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Infrastructure, environment, buildings

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Mr. Todd Caffoe, P.E.
New York State Department of Environmental Conservation
Division of Environmental Remediation
6274 East Avon-Lima Road
Avon, New York 14414-9519

Subject:
Response to NYSDEC Supplemental Remedial Design Work Plan Addendum (June 2009) and Supplemental Final Engineering Report (March 2009) Comment Letter
Former Roehlen Engraving
NYSDEC Site #828077
Henrietta, New York

Date:
July 27, 2009

Contact:
William B. Popham

Phone:
585.385.0090

Email:
bill.popham@arcadis-us.com

Our ref:
B0083317.0000

Dear Mr. Caffoe:

On behalf of Standex International Corporation (Standex), ARCADIS has prepared this letter in response to your comment letter dated July 15, 2009 regarding the *Supplemental Remedial Design Work Plan Addendum* (SRD Work Plan Addendum), previously submitted on June 11, 2009, and the *Supplemental Final Engineering Report,* dated March 10, 2009, for the former Roehlen Engraving site located in Henrietta, New York.

The New York State Department of Environmental Conservation's (NYSDEC's) comments are included in this letter and are in italics, with Standex's responses presented at the end of each comment. The SRD Work Plan Addendum (Revised July 2009) is enclosed and includes revisions to the SRD Work Plan Addendum in accordance with Standex's responses below.

NYSDEC Comment #1:

Consideration must be given as to the source of contamination that has caused the localized groundwater contamination in the former chrome plating pit area. If there is a residual source outside the area of excavation, then there is a potential for a rebound of Cr^{+6} contamination in the groundwater. There must be provisions for more than one round of follow-up monitoring and additional molasses injection if concentrations of Cr^{+6} in groundwater significantly rebound. Quarterly sampling for chromium (Cr^{+6} and Cr^{+3}) and redox parameters is recommended for at least one year. Further sampling or injection can be evaluated thereafter.

Standex Response #1:

The post-injection monitoring will include sampling at approximately 1 month following the injection, with three subsequent monitoring events (Month 4, Month 8, and Month 12) and analysis for chromium (Cr^{+6} and Cr^{+3}) and oxidation reduction parameters. Additional monitoring events will be performed, if necessary, based on the results of the previous sampling events. The need for additional injection events will be evaluated based on the post-injection monitoring data.

NYSDEC Comment #2:

Furthermore, injection outside the excavation foot print should be considered. Either installation of an additional injection well outside of the excavation area or modification of the proposed shallow injection well to deeper injection well with a screened interval within the native soil and backfill should be evaluated.

Standex Response #2:

Historical groundwater monitoring data presented in the SRD Work Plan Addendum (Revised July 2009), *Supplemental Final Engineering Report*, and site monitoring reports do not indicate that the chromium plume extends significantly beyond the former excavation area limits and the proposed injections have been designed accordingly. The injections have been designed to maintain reducing conditions for an extended timeframe to achieve as robust a treatment effect as practicable. Persistence of the carbon substrate will support treatment of any residual Cr^{+6} within the tighter soil formation surrounding the former excavation area by allowing carbon substrate to penetrate/diffuse into it. Injections beyond the proposed treatment area, if necessary, will be evaluated if post-injection monitoring data indicates it should be considered to achieve remedial objectives.

In a recent telephone conversation with the NYSDEC, ARCADIS agreed to have a portion of the screened section of the two proposed injection wells to be advanced into the native soil below the imported backfill. The design of the two proposed injection wells have been revised such that the screened section of each well will be advanced approximately 2 feet into the native soil. This will be confirmed by obtaining soil samples and observing the recovered soil cores. Figure 3 of the enclosed SRD Work Plan Addendum (Revised July 2009) shows the injection well revisions.

NYSDEC Comment #3:

Since the completion of the 2008 soil removal action, soil vapor sampling has not been conducted due to high water table conditions. Soil vapor sampling is still required to determine if there is a soil vapor issue on-site. Please provide a schedule for soil vapor sampling.

Standex Response #3:

A high groundwater table has prevented the collection of soil vapor samples. The groundwater table will be monitored periodically and soil vapor sampling scheduled when the groundwater elevations permit. Notice will be given to the NYSDEC as soon as possible once the soil vapor sampling event has been scheduled. It is anticipated that drier conditions will occur within the next several weeks.

NYSDEC Comment #4:

Please include provisions to secure the molasses tank on-site to prevent vandalism.

Standex Response #4:

A temporary chain-link fence will be installed and secured around the on-site tank to be used during the proposed injections.

NYSDEC Comment #5:

Please include a contingency for odor control after injection of the molasses should site conditions cause excessive gassing of fermentation byproducts.

Standex Response #5:

Odor generation was evaluated during the design of the injections and it is anticipated that any odor generation will not be a concern due to the lack of any sensitive receptors. Odors related to fermenting molasses (the proposed carbon substrate to be injected) are the result of volatile fatty acids. Odors caused by this process could be a concern if the solution is at the land surface, and given the outdoor setting will still likely not be an issue.

NYSDEC Comment #6:

Please provide the basis that was used for dosing (concentration and volume) of the molasses injection.

Standex Response #6:

The required volume was determined by the porosity of the fill material, the vertical thickness of the backfill area where impacts were observed, and the anticipated lateral extent of solution distribution in the target area. Based on these parameters and the perceived injectability of the permeable backfill, a total volume of approximately 4,800 gallons and 1,000 gallons will be injected into the deeper (near MW-26) and shallower (near TW-4) wells, respectively. Organic carbon dosing was determined based on a desire to maintain reducing conditions for an extended timeframe to achieve as robust a treatment effect as practicable. A 5 percent solution of organic carbon will yield about 7,000 parts per million (ppm) total organic carbon; orders of magnitude more than we need to treat the few ppm of Cr^{+6} currently observed in the groundwater. These concentrations are well above the required stoichiometric ratio for Cr^{+6} treatment; excess concentrations will migrate with ambient groundwater flux and will provide additional treatment of any residual Cr^{+6} existing within the lower permeability, native soils surrounding the former excavation area.

NYSDEC Comment #7:

The final results of the injection and soil vapor study must be included in a final engineering report. The Supplemental Final Engineering Report (dated March 2009) must be revised to include these results and include a certification by a licensed New York State Professional Engineer.

Standex Response #7:

The results of the implementation of the SRD Work Plan Addendum (Revised July 2009) and the soil vapor sampling will be included in a Supplemental Final Engineering Report Addendum, which will include a certification by a licensed New York State Professional Engineer.

As discussed, Standex is moving forward with pre-mobilization activities to implement the SRD Work Plan Addendum (Revised July 2009) and is prepared to conduct the field activities once your approval of the SRD Work Plan Addendum is received. At this time, it is anticipated that the two new injection wells and the new shallow monitoring well will be installed on August 3, 2009, with injection of the molasses scheduled for August 10, 2009. Please contact me at 585.385.0090, ext. 22 if you have any questions or concerns.

Sincerely,

ARCADIS

William B. Popham
Vice President

Copies:
Ms. Stacey Constas, Standex International Corporation
Mr. David Kingsley, ARCADIS

ARCADIS

Supplemental Remedial Design Work Plan Addendum (Revised July 2009)

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Mr. Todd Caffoe
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Division of Environmental Remediation, Region 8
6274 East Avon-Lima Road
Avon, New York 14414-8696

Subject:
Supplemental Remedial Design Work Plan Addendum (Revised July 2009)
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Date:
July 27, 2009

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Dear Mr. Caffoe:

On behalf of Standex International Corporation (Standex), ARCADIS is submitting this *Revised Supplemental Remedial Design Work Plan Addendum* (Revised SRD Work Plan Addendum) to conduct in-situ treatment of residual aqueous concentrations of hexavalent chromium present near monitoring well MW-26 at the former Roehlen Engraving facility located in Henrietta, New York (site).

In November 2008, Standex implemented the soil and concrete excavation and off-site disposal activities proposed in the New York State Department of Environmental Conservation- (NYSDEC-) approved *Supplemental Remedial Design Work Plan* (SRD Work Plan) (ARCADIS, 2008). The excavation activities included the removal of approximately 1,900 tons of soil and 424 tons of concrete for off-site disposal from the area of the former chrome plating room. Excavation activities were discontinued when post-excavation soil sample analyses indicated that the soil cleanup objectives for chromium were achieved. The excavation was backfilled and compacted with clean imported fill. The *Supplemental Final Engineering Report* (ARCADIS, 2009), submitted to the NYSDEC on March 10, 2009, provided details of the soil removal, soil sampling and analysis, and backfilling activities, as well as pre-excavation groundwater sampling concentrations and monitoring well decommissioning activities.

Monitoring well installation and groundwater sampling and analysis proposed in the SRD Work Plan (ARCADIS, 2008) was completed on February 24, 2009. Based on elevated chromium results, additional groundwater sampling and analysis events were completed on March 16, 2009 and from April 29 through May 1, 2009.

Depth to groundwater measurements obtained during these sampling events from the wells indicated that groundwater recharge and/or surface-water infiltration and groundwater flow into the backfilled former 2008 excavation area has resulted in the saturation of the excavation area and the dissolution of residual hexavalent chromium to groundwater within two distinct areas of the former excavation area.

As demonstrated by previous groundwater sampling events, the native site soil lithologies (primarily clay) surrounding the excavated area act as semiconfining features that restrict groundwater flux through the excavation area and are preventing any migration of concentrations of dissolved hexavalent chromium that exceed groundwater standards beyond the limits of the former 2008 excavation. This is additionally supported by the most recent hexavalent chromium concentrations at monitoring wells MW-4 (not detected), MW-18 (not detected), and RW-2 (not detected). Figure 1 of this Revised SRD Work Plan Addendum includes the groundwater analytical results for the April 29 through May 1, 2009 sampling event.

Groundwater samples were collected between April 29 through May 1, 2009 from existing monitoring wells MW-4, MW-18, MW-26, RW-2, and temporary wells TW-1 through TW-5 and TW-7 through TW-12 (TW-6 yielded insufficient groundwater volume for sampling) and were analyzed for trivalent and hexavalent chromium. These results indicated that trivalent and hexavalent chromium concentrations were above their applicable groundwater standard (50 micrograms per liter [µg/L]) at MW-26 (trivalent chromium, 1,300 µg/L; hexavalent chromium, 2,400 µg/L) and TW-4 (trivalent chromium 280, µg/L; hexavalent chromium, 3,500 µg/L).

To address these residual dissolved-phase concentrations, in-situ anaerobic bioprecipitation via the injection of a dilute organic carbon solution is proposed to promote the development of reducing conditions and facilitate the removal of hexavalent chromium in groundwater to achieve closure of the site.

This Revised SRD Work Plan Addendum includes a summary of the overall technical approach and discussion of the treatment logistics and monitoring activities to confirm overall remedial effectiveness via the in-situ technology referenced above.

Technical Summary

In-situ anaerobic bioprecipitation is facilitated via the stimulation of native microorganisms through the delivery of a degradable organic carbon source. The goal of this process is to overcome the aquifer's supply of aerobic electron acceptors (primarily oxygen and nitrate) to reach iron- and sulfate-reducing conditions. In this environment, microorganisms support the reduction of hexavalent chromium by a variety of mechanisms. These include enzymatic extracellular and intracellular reductions (Zhu et al., 2008), as well as direct reduction with naturally occurring iron and sulfate (by microbial respiration) that generate ferrous iron and sulfides (H_2S, HS^-). These compounds subsequently react abiotically with hexavalent chromium, reduce it to trivalent chromium, and form low-solubility trivalent chromium hydroxide solids via the following reactions at neutral pH values:

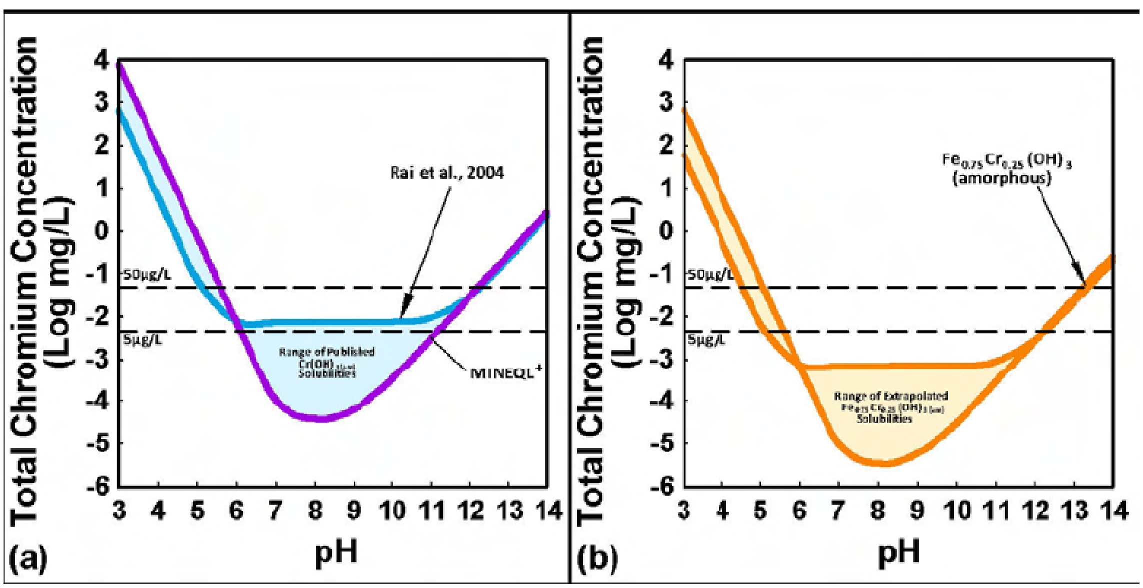
1. $2CrO_4^{2-} + 3HS^{-} + 7H^{+} \rightarrow 2Cr(OH)_{3(s)} + 3S^{0}_{(s)} + 2H_2O$

2. $CrO_4^{-} + 3Fe^{2+} + 8H_2O \rightarrow Cr(OH)_{3(s)} + 3Fe(OH)_{3(s)} + 4H^{+}$

In addition, hexavalent chromium also reacts with ferrous iron to form a mixed iron-chromium hydroxide that is considerably less soluble and more stable than pure chromium hydroxide (Sass and Rai, 1987; Eary and Rai, 1988) via the following reaction:

3. $CrO_4^{2-} + 3Fe^{2+} + 8H_2O \rightarrow 4Fe_{0.75}Cr_{0.25}(OH)_{3(s)} + 4H^{+}$

This remedial process is designed to reductively precipitate and permanently fix/immobilize the chromium in the aquifer, thereby removing chromium from the groundwater. The figure below depicts theoretical solubility curves for both pure trivalent chromium hydroxide and mixed iron/trivalent chromium hydroxide minerals. This figure was prepared based on published solubility constants for pure amorphous



trivalent chromium hydroxide and mixed iron-trivalent chromium hydroxides (Sass and Rai, 1987), and demonstrates that it is possible to achieve total chromium concentrations at or approaching the cleanup goal for the site (50 µg/L) via anaerobic bioprecipitation. This is corroborated by performance data at numerous full-scale remediation sites. For reference, groundwater pH at the site is in the rage of 7 to 8 standard units.

While the kinetics of hexavalent chromium reduction are rapid (near instantaneous) in typical groundwater environments, the same is not true of trivalent chromium oxidation. There are only a few oxidants present in natural systems that are known to be capable of oxidizing trivalent chromium to hexavalent chromium (oxygen and manganese oxide minerals), but neither is expected to be relevant. In general, hexavalent chromium that has been reductively precipitated in-situ will be stable over the long-term under ambient geochemical environments, such as those exhibited at the site. Furthermore, the low-permeability of native soils surrounding the excavation area limits overall mobility and result in negligible long-term risks associated with precipitated hexavalent chromium.

Injection Approach

Based on the discussion presented above, organic carbon injections will be used to establish reducing conditions within the former chrome pit area. Developing reducing conditions following the injection event will result in the reduction of hexavalent chromium in groundwater. In addition, the reducing conditions established within the groundwater in the excavation backfill will permeate into the surrounding clays, and will address residual sources of hexavalent chromium surrounding the treatment area.

Targeted organic carbon delivery will be facilitated via reusable injection well locations installed in the areas targeted for organic carbon injections (i.e., MW-26 and TW-4). Analyses completed on the groundwater samples collected during the April 29 through May 1, 2009 sampling event indicated that hexavalent chromium concentrations of 2,400 µg/L and 3,500 µg/L were observed at monitoring well MW-26 and temporary well TW-4, respectively. The results of the remaining groundwater samples collected during this event indicate that hexavalent chromium concentrations exceeding groundwater standards are not present throughout the former excavation area, and are only present at two distinct, limited locations (i.e., within the deeper zone of the excavation within the immediate area of MW-26 and also within the shallow zone of the former excavation within the immediate area of TW-4). Accordingly, injection well locations and screened intervals have been proposed to deliver organic carbon across each of these areas to stimulate the bioprecipitation process (Figures 2 and 3).

The proposed injection wells will be completed with 6-inch-diameter polyvinyl chloride (PVC) casing and stainless steel wire-wrapped screens. Each of the two injection wells will be completed to a depth of approximately 2 feet below the bottom of the former excavation at their respective locations, which is approximately 20 feet below ground surface (bgs) in the vicinity of MW-26 (IW-1), and approximately 9 feet bgs near TW-4 (IW-2). Injection well IW-1 will be screened over a 7-foot vertical interval between 13 feet bgs and 20 feet bgs, and injection well IW-2 will be screened between 2 feet bgs and 9 feet bgs to allow distribution of organic carbon across the impacted vertical intervals and into the surficial native soils. Following installation, each of the wells will be developed to confirm maximum hydraulic communication with the surrounding formation. In addition, one additional monitoring well will be installed adjacent to IW-2 to evaluate chromium concentrations in the shallow zone following injection. Well construction will include 2-inch PVC casing and 2-inch PVC slotted screen, and will be screened over a 7-foot interval between 2 and 9 feet bgs.

ARCADIS will containerize and dispose off site of all liquid investigation-derived wastes generated during this process. Based on the proposed locations and depths of the wells, drill cuttings from the well installations will consist of only the clean imported fill used to backfill the excavation. Therefore, it is proposed that this material remain on site and be blended in at the surface with the existing imported fill near the respective well locations.

Following installation and development of the new wells, a substrate injection will be performed. It is anticipated that up to 4,800 gallons of solution will be delivered at injection well IW-1, and approximately 1,000 gallons of solution will be delivered at injection well IW-2. These volumes were estimated based on the magnitude of vertical thickness and the desired lateral treatment influence. Given the relatively shallow groundwater depth (approximately 1 foot bgs), the injection flow rates will be managed during delivery to confirm that groundwater does not mound and flood the treatment area. Thus, at a sustained injection rate of approximately 1 gallon per minute, injecting 24 hours per day, it will take approximately 3 days to effectively deliver the proposed organic carbon volumes.

Prior to the injection event, a 5 percent molasses solution (by volume) will be delivered to the site and temporarily stored in a high-density polyetheylene holding tank within the treatment area. A temporary chain-link fence will be installed surrounding the tank for security purposes. As shown on Figure 3, the concentrated molasses solution will be pumped from the on-site holding tank via a manifold system to each of the injection wells simultaneously. The manifold system will allow for flow adjustments, wellhead pressure measurements, and full injection control. Well delivery from the manifold will occur via rubber hosing equipped with quick connect fittings. The staging area for the holding tank(s) will be located directly south of the excavation area.

To allow for evaluation of the bioprecipitation remedy, post-remedial monitoring is proposed following the injection to evaluate chromium concentrations in groundwater and to confirm overall treatment effectiveness. Samples will be collected from each of the injection wells, monitoring well MW-26, and the new shallow monitoring well to evaluate total organic carbon, total and dissolved iron, total chromium, hexavalent chromium concentrations, and oxidation reduction parameters. The first event will be conducted approximately 1 month following the injection, with three subsequent monitoring events (Month 4, Month 8, and Month 12). Additional monitoring events, if required, will be performed based on previous sampling results. Based on the data, the need for additional injections will be evaluated and proposed to the NYSDEC, if necessary.

After the work described in this work plan has been completed, the results of the implementation of this Revised SRD Work Plan Addendum will be included in a Supplemental Final Engineering Report Addendum, which will include a certification by a licensed New York State Professional Engineer and submitted to the NYSDEC.

Schedule

Following approval of this Revised SRD Work Plan Addendum, ARCADIS will immediately schedule the installation of the two injection wells and one new monitoring location (approximately 1 week). Injection activities are anticipated to be conducted approximately 1 week after the wells have been installed and developed. As stated earlier, the initial post-remedial sampling event will be conducted approximately 1 month after completion of the organic carbon injection, with subsequent sampling events at Month 4, Month 8, and Month 12.

As discussed, due to the intended redevelopment plans for this site, your immediate attention/approval is greatly appreciated. If you have any questions, please contact me at 585.385.0090, ext. 22.

Sincerely,

ARCADIS

William B. Popham
Vice President

Copies:
Ms. Stacey Constas, Standex International Corporation
Mr. Mark B. Hanish, ARCADIS
Mr. David Kingsley, ARCADIS
Mr. Cullen Flanders, ARCADIS
Mr. John Horst, ARCADIS

References

ARCADIS. 2009. *Supplemental Final Engineering Report*. March.

ARCADIS. 2008. *Supplemental Remedial Design Work Plan*. Revised September.

Eary, L. E., and Rai, D. 1988. “Chromate Removal from Aqueous Wastes by Reduction with Ferrous Ion.” Environ. Sci. Technol., Vol 22, pp 972-977.

Sass, B. M., and Rai, D. 1987. “Solubility of Amorphous Chromium(III)-Iron(III) Hydroxide Solid Solutions.” Inorg. Chem., Vol 26, pp 2228-2232.

Zhu, Wenjie, Zhihui Yang, Zemin Ma, and Liyuan Chai. 2008 “Reduction of High Concentrations of Chromate by Leucobacter sp.CRB1 Isolated from Changsha, China”. World J Microbiol Biotechnol, Vol 24, pp 991-996.

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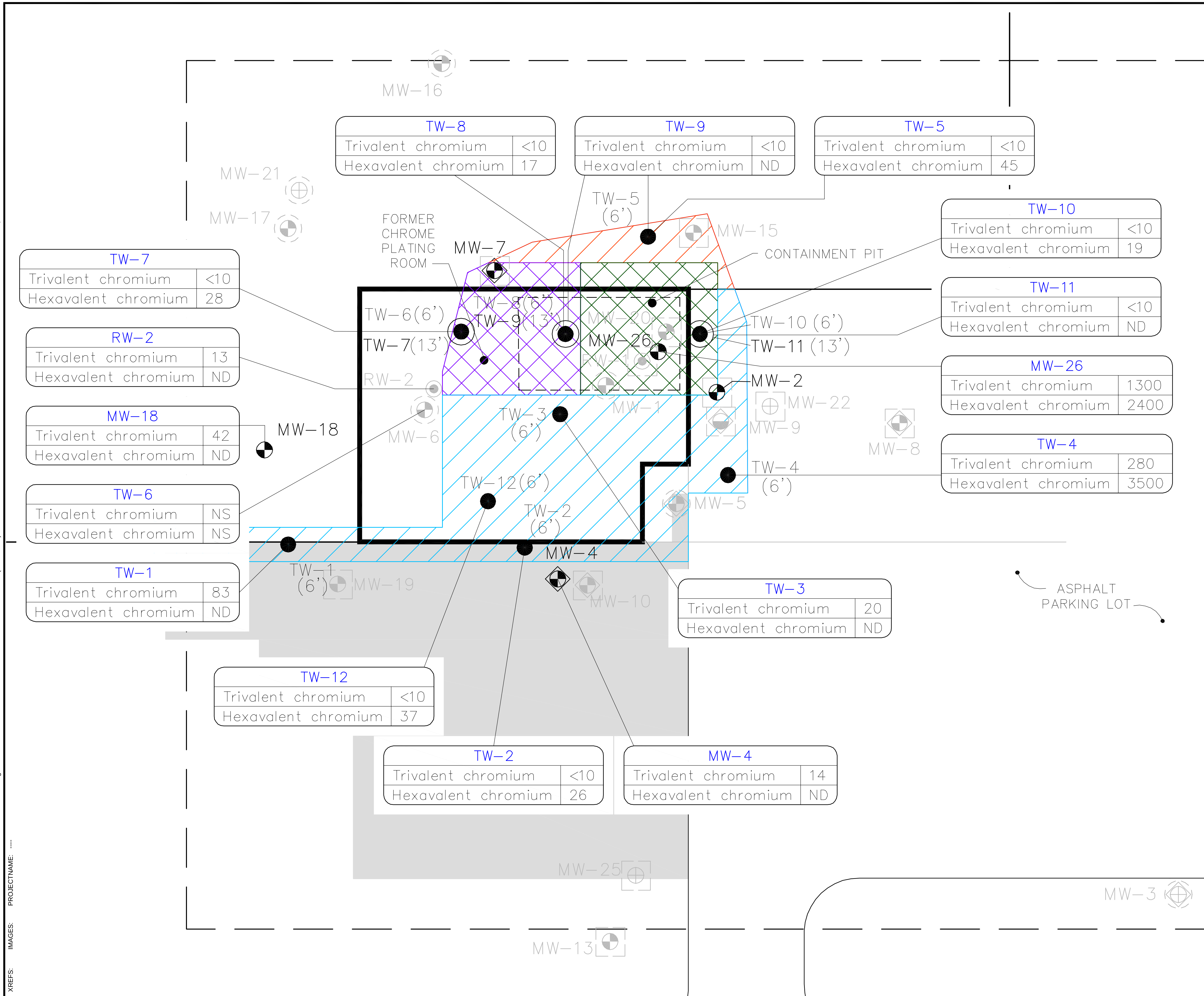
Figures



LEGEND:

- FORMER CONTAINMENT PIT
- LIMITS OF 1995 EXCAVATION
- WEST SHALLOW EXCAVATION (6 FEET)
- EAST SHALLOW EXCAVATION (7 FEET)
- NORTH PORTION OF CONTAINMENT PIT EXCAVATION (13 FEET)
- SOUTH PORTION OF CONTAINMENT PIT EXCAVATION (18 FEET)
- APPROXIMATE LIMIT OF WORK
- LACUSTRINE MONITORING WELL LOCATION
- TILL MONITORING WELL LOCATION
- BEDROCK MONITORING WELL LOCATION
- GROUND-WATER EXTRACTION WELL LOCATION
- MONITORING WELL INSTALLED BY OTHERS
- DESTROYED MONITORING WELL
- DECOMMISIONED MONITORING WELL
- 6 FOOT DEEP TEMPORARY WELL SAMPLED IN APRIL 2009
- 13 FOOT DEEP TEMPORARY WELL

NOTES:

1. FORMER ROEHLEN ENGRAVING BUILDING DEMOLISHED IN APRIL/MAY 2008.
2. DESTROYED MONITORING WELLS WERE DAMAGED DURING THE DEMOLITION ACTIVITIES, AND COULD NOT BE RELOCATED.
3. DECOMMISSIONED MONITORING WELLS WERE DECOMMISSIONED IN ACCORDANCE WITH THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION'S GROUNDWATER MONITORING WELL DECOMMISSIONING PROCEDURES.
4. ALL CONCENTRATIONS ARE IN MICROGRAMS/LITER.
5. ND – NOT DETECTED
6. NS – NOT SAMPLED–INSUFFICIENT VOLUME FROM WELL.

0 20' 40'

GRAPHIC SCALE

STANDEX INTERNATIONAL CORPORATION
FORMER ROEHLEN ENGRAVING SITE
HENRIETTA, NEW YORK

APRIL 29 - MAY 1, 2009 GROUNDWATER SAMPLING CONCENTRATIONS

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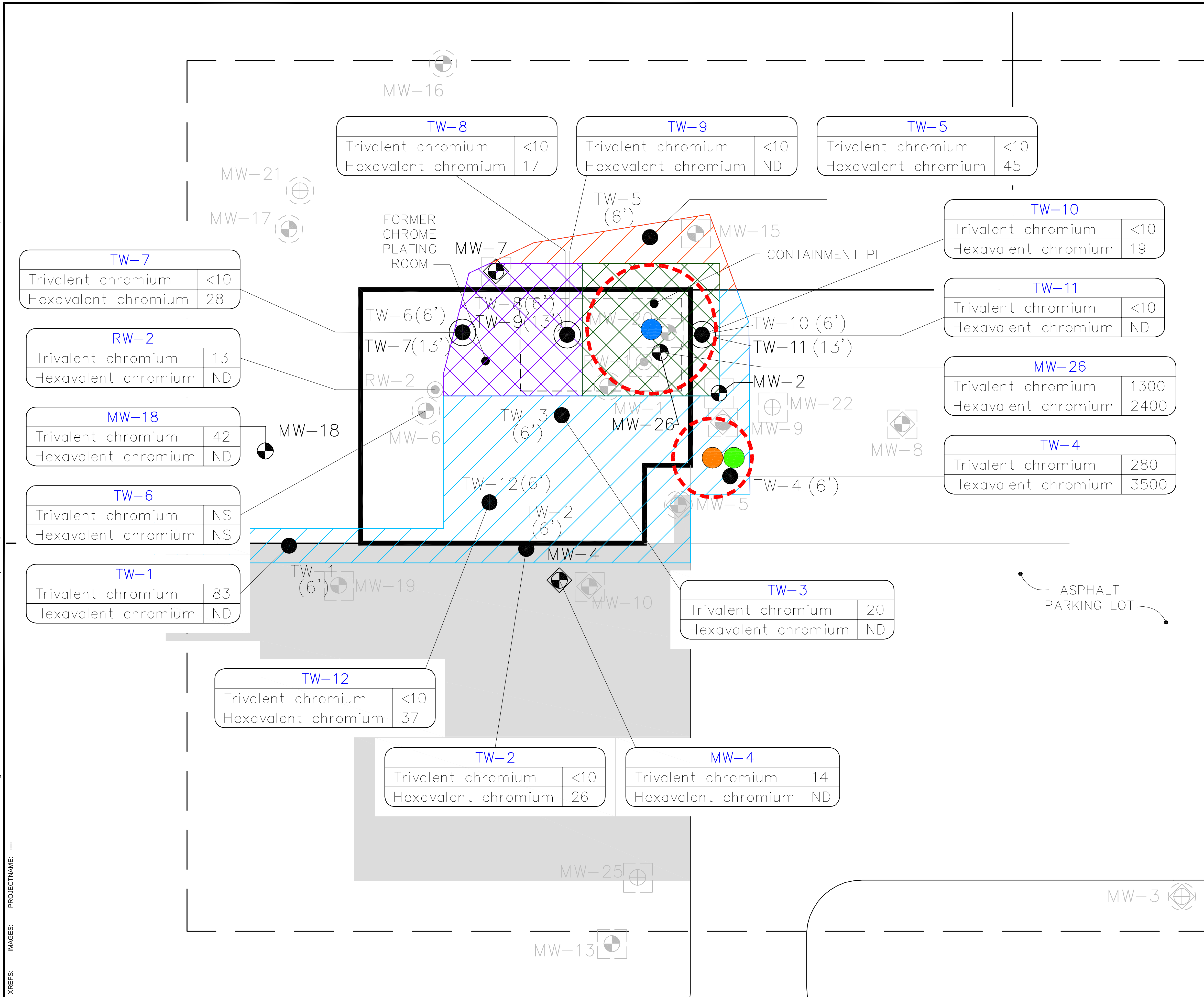
FIGURE **1**



LEGEND:

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- DESTROYED MONITORING WELL
- DECOMMISIONED MONITORING WELL
- 6 FOOT DEEP TEMPORARY WELL SAMPLED IN APRIL 2009
- 13 FOOT DEEP TEMPORARY WELL
- PROPOSED DEEP INJECTION WELL
- PROPOSED SHALLOW INJECTION WELL
- NEW MONITORING WELL
- ESTIMATE RADIUS OF INFLUENCE FROM WELL

NOTES:

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2. DESTROYED MONITORING WELLS WERE DAMAGED DURING THE DEMOLITION ACTIVITIES, AND COULD NOT BE RELOCATED.
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4. ALL CONCENTRATIONS ARE IN MICROGRAMS/LITER.
5. ND – NOT DETECTED
6. NS – NOT SAMPLED–INSUFFICIENT VOLUME FROM WELL.

0 20' 40'

GRAPHIC SCALE

STANDEX INTERNATIONAL CORPORATION
FORMER ROEHLEN ENGRAVING SITE
HENRIETTA, NEW YORK

PROPOSED INJECTION AND MONITORING WELLS

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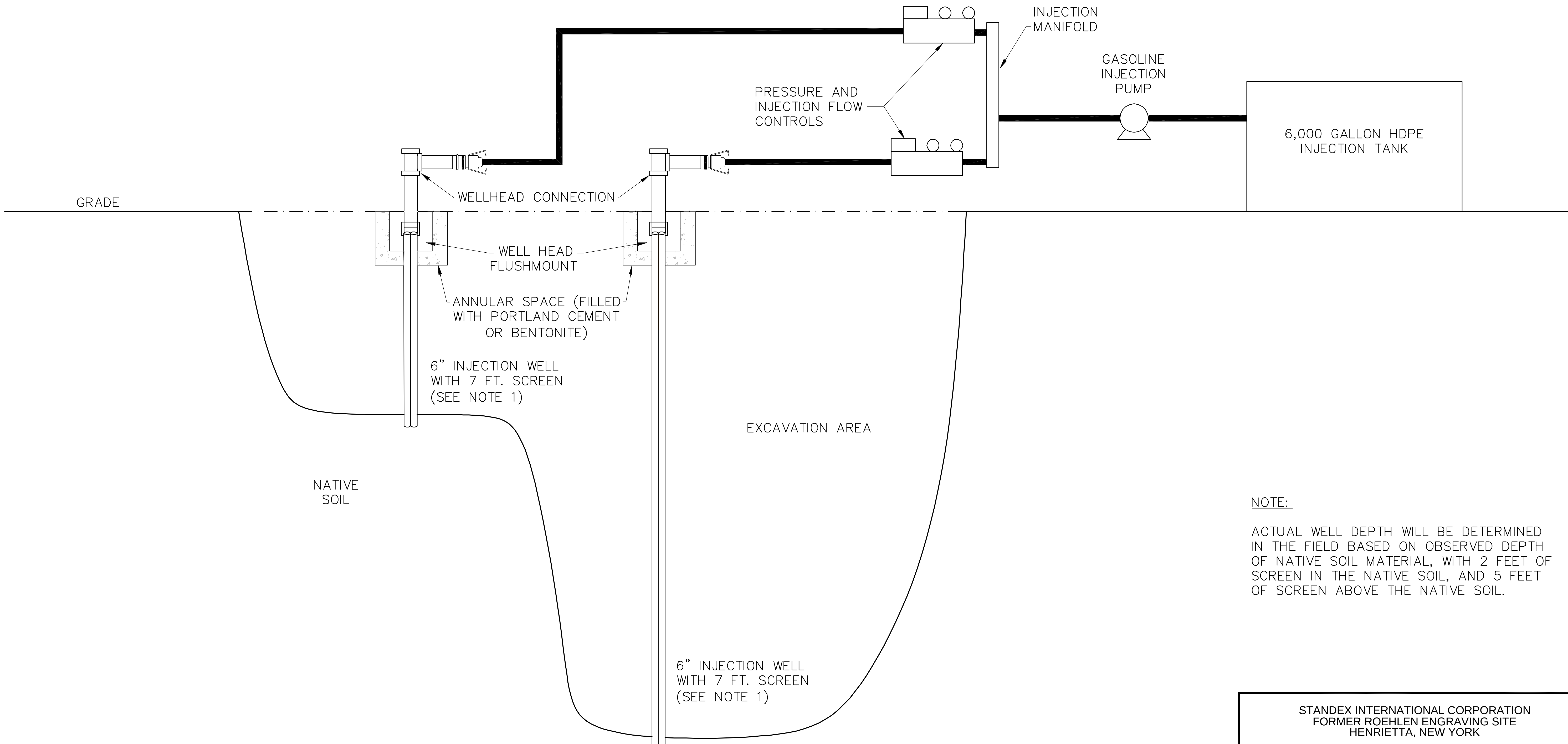
FIGURE 2



NOTE:

ACTUAL WELL DEPTH WILL BE DETERMINED IN THE FIELD BASED ON OBSERVED DEPTH OF NATIVE SOIL MATERIAL, WITH 2 FEET OF SCREEN IN THE NATIVE SOIL, AND 5 FEET OF SCREEN ABOVE THE NATIVE SOIL.

NOT TO SCALE

STANDEX INTERNATIONAL CORPORATION
FORMER ROEHLEN ENGRAVING SITE
HENRIETTA, NEW YORK

PROCESS FLOW DIAGRAM
INJECTION INFRASTRUCTURE

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FIGURE
3