td>
<td>Wed 9/14/16</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>24” Microtunneling</td>
<td>28 days</td>
<td>Wed 9/14/16</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Mobilization</td>
<td>3 days</td>
<td>Wed 9/14/16</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Mobilize Micro Tunnel Equipment</td>
<td>3 days</td>
<td>Wed 9/14/16</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Microtunnel Drive No.1</td>
<td>21 days</td>
<td>Sat 9/17/16</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Setup Surface &amp; Pit &amp; Equipment</td>
<td>6 days</td>
<td>Sat 9/17/16</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>Thrust Block &amp; Entrance Ring</td>
<td>3 days</td>
<td>Sat 9/24/16</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Launch Tunnel Machine</td>
<td>1 day</td>
<td>Wed 9/28/16</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Microtunnel 24 Steel Casing (300ft) Single Shift 10-hours</td>
<td>6 days</td>
<td>Thu 9/29/16</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Retrieve MTBM &amp; Slurry Lines/Cables</td>
<td>2 days</td>
<td>Thu 10/6/16</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>Breakdown Separation Plant</td>
<td>2 days</td>
<td>Sat 10/8/16</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>Install Gas Line &amp; Cycle out casing Single Shift (100-foot per Shift by ARB)</td>
<td>3 days</td>
<td>Sat 10/8/16</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>Final Cleanup</td>
<td>4 days</td>
<td>Wed 10/12/16</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Final Cleanup &amp; Demobilization</td>
<td>4 days</td>
<td>Wed 10/12/16</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Project Finish</td>
<td>0 days</td>
<td>Sat 10/15/16</td>
</tr>
</tbody>
</table>

Project: 41-101 Palo Alto Microtunnel
Date: Thu 6/23/16
L-101, MP 12.33 - 12.87
Relocate 3,350 Feet of 24" Pipe
San Francisquito Creek - Palo Alto, East Palo Alto

SCHEDULE OF SHEETS
SHEET 1 - TITLE & INDEX
SHEET 2 - CONSTRUCTION NOTES
SHEET 3 - LEGEND & STAMPS
SHEET 4 - PLAN & PROFILE
SHEET 8 - DETAILS
SHEET 11 - BILL OF MATERIALS
SHEET 12 - DEACTIVATION SHEET
SUMMARY OF PROPOSED WORK:
1. INSTALL APPROX. 3,520 FEET OF 24" STEEL PIPE.
2. INSTALL APPROX. 13 FEET OF 36" STEEL PIPE.
3. TRENCH AND BACKFILL.
4. MICRO-TUNNEL AT THE SAN FRANCISCO CREEK CROSSING.
5. SITE OF APPROX. 5,000 FEET OF STEEL PIPE.
6. INSTALL 12 CYTS STATION.

CONSTRUCTION NOTES:
GENERAL REQUIREMENTS:
1. UNDERGROUND PIPE INSTALLATION:
   a. All underground pipe shall be installed in accordance with local jurisdictional requirements.
   b. All underground lines shall be separated by at least 100 feet from any other utility.
2. SEQUENTIAL OPERATIONS:
   a. All work shall be fully coordinated with all other underground utilities.
   b. All work shall be coordinated with all other underground utilities.
3. QUALITY ASSURANCE:
   a. All inspections shall be performed in accordance with local jurisdictional requirements.
   b. All quality control measures shall be in place and documented for all work.
4. WORK PROTECTION:
   a. All work shall be protected from damage during installation.
   b. All work shall be protected from damage during installation.

REFERENCE DRAWINGS:
- OPERATING MAP:
  - 345532 REV B Page 1 of 2
  - PLAN SHEETS:
    - 832006, 8321, 8322
  - AS BOLT:
    - GM 516671
  - DRAWING:
    - 831306 REV B Page 2

CONTACT INFORMATION:
- PROJECT MANAGER:
  - JIM KARN
  - 510-228-0333
- DESIGN ENGINEER:
  - JOSE TRUJILLO
  - 510-228-0333
- PIPELINE ENGINEER:
  - GLENN R. HASSLE
  - 510-228-0333
- PIPELINE TECHNICAL DIRECTOR:
  - GLENN R. HASSLE
  - 510-228-0333
- CONTRACTOR:
  - R. L. WELLS
  - 510-228-0333
- LANDSCAPER:
  - JIM KARN
  - 510-228-0333
- ELECTRICIAN:
  - JOSE TRUJILLO
  - 510-228-0333
- FABRICATOR:
  - GLENN R. HASSLE
  - 510-228-0333
- BULK MATERIALS:
  - JIM KARN
  - 510-228-0333
- SEQUENCING:
  - JOSE TRUJILLO
  - 510-228-0333
- HIRING:
  - GLENN R. HASSLE
  - 510-228-0333