TECHNICAL SCOPE OF WORK FOR CHEMICAL OXIDATION INJECTION

123 POST AVENUE SITE
OPERABLE UNIT 2
(Offsite Groundwater Remediation)
VILLAGE OF WESTBURY
NASSAU COUNTY, NEW YORK
(SITE N0. 1-30-088)

WORK ASSIGNMENT NO. D004446-21

Prepared For

New York State Department of Environmental Conservation

AUGUST 2011

DVIRKA AND BARTILUCCI
CONSULTING ENGINEERS
A DIVISION OF D&B ENGINEERS AND ARCHITECTS, P.C.

TECHNICAL SCOPE OF WORK
FOR
CHEMICAL OXIDATION PILOT STUDY

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OPERABLE UNIT 2
SITE NO. 1-30-088
WESTBURY, NEW YORK

Prepared for:

NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION

Prepared by:

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AND
GEO-CLEANSE INTERNATIONAL, INC.

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1.0 GENERAL

1.1 Scope of Work

A. Furnish all labor, materials, power, equipment and other facilities and incidentals necessary to construct 13 monitoring wells, four injection wells and inject sodium permanganate into the subsurface at the 123 Post Avenue OU2 site. See Figures 1 and 2.

B. The work also includes the furnishing of all labor, materials, fuel, supplies, equipment and all other facilities and incidentals, including, but not limited to, utility markouts, water permits and road opening permits, necessary to perform the work.

C. All work shall be performed by the Contractor in accordance with all applicable federal, state and local laws, rules and regulations. The Contractor shall, at all times, maintain noise levels within the limits of local noise ordinances.

D. Provision has been made for the use of the Westbury Department of Public Works (DPW) facility on Dover Street in Westbury for the storage of equipment and materials. However, the Contractor shall provide temporary electric power for equipment, lighting, sanitary facilities, potable water, etc., as necessary to perform the work.

E. All electrical work shall be in accordance with the standards and guidance of the National Electrical Code, the National Electrical Safety Code and with local codes which apply, including the requirements for hazardous locations.

F. All work shall be performed during the hours designated by the Engineer. There shall be no work on State and Federal holidays and weekends, unless specifically approved by the Engineer. No payment shall be made for equipment left by the Contractor during holidays and weekends and any other non-working days.

G. The Contractor shall store and protect all materials brought to the site. Materials shall be stored in accordance with all applicable federal, state and local laws, rules, regulations and manufacturer's instructions, with seals and labels intact and legible. The Contractor shall maintain temperature and humidity within ranges required by manufacturer's instructions. The Contractor shall make periodic inspections of stored materials and equipment to assure that materials and equipment are maintained under specified conditions and free from damage or deterioration. The Contractor shall ensure that the discharge port on the tank truck be locked at all times that the tank truck is not in use.

H. The Contractor is solely responsible for the safety and security of its materials, supplies, equipment and the work. The Contractor shall make provision to have 24-hour security for the permanganate while on-site. The Contractor shall also make provision to have security for mud rotary equipment that cannot be removed from the drilling location during installation of SB-03/OU2-11.

I. All work shall be performed in the presence of the Engineer.

J. The Contractor shall be responsible for performing the work in a manner which minimizes exposure of personnel and the surrounding community to noise, dust, vapors, odor, etc., including implementing measures and controls as necessary to minimize potential impact.

K. The Contractor shall continuously maintain qualified personnel at the work site at all times when the work is being performed.

L. Immediately after mobilizing to the work area and prior to performing any intrusive work, the Contractor shall construct a temporary barricade along the perimeter of the limits of work using safety cones and caution tape or alternate approved equipment.

M. The work shall be performed in accordance with the project schedule prepared by the Contractor and approved by the Engineer.

N. In general, the overall monitoring well and injection well construction procedures shall be as follows:

1. Construction of a decontamination pad;

2. Equipment and materials decontamination;

3. Drilling, sampling and logging the borehole;

4. Installing casing (riser pipe) and screens;

5. Setting gravel pack and installing a seal above the screens;

6. Sealing the annular space between the well casing (riser pipe) and borehole wall;

7. Installing a protective locking surface casing (or vault) and surface seal;

8. Developing and completing the wells; and

9. Site cleanup, restoration, and containment of cuttings/drillings, drilling fluid and well development water and disposal of cuttings, drilling fluid and well development water off-site.

O. In general, the overall permanganate injection procedures shall be as follows:

1. Construction of injection system equipment;

2. Transferring of permanganate to equalization tank;

3. Total volume injected into each well each day;

4. Injecting permanganate into injection well;

1.2 Description of the Site

The 123 Post Avenue site is a Class 2, inactive hazardous waste disposal New York State Superfund site (Registry No. 1-30-088). The site is a dry cleaning facility located at 123 Post Avenue in Westbury, New York. The focus of this work is the downgradient groundwater contaminant plume. The work described in this Technical Scope of Work shall be performed in the residential neighborhood south of the 123 Post Avenue site. All work shall be limited to the rights of way within the residential neighborhood.

1.3 Reference to Standards and Regulations

A. The Contractor shall comply with the latest revisions of:

1. Standards of AWWA and ASTM as referenced here

2. The New York State Environmental Conservation (NYSDEC) Law, Article 15

4. Article XIX of the Nassau County Fire Prevention Ordinance.

5. The Occupation Safety and Health Act.

B. Comply with all applicable standards and provisions of the below listed regulatory agencies and organizations:

1. National Fire Protection Association

2. Hazardous Materials Transportation Board

3. Interstate Commerce Commission

4. Department of Transportation

1.4 Permits

A. The Contractor shall be responsible for obtaining and purchasing any permits required for obtaining water, constructing the wells (i.e. road opening permits), permanganate injection, transportation of the oxidant, storage of the oxidant or removal and disposal of waste materials. The Contractor shall comply with all requirements of the permits, including traffic requirements.

B. The Contractor shall comply with all requirements of Article XIX of the Nassau County Fire Prevention Ordinance.

C. The Contractor shall furnish separate copies of all permits to the Engineer and Department as the permits are received.

1.5 Utilities

A. The Contractor shall notify New York one call (1-800-962-7962) and the appropriate utility company no less than 48 hours prior to any work.

B. The Contractor shall be responsible for identifying and protecting all aboveground and buried utilities and structures. As an added precaution, the Contractor shall be required to clear the first 5 feet below ground surface using hand tools. Any damages to utilities due to work conducted during the pilot test will be repaired at the Contractor's expense.

1.6 Environmental Protection

A. The Contractor shall furnish all labor, materials, equipment and incidentals necessary to perform all work required for environmental protection in accordance with all federal, state and local laws and regulations, and as directed by the Engineer. For the purpose of this Scope of Work, environmental protection is defined as the retention and restoration of the environment in its natural state to the greatest extent possible during the work. Environmental protection includes protection of air, water and land resources, and involves elimination of noise, dust and vapors, solid waste management and management of waste and pollutants.

B. The Contractor shall schedule and conduct all work in a manner that will prevent the erosion of soil and release of soil and water in the work area. Control measures shall be provided, such as diversion channels, berms, sedimentation or

filtration systems, silt fences or other special surface treatments as required to prevent the release of soil and water, and silting, muddying and contamination of surface waters, drainage ways, storm water collection systems and recharge basins. All necessary control measures shall be in place in an area prior to performing Work.

C. The Contractor shall take all necessary measures to prevent the migration of dust outside the work area due to the work activities. No oil, calcium chloride or liquids other than liquids specifically approved by the Engineer shall be used for dust control.

D. All waste resulting from work activities shall be removed and disposed at an approved permitted facility in accordance with applicable federal, state and local laws and regulations, and the requirements of this Contract. The Contractor, shall containerize all waste in leak proof, vapor tight Department of Transportation (DOT) approved 55-gallon ring top drums, or approved equal. All waste shall be removed from the work area at the completion of each work day and may be temporarily stored on pallets at the Westbury Department of Public Works (DPW) Yard located at Dover Street, Village of Westbury. Prior to requesting final acceptance of the Work, the Contractor shall remove such materials from the DPW facility.

E. Disposal in and adjacent to the work area of any debris, wastes, effluent, trash, garbage, oil, grease, chemicals, etc. resulting from the work will not be permitted. If any waste material is placed in unauthorized areas, the Contractor shall remove the waste and restore the area to its original condition. If necessary, soil contaminated from such unauthorized disposal operation shall be excavated, disposed as directed by the Engineer, replaced with general fill, compacted and paved.

F. The Contractor shall take all necessary measures to control the release of odors and vapors. These measures will be employed at the Contractor's expense following approval by the Engineer.

G. The Contractor shall not pollute any surface waters or groundwater with substances including, but not limited to, fuels, oils, bitumens, calcium chloride, acids, insecticides, herbicides or other harmful materials.

H. The Contractor shall perform all work in strict compliance with all applicable requirements of governing authorities having jurisdiction.

1.7 Spill Control

A. The Contractor shall prepare and submit a project-specific Spill Contingency Plan. The Plan shall describe in complete detail the procedures to be implemented in the event of a spill.

B. The Contractor shall furnish all labor, materials, equipment and incidentals necessary to implement all required spill prevention and control measures during the work, including required secondary containment measures, as necessary to protect the site and adjacent properties. "Spill" shall include any release of any contaminant to air, land or water.

C. The Contractor shall construct a secondary containment around the injection system, equalization tank and permanganate storage area lined with material that is permanganate resistant. The secondary containment area shall be capable of holding 110% of the storage volume. The Contractor shall follow all applicable OSHA and Hazardous Materials regulations.

D. The Contractor shall devise methods, provide the means and take action to prevent further contamination and spread of contamination to soil, water, air, structures, equipment or material resulting from spills generated from the work.

E. The Contractor shall maintain equipment and trained personnel within the pilot test injection area to perform emergency measures necessary to contain, remove and clean up all spills generated from the work.

F. In the event of a spill, the Contractor shall take immediate action in accordance with the approved Spill Contingency Plan, and federal, state and local laws and regulations. In addition, the Contractor shall notify the Engineer immediately of any spill and shall continuously inform the Engineer of any and all actions implemented to comply with applicable requirements.

G. The Contractor shall maintain within the work area a solution of approximately 33 parts water, 33 parts white vinegar and 33 parts 3% hydrogen peroxide in a 3-gallon garden sprayer for use to reduce the permanganate solution. The Contractor shall maintain a minimum of 5 gallons of solution within the work area during the work.

H. All spill material, absorbents, vermiculite, etc. resulting from a spill shall be removed from the work area and disposed in accordance with all applicable federal, state and local laws and regulations at no additional cost to the Engineer.

I. Any material contaminated as a result of a spill shall be removed from the work area and disposed in accordance with all applicable federal, state and local laws and regulations at no additional cost to the Engineer.

J. Any material necessary for completion of work, which is contaminated as a result of a spill or Contractor negligence, shall be replaced at the expense of the Contractor.

K. In the event of a spill, the Contractor's Health and Safety Officer shall immediately notify all applicable federal, state and local agencies having jurisdiction.

L. When a spill occurs, the Contractor's Health and Safety Officer shall submit a written report to the Engineer within 48 hours of the incident. The report, at a minimum, shall include the following:

1. The date and type of incident;

2. A map delineating the area impacted by the incident;

3. Details of the cause and resolution of the incident;

4. Identification of all outside agencies contacted and involved in the spill control;

5. Descriptions of corrective action;

6. Impact on human health and the environment; and

7. Potential claims by third parties.

1.8 Health and Safety

A. The Contractor shall provide for his employees, and any subcontractor, all equipment, and clothing necessary, including monitoring equipment, respirators, self-contained breathing apparatus, and chemical resistant clothing, to provide adequate health protection and safety in any area containing hazardous materials. This equipment and clothing shall be readily available at the site to the Contractor's employees as specified in the Contractor's Health and Safety Plan. The Contractor shall also provide traffic control as necessary, or as required by permit, law or regulation. Any costs resulting from delays in work due to appropriate health and safety equipment and clothing not being within the work area and ready for immediate use shall be borne by the Contractor, including the Engineer's labor and expense costs during the delay period.

B. The Contractor shall be responsible for the health and safety of his/her employees. The Contractor shall prepare a Health and Safety Plan for the work, and it shall be followed by all personnel. All Contractor personnel shall have completed OSHA training and medical monitoring requirements for work on hazardous waste sites.

C. The Contractor shall be responsible for performing air monitoring for volatile organic compounds and particulates at both upwind and downwind locations to document real time levels of contamination which might be moving outside the work, in accordance with the New York State Department of Health Community Air Monitoring Plan.

1.9 Qualifications

A. The Contractor shall employ only competent work persons for the execution of this work, and all such work shall be performed under the direct supervision of experienced personnel satisfactory to the Engineer. The Contractor shall have at his immediate disposal, operational equipment in good working order rated to do that work required to install monitoring wells and injection wells and inject permanganate.

B. The well driller shall be capable of identifying geologic formations, maintaining complete and current well and boring logs and daily notes for a well completion report, and developing and testing the wells.

C. The Contractor shall furnish satisfactory evidence, upon request, that all materials to be furnished in performing the work are new and all equipment to be used is in good condition and working order.

D. The Contractor shall complete the work in accordance with all applicable requirements of the federal, state and local agencies including the New York State Department of Environmental Conservation.

E. The Contractor shall be responsible for the security of the Contractor's equipment, materials and supplies.

1.10 Submittals

A. A sample, catalogue cut and specification for each of the materials listed in this specification shall be submitted to the Engineer upon request for approval prior to mobilization to the project site and the commencement of field operations.

B. During drilling of each well, a complete log shall be maintained by the Contractor and submitted to the Engineer. The report shall include the following:

1. The reference point for all depth measurements.

2. The depth at which each change of formation occurs.

3. The identification of the material of which each stratum is composed.

4. The depth interval from and method which formation samples were taken.

5. The depth at which hole diameters (bit sizes) change.

6. Other pertinent data requested by the Engineer.

C. During drilling of each well, a detailed daily driller's report shall be maintained and submitted as requested by the Engineer. The report shall give a complete description of all formations encountered, number of feet drilled, number of hours on the job, shutdown due to breakdown, materials used, feet of casing set, and other pertinent data requested by the Engineer.

D. During injection, a detailed daily report shall be maintained and submitted to the Engineer. The report shall include the following:

1. Time and injection rate shall be recorded at the beginning of injection and each time there is a change in the injection rate.

2. Injection pressure and injection totalizer (volume) shall be recorded at a frequency of 1 reading per 15 minutes of injection.

3. Total volume injected into each well each day.

4. Total volume injected each day.

1.11 Handling of Materials

A. All equipment, parts and materials shall be properly protected so that no damage or deterioration will occur during a prolonged delay from time of shipment until installation is completed, and the units and equipment are ready for operation.

B. All equipment, parts and materials shall be properly protected against damage during a prolonged period at the site. Any equipment, parts and materials damaged, or deemed unacceptable by the Engineer, shall be removed from the site and replaced with new, like equipment, parts or materials by the Contractor at no additional cost to the Engineer.

C. If water for mud rotary drilling is used, the Contractor shall provide potable water approved by the Engineer and a waste storage tank or container for each well. For mud rotary drilling, unless approved by the Engineer in advance of the work, only pure Wyoming bentonite drilling fluid or equivalent is acceptable. The storage capacity shall be 50% greater than the anticipated drilling waste generated per borehole. The Contractor is responsible for providing all water necessary for

cleaning, well construction and any other purposes for the successful completion of the work.

D. The Contractor shall contain all spent cuttings, drillings, drilling fluids (if used), flushing water and development water in a leak proof container. No cuttings, fluids (if used) or water shall be allowed to flow on the site surface. The Contractor shall supply and contain all cuttings, fluids and waters in DOT-approved 55-gallon "ring top" drums or approved equal.

E. The Contractor shall be responsible for containerizing, characterizing and disposing off-site all waste generated in accordance with all applicable federal, state and local laws and regulations. This includes, but is not limited to, drill cuttings, drilling fluids (if used), used personal protective equipment, decontamination wastewater and disposable sampling equipment. Prior approval of all disposal facilities by the Engineer shall be required. The Contractor shall containerize all waste in leak proof, vapor tight Department of Transportation (DOT) approved 55-gallon ring top drums, or approved equal. All waste shall be removed from the work area at the completion of each day's work and transported to the DPW facility.

1.12 Site Cleanup

A. Immediately upon completion of the work, the Contractor shall remove all of his equipment, materials and supplies from the work area, remove all surplus materials and debris, fill in all holes or excavations, and grade the work area to elevations of the surface levels which existed before work started. The Contractor shall complete all pavement replacement as directed by the Engineer. The work shall be thoroughly cleaned by the Contractor and approved by the Engineer.

B. Upon completion of the work, the Contractor shall remove all equipment, materials, supplies and waste material from the DPW facility and restore the area to pre-existing conditions.

1.13 Warranty

A. All equipment supplied under this Section shall be warranted by the Contractor and equipment manufacturers for a period of 1 year from date of acceptance by the Engineer. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period.

B. The wells shall be warranteed to be free from defects in workmanship and materials. If any part of the wells should fail during the warranty period due to the fault of the Contractor, it shall be replaced and the wells restored to service at no additional expense to the Engineer.

2.0 SOIL BORING, MONITORING WELL AND INJECTION WELL INSTALLATION

2.1 Specifications of the Boring

A. The soil boring shall be installed at the OU2-11 location as shown on Figure 1 using mud rotary drilling method. Split spoon samples shall be collected every 5 feet from 80 feet to 200 feet below ground surface.

B. Split spoon soil samples shall be collected from 80 feet below ground surface to 200 feet below ground surface.

C. Samples shall be collected from decontaminated split spoon samplers. Upon retrieval, the soil samples shall be provided to the Engineer. The Contractor shall also obtain split spoon samples during drilling operations as directed by the Engineer.

D. Split spoon samples will be used to obtain information on the physical characteristics of the soil.

E. A 2-inch diameter, 2-foot long split spoon sampler shall be driven vertically into the undisturbed formation at the bottom of the drilled hole.

F. The sampler shall be returned to the surface to the Engineer. The Contractor is required to have at least one cleaned sampling spoon on hand at each well prior to beginning work. After each sampling, the samplers shall be cleaned by the procedure as described in Section 2.10.

G. The soil boring shall be gamma logged.

2.2 Specifications of the Wells

A. Monitoring Wells

1. The pilot study monitoring wells (OU2-6, OU2-7A and OU2-7B) shall be installed as shown on Figure 1. Although the exact locations of the monitoring wells shall be determined in the field once utility markouts have been completed, OU2-6 shall be installed midway between injection wells IW-2 and IW-3 described below. OU2-7A and OU2-7B shall be installed approximately 25 feet south of IW-1 and IW-2. Well locations shall be approved by NYSDEC prior to initiation of drilling activities. The downgradient monitoring wells shall be installed as three-well clusters at three locations along Bedford Avenue. Each well cluster shall be installed approximately 50 feet apart. With the exception of OU2-11,

the monitoring wells shall be installed using hollow stem auger drilling method. The Contractor shall provide a minimum of 3 to 5 feet horizontal spacing between each well in the cluster. Each well shall be constructed of 2-inch diameter Schedule 40 PVC riser and well screen. The following table summarizes the specifications for each well.

Well ID	Well Inner Diameter	Well Depth (feet bgs)	Screen Length
OU2-6	2 inch	115 feet	10 feet
OU2-7A	2 inch	100 feet	10 feet
OU2- 7B	2 inch	120 feet	10 feet
OU2-8A	2 inch	100 feet	10 feet
OU2-8B	2 inch	125 feet	10 feet
OU2-8C	2 inch	150 feet	10 feet
OU2-9A	2 inch	100 feet	10 feet
OU2-9B	2 inch	125 feet	10 feet
OU2-9C	2 inch	150 feet	10 feet
OU2-10A	2 inch	100 feet	10 feet
OU2-10B	2 inch	125 feet	10 feet
OU2-10C	2 inch	150 feet	10 feet
OU2-11	2 inch	200 feet	10 feet

B. Injection Wells

1. The injection wells shall be installed at the locations shown on Figures 1 and 2 using hollow stem auger drilling method. Although the exact location of the injection wells shall be determined in the field once utility markouts have been completed, it is intended to install each injection well approximately 50 feet apart along Lenox Avenue. Well locations shall be approved by NYSDEC prior to initiation of drilling activities. Each well shall be constructed of 2-inch diameter Schedule 40 PVC riser and well screen. The following summarizes the specifications for each well.

Well ID	Well Inner Diameter	Well Depth (bgs)	Screen Length
IW-1	2 inch	95 feet	5 feet
IW-2	2 inch	95 feet	5 feet
IW-3	2 inch	95 feet	5 feet
IW-4	2 inch	95 feet	5 feet

2.3 Well Construction

A. Monitoring well/injection well schematic is shown on Figure 3.

B. Clean equipment as per Section 2.10.

C. Construction of monitoring wells/injection wells may include the removal and excavation of pavement or concrete prior to initiation of drilling.

D. The borehole for the installation of monitoring wells/injection wells shall be drilled by 4-1/4-inch I.D. hollow stem auger method.

E. Drill pipe lubrication if any shall be limited to vegetable shortening or approved equal.

F. Drilling fluid (if used) shall only consist of potable water approved by the Engineer. No other fluids or additives shall be used unless approved by the Engineer. If mud is used, only pure bentonite powder of the Wyoming type shall be employed unless otherwise approved by the Engineer in advance of the work. The Contractor shall be responsible for providing all water necessary for borehole and well construction. At the Engineer's request, the Contractor shall provide proof of the potability of the water source.

2.4 Well Casing and Screen

A. Well casing shall be 2-inch inner diameter (I.D.) Schedule 40 PVC conforming to ASTM D1784 and ASTM D1785, as manufactured by Atlantic Screen and Manufacturing, Inc., or approved equal. The riser shall be adjoined using internally threaded flush joints. Solvent weld pipe shall not be permitted.

B. Well screen shall be 2-inch I.D. 0.010-inch slotted Schedule 40 PVC threaded flush joint manufactured by Atlantic Screen and Manufacturing, Inc., or approved equal. The bottom of the screen shall be fitted with an internally threaded, flush joint PVC plug fabricated from solid stock. Solvent weld pipe shall not be acceptable.

C. The Contractor shall provide all casing (riser pipe), well screen, together with required couplings, plugs, caps, fittings and other parts necessary to satisfactorily complete the well installation. Casing and appurtenances shall be clean and free of all oil, grease and any other organic contamination. All casing must be contained in factory sealed, individually wrapped packaging prior to use. Casing that is not packaged or is removed from damaged packing must be decontaminated prior to installation. All persons handling screens shall wear clean, disposable latex gloves, or equivalent, to prevent possible cross contamination.

D. Every effort shall be made on the part of the Contractor to assure casing plumbness and centralization within the borehole.

E. Centralizers may be employed by the Contractor as an optional method of assuring centralization and plumbness with approval of the Engineer.

F. All drilling and well construction methods shall be as approved by the Engineer.

2.5 Sand Pack

A. Screen sand pack shall be a No. 1 well gravel pack, 100 percent passing the No. 8 sieve and less than 2 percent passing the No. 25 sieve, as supplied by the U.S. Silica Company, or approved equal. The No. 1 well gravel pack shall be clean, washed and graded silica sand supplied in sealed bags.

B. The sand pack shall be placed around the outside of the well screen by means of a tremie pipe or other method approved by the Engineer to ensure that no bridging of the hole occurs and shall extend from the bottom of the borehole to a minimum of 2 feet above the top of the screen or as otherwise directed by the Engineer.

2.6 Cement Bentonite Grout Mix

A. The bentonite for bentonite seals and cement/bentonite grout shall be Wyo-Ben, Inc. Extra High Yield Gel, or approved equal.

B. The cement shall be Type 1 Portland Cement as manufactured by the Lehigh Portland Cement Company, or approved equal.

C. The cement/bentonite grout mix shall be prepared in the following proportion and in accordance with the manufacturer's specifications:

1. 8.3 gallons of potable water

2. 5.0 lbs. of bentonite.

3. One 94-lb. bag of Type 1 cement.

D. The cement/bentonite grout shall be placed between the well casing and formation above the bentonite seal of the well in each borehole. All cement/bentonite grout shall be installed using a tremie pipe.

E. All grout shall be allowed to cure for a minimum of 12 hours or as necessary to provide a proper cure prior to starting the next phase of work.

2.7 Bentonite Seal

A. The bentonite shall be 1/2-inch diameter with a dry bulk density of 82 lbs. per cubic foot and containing a minimum of 90 percent sodium montmorillonite. The pellets shall be capable of swelling to 10 to 15 times their dry volume when hydrated with potable water. The bentonite pellets shall be Volclay Tablets as manufactured by CETCO Drilling Products, or approved equal.

B. A bentonite seal shall be placed in the well by means of a tremie pipe or other method approved by the Engineer to ensure that no bridging of the hole occurs and shall extend from the top of the sand pack to a minimum of 2 feet above the sand pack, or as otherwise directed by the Engineer. In the event that bentonite pellets or chips are utilized for a bentonite seal above the water table, approved potable water shall be used for hydration.

C. The bentonite seal shall be allowed to hydrate for a minimum of 1 hour prior to grouting of the well annulus.

2.8 Well Caps and Protective Covers

A. Each well shall have a vented cap, and each injection well and monitoring well casing shall be protected from entry of foreign materials at all times and upon well completion fitted with a lockable steel cap/cover equipped with keyed-alike locks.

B. Temporary well guard and identifying flagging shall be provided and installed immediately upon well completion and prior to development and removal of the Contractor's drill rig from the well site.

C. If the well is not complete at the end of the work day, the Contractor shall be responsible for securing the uncompleted borehole/well.

D. Protective casings shall be furnished with drain holes to prevent collection of water inside the protective casing.

E. The Contractor shall furnish and install a locking steel protective surface casing with a locking cover with a watertight seal at the wells. Provision shall be made to allow water to drain from the vault. Injection well protective surface casings shall be of sufficient size to house the injection well head equipment described in Section 3.0.

2.9 Neat Cement Grout

A. The Contractor shall furnish and place neat cement grout in the annular space between the well hole wall and the surface casing, and between the casing and the riser pipe, or as directed by the Engineer. Work shall include, but not be limited to:

1. Opening a clear annular space 2 feet by 2 feet by hand using shovels.

2. Mixing and placement of the neat cement/sand grout in one continuous operation

B. Neat cement grout shall be a mixture of Portland cement and potable water. The water to cement ratio shall be 5 to 6 gallons of water per 94-pound bag of cement. A bentonite additive of 3% to 5%, or other ratio, may be specified by the Engineer. The grout shall be placed by a continuous operation before initial setting of the cement. The grout shall be introduced at the base of the grouting interval to minimize dilution of the grout and bridging of the mixture with upper-formation material. The tremie method may be used only when approved by the Engineer. Portland cement shall be Type 2 conforming to ASTM-C-150.

2.10 Cleaning Procedures

A. Sampling Equipment - All sampling equipment shall be, at a minimum, cleaned of all foreign matter, washed with a nonphosphate detergent, rinsed with potable water, then followed by a final rinse with distilled/deionized water in that order, or cleaned of foreign matter and steam cleaned at a temperature of 212°F and void of any external oils and greases prior to use in each well.

B. Contact Equipment - All contact equipment including sample pumps and hoses shall be cleaned and flushed between uses. This cleaning process will consist of steam cleaning of pump casing and cables followed by a 10-gallon flush of potable water through the pump. A new length of dedicated polyethylene tubing shall be used for each well and disposed of after use. The pump, tubing and cables shall always be placed on clean polyethylene sheeting to avoid contact with ground surface.

C. Drilling - Heavy Equipment - All drilling and heavy equipment including drill rigs, well casing and auger flights shall be cleaned after mobilization to and prior to demobilization from the project site and between individual locations on the site. The two options that are available and allowable to accomplish cleaning the heavy equipment include steam cleaning and manual scrub brushing and washing.

D. All equipment shall be stored above ground in a clean manner as approved by the Engineer. All down hole equipment shall be stored in such a manner as to prevent contact with the ground surface.

E. Drilling fluid changes during borehole construction shall include cleaning of all drilling equipment in the manner described in this Section, in addition to the removal of drilling fluid in the borehole by flushing, bailing or air lift, as necessary to ensure clean fluid in the borehole, as approved by the Engineer.

F. All cleaning equipment shall be provided by the Contractor.

G. All water used in the drilling operation shall be provided or obtained by the Contractor. Transport and storage of all water will be the responsibility of the Contractor. All water used for drilling and cleaning must be potable and as approved by the Engineer.

H. The Contractor shall provide/construct a decontamination pad on which to clean all equipment, materials and supplies. The Contractor shall also be responsible for removing the decontamination pad at the end of the drilling program.

2.11 Well Development

A. The Contractor shall develop each monitoring well installed. Development shall be by overpumping with a submersible pump, pump and surge, or bailing as determined by the Engineer. Development shall continue until the well water is less than 50 NTUs as measured with a turbidity meter or until the Engineer approves cessation of development. The sediment-free condition is to be measured within the first 15 minutes of pumping following start-up. In the case of monitoring wells screened in either silt or clay formations, only gentle development methods shall be used (i.e., low pumping of less than 5 gallons per minute). For cases in which the 50 NTU turbidity requirement is unattainable due to the high percentage of fines in the formation, development will proceed until turbidity values stabilize with no evidence that further development will reduce turbidity. If the sediment has not been effectively and satisfactorily developed out, a determination will be made by the Engineer, taking into account the nature of the formation materials, whether or not to continue development. Development water must be collected in 55-gallon drums, properly characterized and disposed of in accordance with all federal, state and local regulations, including the NYSDEC Hazardous Waste Regulations found at 6 NYCRR Parts 370-376. Development water shall be removed from the work area at the end of each day.

2.12 Well Acceptance Criteria

A. To be accepted by the Engineer, a well shall be developed to the point that it is producing water free of drilling fluid additives (if used), and is sediment free. Sediment free shall be defined as not more than 50 NTUs as measured with turbidity meter.

B. In the case of monitoring wells screened in either silt or clay formations, only gentle development methods shall be used (i.e., low pumping of less than 5 gallons per minute). For cases in which the 50 NTU turbidity standard is unattainable due to the high percentage of fines in the formation, development will proceed until turbidity values stabilize with no further evidence for improvement as approved by the Engineer.

C. In order to ensure that all wells are sufficiently straight, and acceptable to the Engineer, the Contractor shall pass a 1.66-inch diameter by 36-inch long submersible pump or dummy to the bottom of the 2-inch well, or a 3.5-inch diameter by 36-inch long submersible pump or dummy to the bottom of the 4-inch well.

2.13 Well Abandonment

A. In the event that the Contractor shall fail to install the well to the depth specified or to such lesser depth as directed by the Engineer, or should the Contractor abandon the well because of loss of tools or for any other cause, through the fault of the Contractor, the Contractor shall, if requested and as directed by the Engineer, plug the well with nonshrink cement/bentonite grout from the bottom of the borehole upwards to the ground level in one continuous operation using a tremie pipe at no additional cost to the Engineer.

3.0 PERMANGANATE INJECTION

3.1 Permanganate

A. The Contractor shall provide 288,000 pounds of RemOx-L 5% sodium permanganate as manufactured by Carus Corporation. A MSDS for 40% sodium permanganate is provided in Appendix A.

B. The injection concentration for this treatment program is 5% sodium permanganate. The sodium permanganate shall be delivered to the site in a trailer containing 5% sodium permanganate.

3.2 Injection System

A. The injection system shall consist of an equalization tank, chemical transfer lines, injection lines, pumps and meters.

B. All wetted parts of the injection system shall be compatible with sodium permanganate (up to 40% concentration). A Sodium Permanganate Materials Compatibility Chart is included as Appendix B. Exhibit 1 shows the complete injection system setup.

C. The Contractor shall construct a secondary containment around the injection system, equalization tank and permanganate storage area lined with material that is permanganate resistant. The secondary containment area shall be capable of holding 110% of the storage volume. The Contractor shall follow all applicable OSHA and Hazardous Materials regulations.

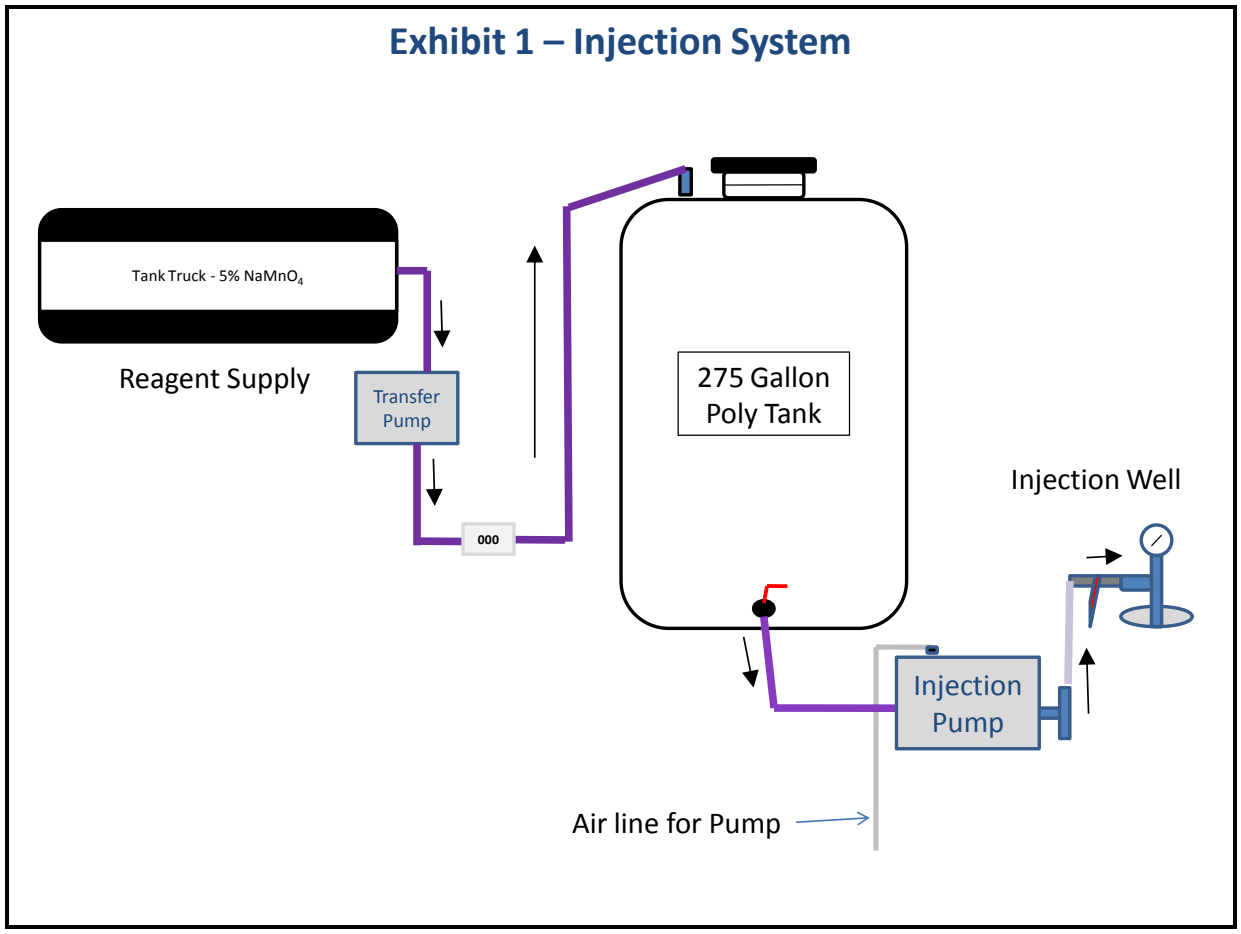
3.3 Equalization Tank

A. A 275-gallon poly tank (or approved equal) shall be used as an equalization tank between the tank trailer utilized for delivery of the 5% sodium permanganate and the injection system.

B. The equalization tank shall be fitted with an influent port near the top of the tank comprised of ¾-inch PVC bulkhead fitting. A female cam-lock fitting shall be connected to the bulkhead fitting, for connection with a male cam-lock fitting on the transfer hose.

C. The equalization tank shall be fitted with a discharge port at the bottom of the tank consisting of a leak-proof PVC bulkhead fitting, if the tank is not already

provided with the tank. A ¾-inch PVC ball valve shall be connected to this fitting, and then adapted to a cam-lock fitting to connect tubing to the injection pump.



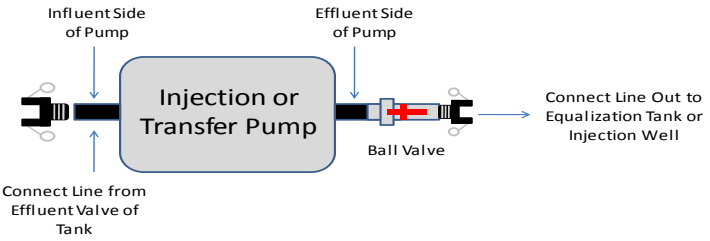
3.4 Transfer and Injection Pumps

A. The transfer and injection pumps shall be constructed of materials compatible with sodium permanganate.

B. The injection pump shall be a Yamada NDP-20 BPT - 3/4" double diaphragm pump or approved equal with Viton diaphragms. A small air compressor (100 psi) shall be used for the pump. A schematic of a typical connection with the pumps is shown in Exhibit 2.

C. The transfer pump shall be a Yamada NDP-5, with Viton diaphragms or approved equal.

Exhibit 2 – Schematic of Injection Pump



3.5 Injection and Transfer Lines

A. The hoses shall be reinforced PVC tubing (3/4-inch diameter) or approved equal. The hoses shall be compatible with sodium permanganate, shall withstand up to 300 psi of pressure, and shall remain flexible in all anticipated outdoor temperatures. The type of lines and where they shall be connected is described below.

B. The transfer line shall be installed from the drop trailer through a transfer pump to the equalization tank. This line shall be metered with a flow totalizer (Section 3.6).

C. The injection line shall be installed from the equalization tank through the injection pump to the injection well. The injection line shall also be installed from the injection pump to the injection well. This line shall be metered with a flow totalizer.

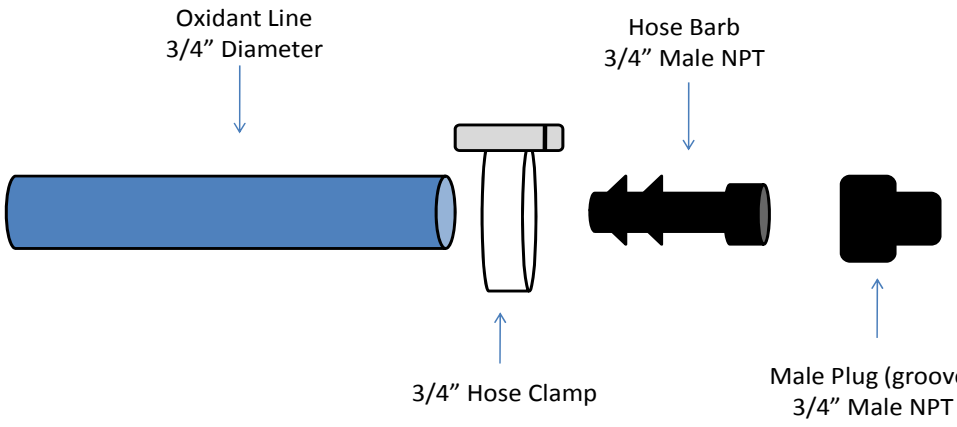
3.6 Flow Totalizers

A. The Contractor shall install McMaster-Carr digital flow meter, Part No. 9978K75 or equivalent to monitor the amount of permanganate injected into each well.

3.7 Fittings

A. Hose Fittings: The hose fittings shall be equipped with the ability to disconnect the hoses without having to unthread parts, such as with cam-lock quick connect fittings. The Contractor shall refer to Exhibit 3 for a schematic of the fittings that shall be fastened to the lines.

Exhibit 3 – Hose Fittings



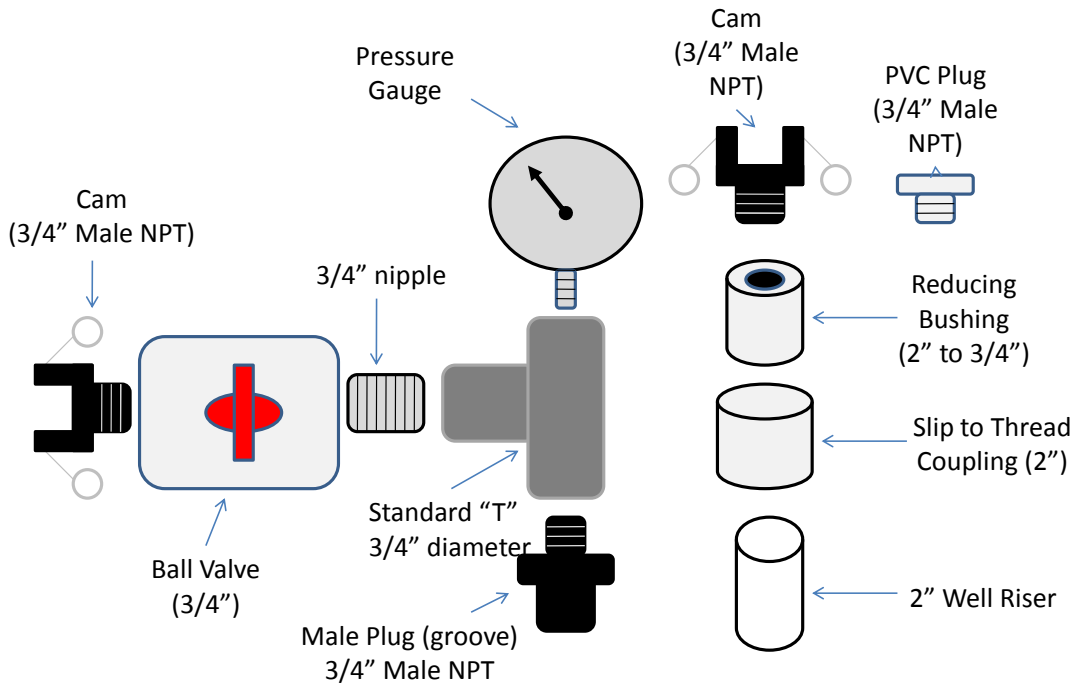
B. Injection Well Head Fittings: In order to connect the injection line to the injection well, the Contractor shall glue a 2-inch Schedule-80, PVC, slip to thread coupling to the outside of the well riser. The Contractor shall use PVC glue to glue the coupling to the well riser. A 2-in. slip reducing to 3/4-in. female threaded NPT bushing shall be glued to the coupling. The coupling and the bushing shall be glued prior to gluing the coupling to the well head in order to prevent glue from infiltrating the well. A 3/4-inch female cam-lock fitting shall be threaded into the bushing. After each injection day or event, the cam shall be removed and replaced by a plug. Exhibit 4 illustrates the necessary injection well head fittings.

3.8 Permanganate Injection

A. The volume of oxidant to be injected in each of the injection wells is 72,000 pounds of 5% sodium permanganate or approximately 8,268 gallons. The exact volume to be injected into each well will be determined in the field at the direction of the Department.

B. The Contractor shall test the injection system with water prior to utilizing permanganate in the injection system. A leak check shall be conducted by dead-heading the tubing at the injection head, and pressuring the system to a minimum of 80 psi. Leaks shall be repaired before proceeding to permanganate reagent preparation and injection.

Exhibit 4 – Injection Well Head Fittings



C. The Contractor shall begin injection at a slow rate, and increase the injection rate based upon the injection pressure and system response. The initial injection rate shall be approximately 1 gallon per minute of the 5% permanganate solution. The system shall be checked continuously for leaks and proper operation, and pressure shall be monitored with the pressure gauge at the injection well head. The pressure is expected to increase, but shall not exceed 80 psi.

D. If pressure is below 80 psi at the 1 gpm rate after 15 minutes of injection, the injection rate shall be increased at approximately 0.5 gpm increments every 15 minutes to assess injection pressure as a function of injection rate. The maximum rate at which the injection can be conducted while maintaining a pressure less than 80 psi shall be determined. The site is anticipated to be able to accept a minimum of 5 gpm at a pressure of approximately 80 psi or less.

E. The Contractor's injection schedule shall include injecting in a different injection well each day starting with injection well IW-1and moving to injection well IW-2 the following day. Injections shall be performed in IW-3 on the third day of injection and injection well IW-4 on the fourth day of injection. The injection schedule shall follow this pattern until the specified volume of permanganate has been injected into each injection well.

F. At the completion of the injection, the Contractor shall rinse the system with approximately 25 gallons of water. This water can be injected into the injection well. This process shall be repeated approximately 2 to 3 times. Once the lines have been rinsed, the Contractor shall rinse the entire injection system including all lines and pumps with a solution of approximately 33 parts water, 33 parts white vinegar and 33 parts 3% hydrogen peroxide to reduce the permanganate solution. All rinsate shall be containerized and disposed of off-site in accordance with all applicable local, state and federal requirements.

FIGURES

5TH AVENUE
LENOX AVENUE
BEDFORD AVENUE
LAFAYETTE AVENUE
SOUTH GRAND STREET
SOUTH FULTON STREET
FULTON STREET
MYRTLE AVENUE
OLD COUNTRY ROAD

50
500
5000

OU2-6
OU2-7
IW-1
SV-7
IW-2
SV-9
IW-4
SV-8
IW-3
OU2-3
6,107
TP-1
0
TP-2
518
SB-1
TP-3
5,575
OU2-10
OU2-8
OU2-9
TP-4
653
TP-5
27
SB-2
OU2-11
SB-3
TP-6
47
OU2-4
29
TP-9
47
OU2-5
2
SB

BIG M CAR WASH OF WESTBURY
CAR WASH SUPPLY WELL 249
WESTBURY WATER DISTRICT WELL NO. 11

LEGEND

- EXISTING PERMANENT MONITORING WELL LOCATION AND DESIGNATION
- EXISTING SOIL VAPOR WELL LOCATION
- PROPOSED DEEP EARLY WARNING MONITORING WELL
- PROPOSED MONITORING WELL CLUSTER LOCATIONS
- PROPOSED INJECTION WELLS
- TP-1 EXISTING TEMPORARY WELL LOCATION
- SB-1 EXISTING SOIL BORING LOCATION
- SB-3 PROPOSED SOIL BORING LOCATION
- AREA OF INJECTION
- OU2-3 / 6,107 MONITORING WELL / TEMPORARY WELL DESIGNATION AND HIGHEST TOTAL TARGETED VOC CONCENTRATIONS (ug/l)
- NS NOT SAMPLED
- —50— ESTIMATED TOTAL VOC CONCENTRATION CONTOUR LINE (ug/l)

0 100'
SCALE: 1"=100'

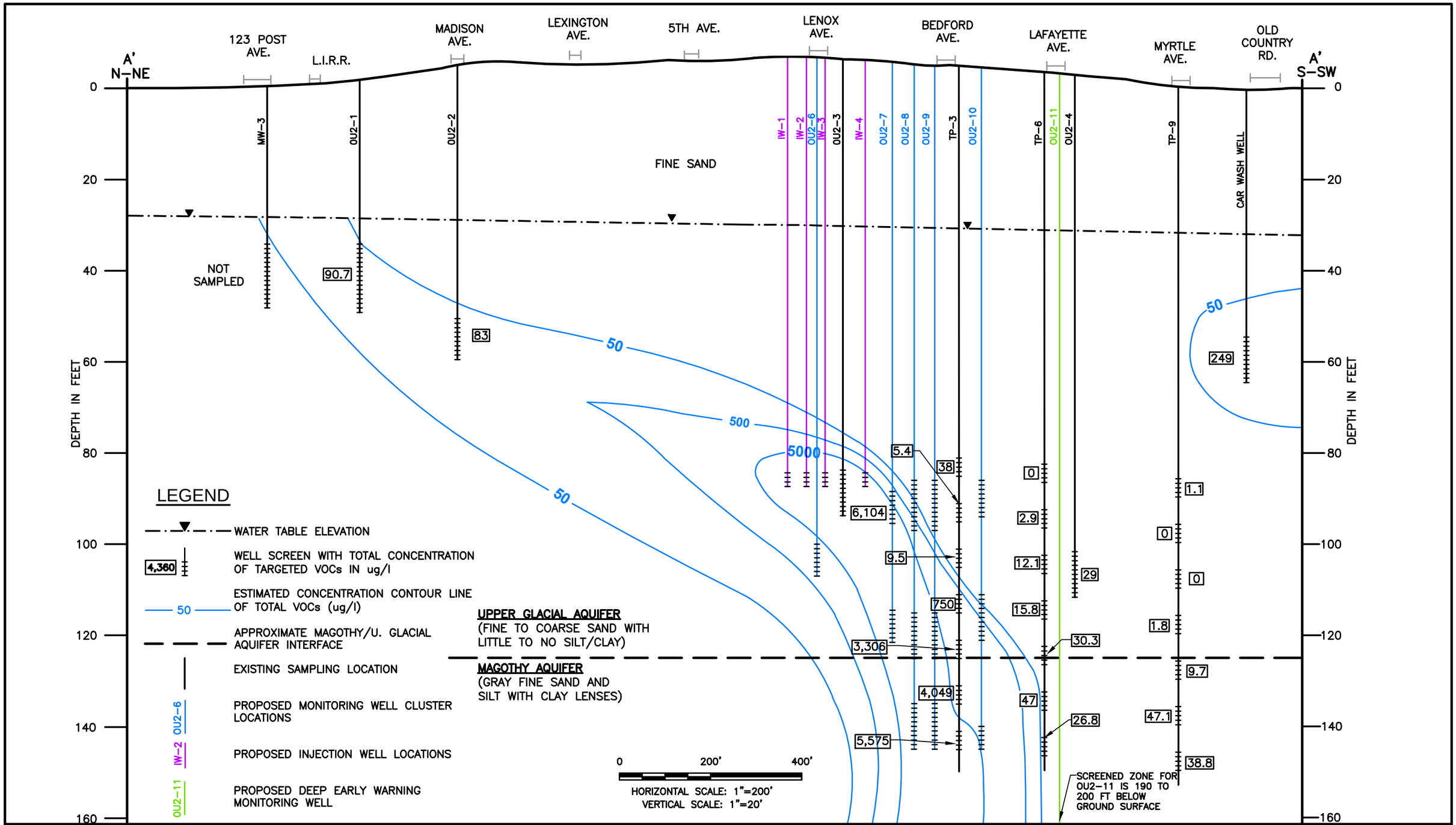
E:\2500\Dwg\2599-FIG-1.dwg, 6/24/2011 12:21:49 PM, astrauss

Dvirka and Bartilucci CONSULTING ENGINEERS
A DIVISION OF WILLIAM F. COSULICH ASSOCIATES, P.C.

123 POST AVENUE - OPERABLE UNIT 2 REMEDIAL DESIGN
WESTBURY, NEW YORK

PROPOSED AND EXISTING MONITORING WELL AND INJECTION LOCATIONS

FIGURE 1



123 POST AVENUE - OPERABLE UNIT 2 REMEDIAL DESIGN
WESTBURY, NEW YORK

CROSS SECTION OF PROPOSED MONITORING/INJECTION WELL LOCATIONS

FIGURE 2

Dvirka and Bartilucci CONSULTING ENGINEERS
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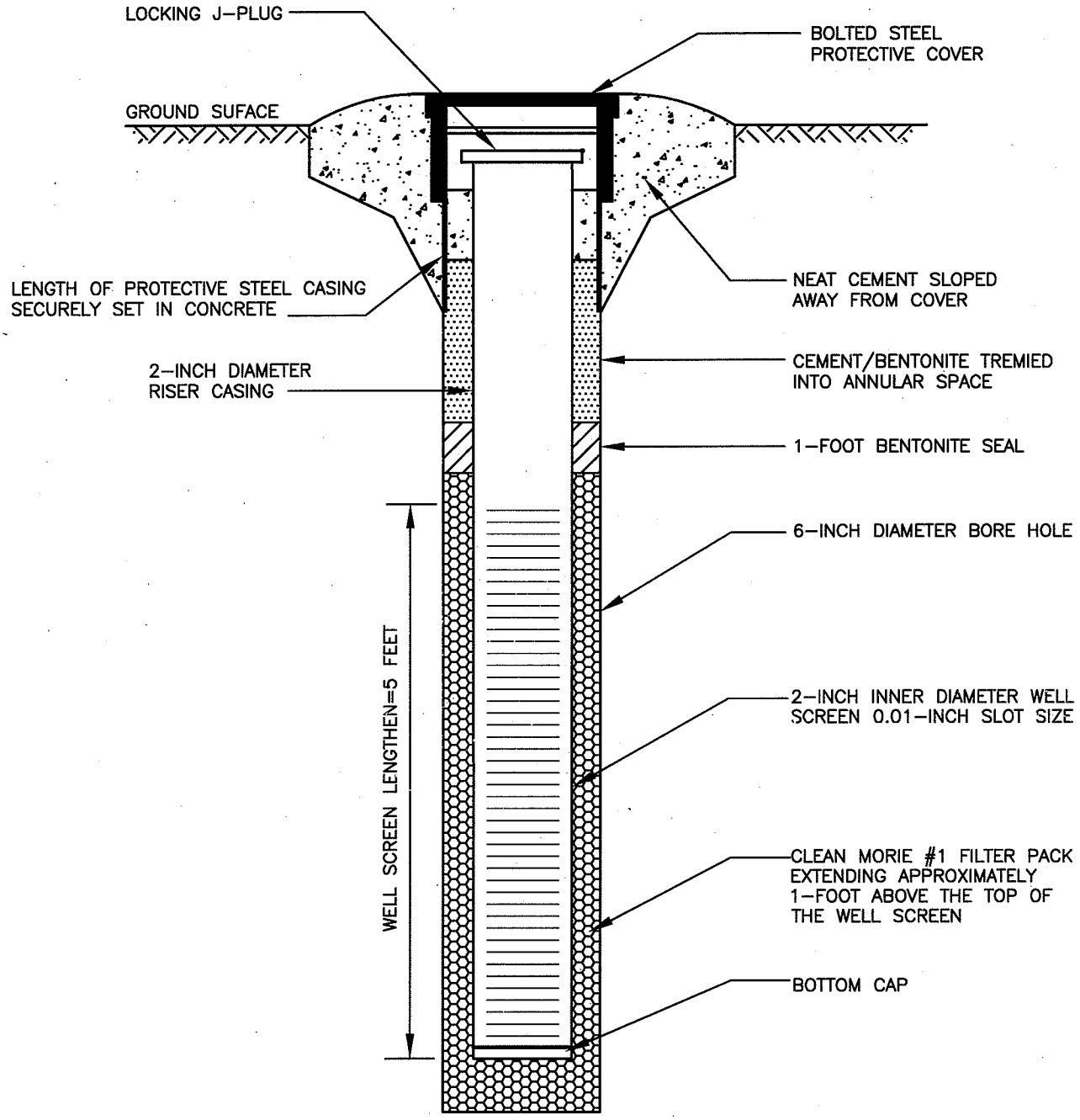
F:\2599-03\2599-03 FIG3-C2011.dwg, FIG 3, 6/24/2011 12:20:33 PM, astrauss



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WESTBURY, NEW YORK

MONITORING WELL / INJECTION WELL SCHEMATIC

FIGURE 3

APPENDIX A

SODIUM PERMANGANATE MATERIALS SAFETY DATA SHEET

RemOx®L
ISCO Reagent

EC- SAFETY DATA SHEET according to EC directive 2001/58/EC
MATERIAL SAFETY DATA SHEET

Section 1 Chemical Product and Company Identification

PRODUCT NAME: RemOx® L ISCO Reagent **TRADE NAME:** RemOx® L ISCO Reagent	**Revision Date: January 2006**

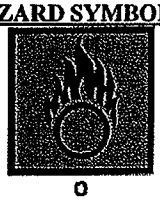
USES OF SUBSTANCE: RemOx® L ISCO Reagent is a liquid oxidant recommended for in-situ and ex-situ remediation of sites that require a strong oxidant.

COMPANY NAME (Europe): CARUS NALON S.L.	**COMPANY ADDRESS:**	Carus Nalon S.L. Barrio Nalon, s/n 33100 Trubia-Oviedo Espana, Spain
	INFORMATION:	(34) 985-785-513 (34) 985-785-513 www.caruseurope.com (Web) carus@carusnalon.com (Email)
COMPANY NAME (US): CARUS CHEMICAL COMPANY	**EMERGENCY TELEPHONE:**	(34) 985-785-513
	COMPANY ADDRESS:	315 Fifth Street Peru, IL 61354, USA
	INFORMATION:	(815)-223-1500 www.caruschem.com (Web) salesmkt@caruschem.com (Email)
	EMERGENCY TELEPHONE:	(800) 435 –6856 (USA) (800) 424-9300 (CHEMTREC, USA) (815-223-1500 (Other countries)

Section 2 Hazardous Ingredients

Material or Component	CAS No.	%	Hazard Data
Sodium Permanganate	10101-50-5	40	**PEL/C** 5 mg Mn per cubic meter of air **TLV-TWA** 0.2 mg Mn per cubic meter of air

HAZARD SYMBOLS: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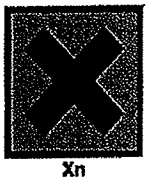
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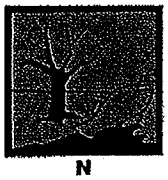
N

RISK PHRASES:

8 Contact with combustibles may case fire.
22 Harmful if swallowed.
50/53 Very toxic to aquatic organisms, may cause long-term effects in the aquatic environment.

SAFETY PHRASES:

17 Keep away from combustible materials.
24/25 Avoid contact with skin and eyes.
26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice

Section 3 Hazards Identification

1. Eye Contact
   RemOx® L ISCO Reagent is damaging to eye tissue on contact. It may cause burns that result in damage to the eye.
2. Skin Contact
   Momentary contact of solution at room temperature may be irritating to the skin, leaving brown stains. Prolonged contact is damaging to the skin.
3. Inhalation
   Acute inhalation toxicity data are not available. However, airborne concentrations of RemOx® L ISCO Reagent in the form of mist may cause irritation to the respiratory tract.
4. Ingestion
   RemOx® L ISCO Reagent if swallowed, may cause burns to mucous membranes of the mouth, throat, esophagus, and stomach.

Section 4 First Aid Measures

1. Eyes
   Immediately flush eyes with large amounts of water for at least 15 minutes holding lids apart to ensure flushing of the entire surface. Do not attempt to neutralize chemically. Seek medical attention immediately. Note to physician: Decomposition products are alkaline.
2. Skin
   Immediately wash contaminated areas with water. Remove contaminated clothing and footwear. (Caution: Solution may ignite certain textiles). Wash clothing and decontaminate footwear before reuse. Seek medical attention immediately if irritation is severe and persistent.
3. Inhalation
   Remove person from contaminated area to fresh air. If breathing has stopped, resuscitate and administer oxygen if readily available. Seek medical attention immediately.
4. Ingestion
   Never give anything by mouth to an unconscious or convulsing person. If person is conscious, give large quantities of water or milk. Seek medical attention immediately.

Section 5 Fire Fighting Measures

NFPA* HAZARD SIGNS:

Health Hazard	1	=	Materials which under fire conditions would give off irritating combustion products. (less than 1 hour exposure) Materials which on the skin could cause irritation.
Flammability Hazard	0	=	Materials that will not burn.
Reactivity Hazard	0	=	Materials which in themselves are normally stable, even under fire exposure conditions, and which are not reactive with water.
Special Hazard	OX	=	Oxidizer

***National Fire Protection Association 704**

FIRST RESPONDERS:
Wear protective gloves, boots, goggles, and respirator. In case of fire, wear positive pressure breathing apparatus. Approach incident with caution. Use 2004 Emergency Response Guidebook (U.S. DOT RSPA, TC and STC). Guide No. 140. (http://hazmat.dot.gov/pubs/erg2004/erg2004.pdf).

FLASHPOINT	None
FLAMMABLE OR EXPLOSIVE LIMITS	Lower: Nonflammable Upper: Nonflammable
EXTINGUISHING MEDIA	Use large quantities of water. Water will turn pink to purple if in contact with RemOx® L ISCO Reagent. Dike to contain. Do not use dry chemicals, CO_2Halon® or foams.
SPECIAL FIREFIGHTING PROCEDURES	If material is involved in fire, flood with water. Cool all affected containers with large quantities of water. Apply water from as far as a distance as possible. Wear self-contained breathing apparatus and full protective clothing.
UNUSUAL FIRE AND EXPLOSION	Powerful oxidizing material. May decompose spontaneously if exposed to heat (135°C/275°F). May be explosive in contact with certain other chemicals (Section 10). May react violently with finely divided and readily oxidizable substances. Increases burning rate of combustible material. May ignite wood and cloth.

Section 6 Accidental Release Measures

PERSONAL PRECAUTIONS

Personnel should wear protective clothing suitable for the task. Remove all ignition sources and incompatible materials before attempting clean up.

ENVIRONMENTAL PRECAUTIONS:

Do not flush into sanitary sewer system or surface water. If accidental release into the environment occurs, inform the responsible authorities. Keep the product away from drains, sewers, surface and ground water and soil.

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

Contain spill by collecting the liquid in a pit or holding behind a dam (sand or soil). Dilute to approximately 6% with water, and then reduce with sodium thiosulfate, a bisulfite or ferrous salt solution. The bisulfite or ferrous salt may require some dilute sulfuric acid (10% w/w) to promote reduction. Neutralize with sodium carbonate to neutral pH, if acid was used. Decant or filter and deposit sludge in approved landfill. Where permitted, the sludge may be drained into sewer with large quantities of water. To clean contaminated floors, flush with abundant quantities of water into sewer, if permitted by federal, state, and local regulations. If not, collect water and treat as above.

Section 7 Handling and Storage

WORK/HYGIENIC PRACTICES
Wash hands thoroughly with soap and water after handling RemOx® L ISCO Reagent. Do not eat, drink or smoke when working with RemOx® L ISCO Reagent . Wear proper protective equipment. Remove clothing, if it becomes contaminated.

VENTILATION REQUIREMETNS
Provide sufficient mechanical and/or local exhaust to maintain exposure below the TLV/TWA.

CONDITIONS FOR SAFE STORAGE
Store in accordance with NFPA 430 requirements for Class II oxidizers. Protect containers from physical damage. Store in a cool, dry area in closed containers. Segregate from acids, peroxides, formaldehyde, and all combustible, organic, or easily oxidizable materials including antifreeze and hydraulic fluid.

Section 8 Exposure Controls and Personal Protection

RESPIRATORY PROTECTION
In cases where overexposure to mist may occur, the use of an approved NIOSH-MSHA mist respirator or an air supplied respirator is advised. Engineering or administrative controls should be implemented to control mist.

EYE
Faceshield, goggles, or safety glasses with side shields should be worn. Provide eyewash in working area.

GLOVES
Rubber or plastic gloves should be worn.

OTHER PROTECTIVE EQUIPMENT
Normal work clothing covering arms and legs, and rubber, or plastic apron should be worn. Caution: If clothing becomes contaminated, wash off immediately. Spontaneous ignition may occur with cloth or paper.

Section 9 Physical and Chemical Properties

APPEARANCE AND ODOR	Dark purple solution, odorless
BOILING POINT, 760 mm Hg	105 °C
VAPOR PRESSURE (mm Hg)	760 mm at 105°C
SOLUBILITY IN WATER % BY SOLUTION	Miscible in all proportions
PERCENT VOLATILE BY VOLUME	61% (as water)
EVAPORATION RATE	Same as water
FREEZING POINT	-15.0 °C
SPECIFIC GRAVITY	1.36-1.39
pH	5-9
OXIDIZING PROPERTIES	Strong oxidizer. May ignite wood and cloth.
EXPLOSIVE PROPERTIES	Explosive in contact with sulfuric acid or peroxides, or

readily oxidizable substances.

Section 10 Stability and Reactivity

STABILITY	Under normal conditions, the material is stable.
CONDITIONS TO AVOID could	Contact with incompatible materials or heat (135°C / 275°F) result in violent exothermic chemical reaction.
INCOMPATIBLE MATERIALS	Acids, peroxides, formaldehyde, antifreeze, hydraulic fluids, and all combustible organic or readily oxidizable materials, including metal powders. With hydrochloric acid, toxic chlorine gas is liberated.
HAZARDOUS DECOMPOSITION PRODUCTS	When involved in a fire, liquid permanganate may form corrosive fumes.
CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION	Material is not known to polymerize.

Section 11 Toxicological Information

SODIUM PERMANGANATE: Acute oral LD_{50} not known.

1. Acute toxicity

Irritating to body tissue with which it comes into contact. No acute toxicity data is available for sodium permanganate. Toxicity is expected to be similar to that of potassium permanganate. The toxicity data for potassium permanganate is given below:

Ingestion:
LD 50 oral rat: 780 mg/kg male (14 days); 525 mg/kg female (14 days).
Harmful if swallowed. ALD: 10g. Ingestion may cause nausea, vomiting, sore throat, stomach-ache and eventually lead to a perforation of the intestine. Liver and kidney injuries may occur.

Skin contact:
LD 50 dermal no data available.
The product may be absorbed into the body through the skin. Major effects of exposure: severe irritation, brown staining of skin.

Inhalation:
LC 50 inhal. no data available.
The product may be absorbed into the body by inhalation. Major effects of exposure: respiratory disorder, cough.

2. Chronic toxicity

No known cases of chronic poisoning due to permanganates have been reported. Prolonged exposure, usually over many years, to heavy concentrations of manganese oxides in the form of dust and fumes may lead to

chronic manganese poisoning, chiefly involving the central nervous system.

3. Carcinogenicity
Sodium permanganate has not been classified as a carcinogen by ACGIH, NIOSH, OSHA, NTP, or IARC.

4. Medical Conditions Generally Aggravated by Exposure
Sodium permanganate solution will cause further irritation of tissue, open wounds, burns or mucous membranes.

Section 12 Ecological Information

Entry to the Environment
Permanganate has a low estimated lifetime in the environment, being readily converted by oxidizable materials to insoluble MnO_2.

Bioconcentration Potential
In non-reducing and non-acidic environments MnO_2 is insoluble and has a very low bioaccumulative potential.

Aquatic Toxicity
No data.

Section 13 Disposal Considerations

Waste Disposal

RemOx® L ISCO Reagent, once it becomes a waste, is considered a D001 hazardous (ignitable) waste. For disposal of RemOx® L ISCO Reagent solutions, follow procedures in Section 6 and deactivate the permanganate to insoluble manganese dioxide. Dispose of it in a permitted landfill. Contact Carus Chemical Company for additional recommendations.

Section 14 Transport Information

USA (land, D.O.T.)	**Proper Shipping Name:**	49 CFR172.101 Permanganates, inorganic, aqueous solution, n.o.s .(contains sodium permanganate
	Hazard Class:	49 CFR172.101....Oxidizer
	ID Number:	49 CFR172.101....UN 3214
	Packing Group:	49 CFR172.101....II
	Division:	49 CFR172.101....5.1
European Labeling in accordance Road/Rail Transport (ADR/RID)	**ID Number:**	UN 3214
	ADR/RID Class	5.1
	Description of Goods:	Permanganates, inorganic, aqueous solution, n.o.s (contains sodium permanganate)
	Hazard Identification No.	50
European Labeling in accordance with EC directive (Water, I.M.O.)	**Proper Shipping Name:**	Permanganates, inorganic, aqueous solution, n.o.s (contains sodium permanganate)
	Hazard Class:	Oxidizer
	ID Number:	UN 3214

	Packing Group:	II
	Division:	5.1
	Marine Pollutant:	No
European Labeling in accordance with EC directive (Air, I.C.A.O.)	**Proper Shipping Name:**	Permanganates, inorganic, aqueous solution, n.o.s (contains sodium permanganate)
	Hazard Class:	Oxidizer
	ID Number:	UN 3214
	Packing Group:	II
	Division:	5.1

Section 15 Regulatory Information (Sodium Permanganate)

TSCA	Listed in the Toxic Substances Control Act (TSCA) Chemical Substance Inventory.	
CERCLA	Not listed.	
RCRA	Oxidizers such as RemOx® L ISCO Reagent solution meet the criteria of ignitable waste. 40 CFR 261.21.	
SARA TITLE III Information		
	Section 302/303	Extremely hazardous substance: Not listed
	Section 311/312	Hazard categories: Fire, acute and chronic toxicity.
	Section 313	RemOx® L ISCO Reagent contains 40% manganese compounds as part of the chemical and is subject to the reporting requirements of Section 313 of Title III, Superfund Amendments and Reauthorization Act of 1986 and 40 CFR 372.
FOREIGN LIST	Canadian Non-Domestic Substance List, EINECS	

Section 16 Other Information

NIOSH	National Institute for Occupational Safety and Health
MSHA	Mine Safety and Health Administration
OSHA	Occupational Safety and Health Administration
NTP	National Toxicology Program
IARC	International Agency for Research on Cancer
PEL	Permissible Exposure Limit
C	Ceiling Exposure Limit
TLV-TWA	Threshold Limit Value-Time Weighted Average
CAS	Chemical Abstract Service
EINECS	Inventory of Existing Chemical Substances (European)

Chithambarathanu Pillai (S.O.F.)
January 2006

handling, and use of the product are beyond the control of Carus Chemical Company, and shall be the sole responsibility of the holder or user of the product.

APPENDIX B

SODIUM PERMANGANATE MATERIALS COMPATIBILITY CHART

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Tel 800.435.6556
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Liquid Permanganate Materials Recommendation

General Compatibility
Please refer to complete compatibility tables for more details

METAL/CERAMICS

Ductile Iron	Tungsten Carbide
Stainless Steel	Cast Iron
Carbon Steel	
Aluminum Oxide Ceramic	

PLASTICS, SEALS, DIAPHRAGMS, ELASTOMERS

HDPE	EPDM
PVC Sch. 80	Ryton
Noryl	Teflon
Hypalon	Polypropylene
Kynar	

STORAGE TANKS

Recommended Material: HDPE

Specific Gravity: 1.9

Manufacturers:	Assmann	(888) 357-3138
	Poly Processing	(866) 590-6845
	Snyder/Crown	(402) 467-5221

TRANSFER PUMPS

Recommended Material: SS, Kynar, Polypropylene

Seals / O-Rings: Teflon
EPDM

Manufacturers:	March Pumps	(847) 729-5300
	Grunfos	(800) 333-1366
	Ebara	(803) 327-5005

METERING PUMPS-SOLENOID DRIVEN

Wetted Material: Stainless Steel, PVC

Diaphragm: Teflon

Elastomers/Seals/O-Rings: EPDM

Manufacturers:	Neptune	(215) 699-8700
	LMI	(978) 263-9800

METERING PUMPS-HYDRAULIC DIAPHRAGM

Recommended Material: Stainless Steel

Diaphragm: Teflon

Elastomers/Seals/O-Rings: EPDM

Manufacturers:	Neptune	(215) 699-8700
	PulsaFeeder	(716) 292-8000

VALVES – PIPING - FLOWMETERS

Recommended Material: PVC, SS

Seals and O-Rings: EPDM

Manufacturer:	Chemtrol	(800) 343-5455
	GPI	(800)-835-0113
	+GF+ Signet	(626) 571-2770

GENERAL PRECAUTIONS

Practice good piping practices, follow manufacturers directions on surface preparation and cure times.

ALWAYS use Personal Protective Equipment (PPE).

Minimize threaded connections, when possible weld all joints or use flanges with EPDM or Teflon gaskets.