LINDE FUSRAP SITE REMEDIATION, CHALLENGES AND SOLUTIONS OF REMEDIAL ACTIVITES ON AN ACTIVE INDUSTRIAL FACILITY

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ABSTRACT

The Linde FUSRAP site is centered in Tonawanda, New York at a major research and development facility for Praxair, Inc. In addition to the Praxair facility, Niagara Mohawk Power Corporation, Inc. (NMPC), CSX Transportation (CSX) and small business owners have been affected by this remedial action. Due to the unique use of each property many challenging engineering and operational issues have been encountered and overcome during the remedial action of the Linde FUSRAP site.

A major factor in conducting the remedial action at the Linde site has been ensuring that the remedial activities do not severely impact the business operations of the affected properties. The U.S. Army Corps of Engineers – Buffalo District (USACE) and Shaw Environmental, Inc. (Shaw) have been required to maintain a high degree of communication and coordination with the multiple property owners and site representatives in order to limit the impact to site operations. Examples of the infrastructure removed and/or relocated include buildings, utility tunnels, storm and sanitary sewers, laboratory gas systems, primary electrical distribution, fire suppression, and municipal water supplies.

As remedial actions progress, proper planning and scheduling increase in importance due to the presences of critical infrastructure in the remaining areas requiring remediation. This infrastructure includes sanitary and storm sewers, a main laboratory gas area, and a structurally deteriorated utility tunnel. The continued emphasis on communication and advanced planning will allow for the safe and successful completion of the project.

INTRODUCTION

The Linde site is located in the Town of Tonawanda, a suburb north of Buffalo, New York. The site is an industrial complex owned and operated by Praxair, Inc. (Praxair) that serves as their worldwide research and development facility locally employing over 1,400 personnel. The Praxair property encompasses approximately 135 acres; it is surrounded by a residential neighborhood, a public park and golf course, railroad tracks and other commercial properties. Commercial and industrial activities have been conducted at the Linde site since the 1930s.

During much of the 1940s, the former Linde Air Products Division of Union Carbide Industrial Gas processed uranium ores under contract with the Manhattan Engineer District (MED). Linde was selected to support the MED program because of its experience in processing uranium to produce salts used to color ceramic glazes. The related activities under the MED contract used a three-phase process for separation of uranium dioxide from uranium ores and tailings, and for conversion of uranium dioxide to uranium tetrafluoride. This resulted in elevated levels of radionuclides in portions of the property and several buildings. The principal radionuclides of concern are uranium, thorium, and radium.

The Formerly Utilized Sites Remedial Action Program (FUSRAP) was initiated by the federal government in 1974 to identify, investigate, and clean up or control sites throughout the United States that were part of the early atomic energy program. Under its authority for FUSRAP, the U.S. Department of Energy (DOE) conducted several characterization studies at the Tonawanda Sites between 1978 and 1992 that formed the basis for future actions at the Linde property.

In 1997 the Energy and Water Development Appropriation Act, PL 105-62, transferred responsibility for the administration and execution of FUSRAP from DOE to the USACE was signed into law.

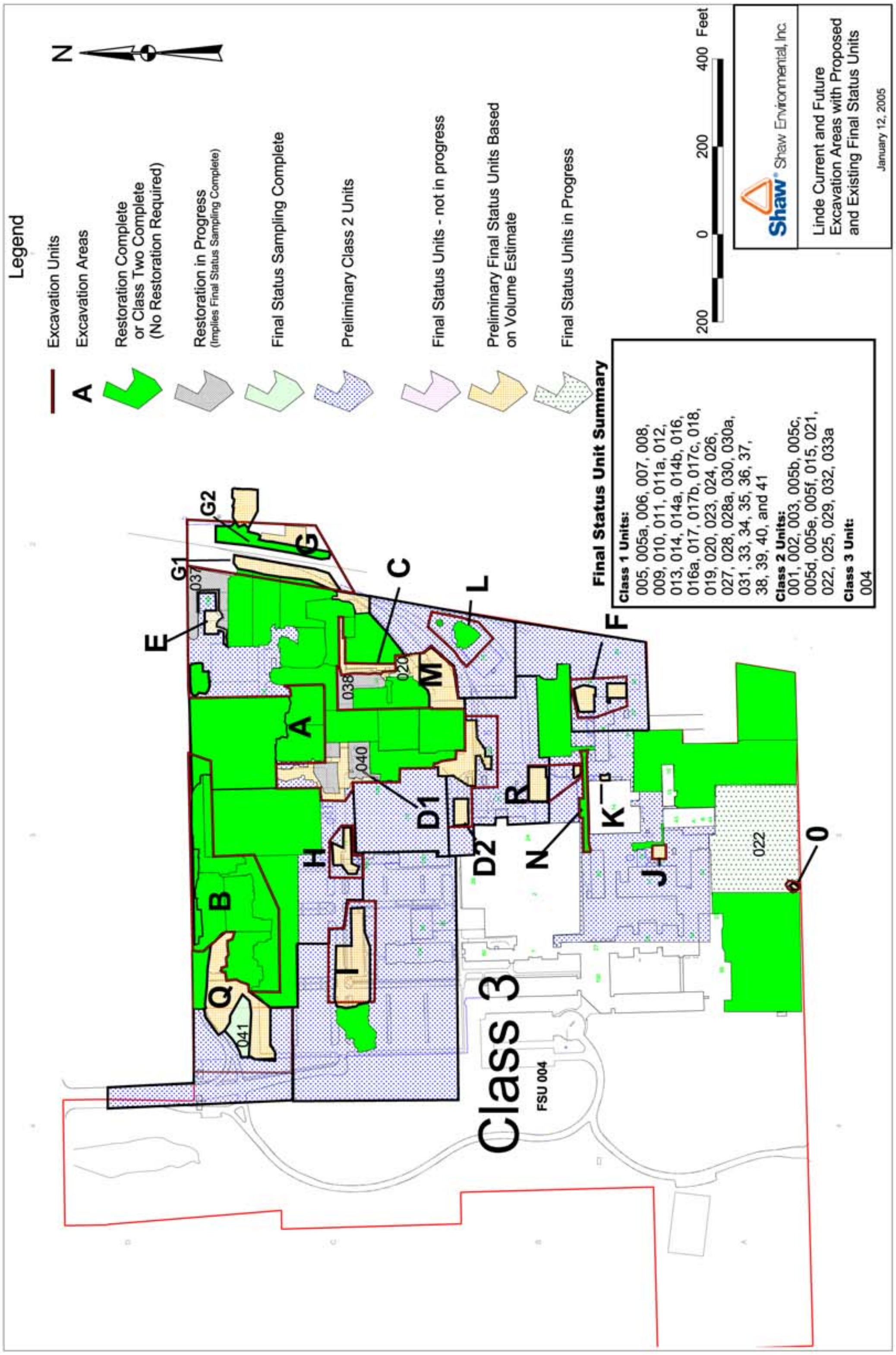
Shaw is designated as the Remedial Action Contractor for the Linde Site. A Record of Decision (ROD) for the site was issued in March 2000, and work began immediately thereafter. To date over 190,000 tons of material have been removed from the Linde site. Current volume forecasts indicate that over 40,000 tons of material remains to be excavated and disposed of.

The Linde site has been divided into separate areas in order to schedule various tasks and track progress (see Figure). This paper deals with some of the aspects of the remedial action at the Linde site and outlines how effective communication and cooperation have enabled the USACE and Shaw to overcome operational challenges and continue successful remediation.

Excavation Area N

Excavation Area N is located on the southern portion of the Praxair property and is bordered on the north by Building 2 and the specialty gas area, the south by Building 14, the west by Building 62 and the east by Building 8 and Building 104 (the new powerhouse). This remedial action was begun for two reasons, to remove contaminated material north of Building 14 and to relocate the utility tunnel beneath Building 14. This tunnel required relocation in order to facilitate the dismantlement of Building 14 and the original utility tunnel scheduled for the spring of 2004.

The final alignment of the new utility tunnel was selected during discussions between USACE, Praxair and Shaw personnel. The location selected effectively isolated the Building 14 utility tunnel by connecting to the existing tunnel system to the east and west


Legend
Excavation Units
Excavation Areas
Restoration Complete or Class Two Complete (No Restoration Required)
Restoration in Progress (Implies Final Status Sampling Complete)
Final Status Sampling Complete
Preliminary Class 2 Units
Final Status Units - not in progress
Preliminary Final Status Units Based on Volume Estimate
Final Status Units in Progress
N
0
200
400 Feet
Shaw Shaw Environmental, Inc.
Linde Current and Future Excavation Areas with Proposed and Existing Final Status Units
January 12, 2005
Final Status Unit Summary
Class 1 Units:
005, 005a, 006, 007, 008, 009, 010, 011, 011a, 012, 013, 014, 014a, 014b, 016, 016a, 017, 017b, 017c, 018, 019, 020, 023, 024, 026, 027, 028, 028a, 030, 030a, 031, 33, 34, 35, 36, 37, 38, 39, 40, and 41
Class 2 Units:
001, 002, 003, 005b, 005c, 005d, 005e, 005f, 015, 021, 022, 025, 029, 032, 033a
Class 3 Unit:
004
Class 3
FSU 004
A
B
C
D1
D2
E
F
G
G1
G2
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022
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of the building. This location proved to be not only the shortest route for by-passing the original tunnel but also provided the least amount of disturbance to Praxair operations.

The design of the new utility tunnel was completed by a multi-disciplinary team of Shaw engineers and Praxair personnel. The team selected reinforced concrete culvert piping as the media to create the tunnel and cast-in-place junction boxes to connect to the existing system. These junction boxes were designed to be wider and higher then the box culverts to allow room for required piping configurations. Pre-cast and cast-in-place sections were designed for HS-20 loading as designated by the New York State Department of Transportation.

The first step in the excavation design was clearing the excavation footprint of all known utilities. Utility searches conducted by Shaw and Praxair personnel verified a number of utility services in the chosen corridor. The utilities contained in the corridor consisted of nitrogen supply, laboratory gases, natural gas, and storm sewers. In addition to identifying utilities, the search identified an abandoned rail siding adjacent to Building 14. Luckily, the storm sewer was located at a depth greater than the new tunnel and was not expected to be impacted during excavation activities. The natural gas was not used on a regular basis and could be abandoned. The challenge therefore, was relocation of the nitrogen and specialty gas services.

By working in tandem with Praxair personnel and subcontractors, Shaw was able to relocate the existing nitrogen service and specialty gas services. The nitrogen supply tank was relocated to a centralized location and in the process consolidated Praxair's nitrogen system, alleviating the need for additional nitrogen piping in the new tunnel. An additional benefit to this relocation was that the new tank was sized large enough for another station to be removed from service allowing remediation to continue in another area of the site.

The specialty gas services proved to be a highly sensitive issue, as this site is the center for Praxair's research and development. Round the clock experiments are conducted in these laboratories, for potentially extensive durations. Interruptions in service or fluctuations in pressure could render months worth of experimental data useless. The services requiring relocation included helium, carbon dioxide, carbon monoxide, hydrogen, and methane. These services originated in the specialty gas area and crossed Building 14 to service various laboratories on the south side of the site.

An alternate route was needed that would not interfere with the existing system until the scheduled shut down. The new alignment was developed through discussions between USACE, Praxair and Shaw representatives. The solution was to completely circumvent Building 14 to the west. This choice allowed the greatest amount of existing infrastructure to be utilized. The new route began in the specialty gas area and traveled west along the exterior of Building 2, entered an existing utility tunnel and then headed south. In order to extend the specialty gas service to the laboratory areas, a new reinforced concrete utility chase (RCUC) was installed at the south end of an existing utility tunnel. Galvanized steel brackets with removable steel covers were installed to cover the structure and to allow access for maintenance and future installations. The relocation of the nitrogen lines and specialty gas services was completed in the fall of 2003, clearing the way for excavation activities to begin on schedule. Since its installation, Praxair has installed additional steam, condensate, and communication services in the RCUC.

The excavation planning for this area presented some interesting engineering and operational considerations. The corridor selected for the new utility tunnel is approximately 30 feet wide between two buildings and the specialty gas area. The depth of excavation required for the utility tunnel was approximately 12 feet. Based on these parameters Shaw engineers decided to use sheet pile for bank stabilization due to its strength and durability. The sheet pile would also be used to protect the new utility tunnel while excavation activities are conducted for the Building 14 dismantlement project.

The sheet pile installation was impeded by the presence of an old rail spur approximately 1 foot below the pavement surface. This rail was located directly in the required line of the sheet pile. Since the excavation area was already minimized and the sheet pile could not be driven through the rail ties with a great deal of accuracy, the entire rail spur was removed prior to mobilization of the sheet pile contractor.

The excavation began in late fall 2003 following the completion of the sheet pile installation. Excavation started at the west end of the new utility tunnel alignment. One of the operational concerns was the sequencing of events to effectively remediate, release and begin installation of the utility tunnel. Since it was not practical to excavate the entire 350-foot corridor prior to the start of the Final Status Survey (FSS), the USACE and Shaw implemented a "stepped approach" for the operation. This approach allowed the excavation, FSS and tunnel installation to progress concurrently and ultimately meet the schedule constraints dictated by the impending Building 14 dismantlement project. The sequence for the stepped approach was:

- Excavate to allow for the start of the FSS
- Conduct gamma walkover surveys
- Collect FSS samples
- Obtain USACE approval for a given section
- Install required infrastructure and backfill the sections

The key to this sequence was to not get too far ahead with the excavation and continue at a steady production rate. This process relied on the coordination of three distinct and separate crews and multiple subcontractors to remain productive. The excavation crew removed material at a rate which would allow them to support the FSS crew if additional contamination was detected during the FSS process. The FSS crew was required obtain and evaluate radiological data efficiently and quickly to allow the restoration proceed. The restoration crew installed the new infrastructure as allowed by the FSS process. The reason for the steady rate was that this activity was being conducted in the winter. By keeping the production rate constant, controls due to winter weather conditions were easier to maintain, as excessive snow and melt had the potential to significantly decrease production if not kept in check. Also, any delay caused by one of the crews would prevent subsequent crews from performing their activities. Snow controls included covers placed over the excavation to prevent the infiltration of snow and prevent the sub grade from freezing. A series of sumps were excavated along the base and functional areas were pumped out as required.

The entire excavation area was divided into 100 square meter sections for the purposes of the FSS process. A gamma walkover survey and sample collection for the FSS technical data package was performed for each area. The sample was sent off-site for alpha spectroscopy analysis. Since off-site analysis takes more time than was tolerable for this operation each area was approved for restoration based on Shaw's gamma walkover survey results and USACE's QA walkover results. The reason for this change in procedure was that the contaminated material existed at a depth of approximately 3 to 5 feet below grade and the excavation required to install the tunnel extended an additional 8 feet into native clay. Restoration activities included installation of the under drain, stone bedding and reinforced concrete tunnel sections. Backfilling of the area was completed utilizing flowable fill and crushed stone. The installation of the tunnel sections was completed in January 2004.

The original utility tunnel was the main route of utility services for all of the buildings on the south side of the Praxair facility. Services contained in this tunnel consisted of low and medium pressure steam and condensate, natural gas, compressed air, oxygen, water, and electric and communication services, none of which could be removed from service for an extended period.

One of the largest tasks of the mechanical and electrical design was to determine which services or lines were active in the existing utility tunnel, documenting their location and determining what purpose, if any, it served in the Praxair plan. The existing utility tunnel had been in service for approximately 50 years and had undergone multiple reconfigurations. Shaw and Praxair personnel found multiple services which were believed to be removed from service and were not. The task was accomplished by researching each system individually and creating new schematics for the systems as the existing figures were not adequate for this design.

The design team determined the layout of the piping based on how the systems could fit into the existing and the new tunnel sections, creating material and installation specifications, and designing the racks to support the systems. The concept was to install the largest piping first and smaller services after. The steam piping was the largest (18-inch) and was lowered into the tunnel in 40-foot lengths through the 13-foot x 12-foot openings of each junction box and placed directly onto the pipe supports.

The tie-ins were handled through a series of weekend events to minimize the impact to Praxair operations and allow one system to be handled at a time. Constant communication was essential to this aspect of the activity. Shaw and their subcontractor discussed the progress daily and held weekly progress meetings with Praxair and the USACE to coordinate and plan any necessary utility shutdowns. These communications led to a very successful and organized plan for the weekend relocation activities. Fortunately none of the weekend events varied significantly from the plan developed for the event and all the tie-ins were completed without incident or major disruptions to Praxair.

The activities in Excavation Area N were successfully completed in May of 2004 ensuring that the Building 14 dismantlement project could begin as scheduled.

Excavation Area I

Excavation Area I is located at the main Praxair entrance. The area consists of parking lots, a main access road, and pedestrian walks used by Praxair employees traveling from the parking lots to main office buildings. During characterization activities, Shaw identified an area that exceeded site criteria and required remediation. Due to the highly visible location, Praxair management expressed concern about the impact the remedial activities would have on traffic patterns and employee perception of the work being performed on the site.

Shaw coordinated with Praxair representatives to develop a detour plan for Praxair employees, installed additional signage to assist Praxair employees and visitors with traffic patterns, and constructed new roads to allow access to additional parking areas. Prior to beginning remediation work in the area, Shaw provided Praxair security personnel with maps outlining new routes and staged flagmen at the detour signs until site personnel were familiar with the new routes. This cooperative effort on the new traffic routes allowed Shaw to concentrate on the remedial activities and provided safe passage for Praxair employees into and around the site.

As remedial activities in the area progressed, there was some concern regarding material over portions of Praxair's storm and sanitary sewers. A 24-inch storm sewer and a 12-inch sanitary sewer that serviced the northern portion of the site ran right through the excavation at depths of 18-feet and 12-feet respectively. The consensus between the USACE and Shaw was to determine if contamination was present adjacent to or beneath the sewer lines. A series of test pits were excavated using a mini-excavator. Material was removed to within one foot of the sewer lines and samples were collected using hand equipment. Based on these sample results, Shaw concluded the sewer lines, which were estimated to be installed in the 1960s, were backfilled with contaminated material.

Shaw worked with Praxair to develop a plan to by-pass the sewers during the remediation of the sewer systems. Two by-pass pumping systems were designed and installed to handle the flow from each sewer line. A 4-inch diesel pump was used for the sanitary sewer and an 8-inch pump was used to handle the storm sewer. The by-pass system included over 700-feet of surface piping. Shaw constructed a pedestrian walkover that provided safe travel for Praxair employees over the by-pass lines. The excavation and replacement of the sewer lines was performed over a weekend when sanitary flow was expected to be low and weather conditions were expected to be favorable (no precipitation).

The USACE and Shaw worked together to complete gamma walkover surveys following excavation and prior to setting manholes and placing pipe into the ground. This coordination and cooperation allowed for accelerated approvals to set the pipe and backfill the area. The quicker turn around time allowed for restoration and the return of the parking lot and roadway to Praxair.

Niagara Mohawk Power Corporation

NMPC property is located immediately east of the Linde site. Initial volume estimates identified contaminated material on the NMPC property. The major concern in working on the property was the high voltage electric wires servicing the Tonawanda area located directly overhead. Utility poles supporting these lines also needed to be relocated to complete the remediation. These concerns not only affected the USACE and Shaw, but also NMPC as these lines serviced many residential, commercial, and industrial properties.

Shaw developed a plan for the remediation and submitted it to the USACE for approval. Once approved, a meeting between USACE, Shaw, and NMPC personnel was held and the remedial action plan was outlined. NMPC personnel raised some issues about working in their rights-of-way and provided specifications for grounding equipment. Additionally, a NMPC health and safety manager visited the site to answer any questions and inspect the area of concern prior to work being performed.

NMPC engineers identified the best location for the utility pole relocations. The new locations were remediated and sampled in accordance with site work plans. The USACE performed their QA survey of the area and provided concurrence the areas had been effectively remediated. NMPC personnel were brought in to install the new poles, transfer the electric lines and remove the above grade portion of the pre-existing poles. Their employees were concerned about working inside a radiologically controlled area. Personnel from the USACE and Shaw met with the NMPC employees to outline work tasks and review potential radiological hazards. Shaw also provided the NMPC employees with full-time health physics support to assist with personal frisking and to release tools and equipment from the area.

The utility poles and lines were successfully relocated and Shaw continued with the remediation of the area. The cooperation among the groups paved the way for utility pole relocation on the Praxair property. The activity involved relocation of a utility pole that supported the electrical supply of a Praxair substation. Obviously Praxair had a vested interest in the successful work of NMPC, the USACE and Shaw. Praxair representatives were involved from the outset with the proposed layout and schedule. Shaw and the USACE coordinated with NMPC personnel once again to allow for minimal disruptions to Praxair and the safe relocation of the power supply line.

CSX Transportation

CSX property is located east of the Linde site. Initial volume estimates identified contamination on the western portion of the property adjacent to NMPC property. However, subsequent characterization resulted in identifying contaminated areas east of the track.

Existing characterization data proved contamination was present, but did not identify the extent. A meeting of USACE, CSX, and Shaw representatives was held to discuss options for effectively characterizing and determining the extent of the contamination. One significant issue was the potential for contamination beneath the track. CSX personnel displayed misgivings on the possibility of conducting a remedial action on their track. Alternatives were discussed on what was required to determine the final disposition of the area. The result of the meeting was that Shaw would develop a characterization plan to determine the extent and location of the contamination.

With the cooperation of USACE and CSX representatives, Shaw developed a characterization plan to effectively characterize and bound the contamination present on the CSX and adjacent properties. The USACE and CSX approved the plan in the fall of 2002. The plan called for a total of 21 hollow stem auger samples from the beneath the track, two test pits on the west side of the track to supplement existing data, and a shallow investigation area enclosed by fencing to characterize the area east of the tracks.

In order to characterize the track, Shaw was required to procure a CSX flag person for the duration of the characterization. This person is required at the site any time the track is fouled, defined as when equipment or personnel are within 15 feet of the track center line.

Characterization of the west side of the track and beneath the track was completed during the winter of 2002. Sample results indicated that the area west of the track had been properly identified in original volume estimates, and the area beneath the tracks was free of contaminated material.

Characterization of the east side of the tracks did not provide such favorable results. Contaminated material was found to extend closer to the track and onto adjacent properties. A decision was made to remediate the area rather than demobilize, under the assumption that the contamination would be removed in short order. This was not the case. The construction zone was extended to within 12 feet of the track centerline and farther onto the adjacent properties. In addition, further discussions with CSX engineers were conducted to ensure excavation activities did not require shoring or sheeting as dictated by their specifications. CSX engineers approved of the excavation depth, allowing excavation to continue without shoring.

To date remediation continues east of the tracks on the adjacent properties with the full extent of the contamination yet to be determined. Remediation activities west of the tracks cannot be complete until the end of the project because the remediation of this area will include removal of the site rail siding which in turn will eliminate the Shaw's ability to transport and dispose of the contaminated material.

Restoration

One of the toughest challenges has been restoration of areas following remediation. The USACE, Shaw, and Praxair have spent a significant amount of time discussing restoration of various areas of the site. It is one of USACE's primary responsibilities under this contract to ensure improvements are not made at the Praxair facility at taxpayer expense.

The major problem with restoration is the fact this facility has been in operation for over 70 years and much of the infrastructure has evolved during that time. Many of the decisions made during that evolution were based on the presence of existing infrastructure; now that those hindrances are gone it is not practical to restore all items "in kind". In some cases old buildings, roads, and concrete pads have been removed during the remediation. Other cases may involve old sewer lines, water lines or even large soil piles. In any case, Shaw and the USACE have worked closely with Praxair to ensure the restoration of areas serves the function of what previously existed.

Some of the removed infrastructure was installed in the 1950s and 1960s when codes and standards were not what they are today. USACE and Shaw personnel take this into consideration when designing and approving restoration plans. The general consensus among designers has been to replace infrastructure using current standards and specifications. This allows for standard installation using familiar engineering and construction methods. Restoration plans are initiated by Shaw engineers with input from Praxair representatives. The plan is discussed with on-site USACE personnel to ensure concurrence prior to design. The plan is then submitted to the USACE for review and approval. Once approved, field work is performed according to the design and as-built drawings are provided to the USACE to distribute to Praxair.

To date restoration activities have encompassed all phases of construction. These activities have included grade work, concrete and asphalt installation, underground and aboveground utility installation, landscaping and building construction. All restoration efforts are designed and coordinated from start to finish by Shaw and approved by USACE and Praxair for implementation. This coordination has kept each party involved during every step and has made the restoration phase of the project one of the most productive.

CONCLUSION

One of most important lessons to be taken from the experiences at the Linde FUSRAP site is that communication and cooperation are integral to successfully conducting a remedial action on an active facility. In addition, the ability of the USACE, Praxair, and Shaw to work together and develop mutually beneficial solutions to remedial issues has allowed the project to progress and ensures continued progress toward successful completion.