FIVE- YEAR REVIEW REPORT

U. S. Titanium Superfund Site

Nelson County, Virginia

Prepared by:

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Region III

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3/17/00
I. Introduction

A. Purpose

EPA Region III conducted this review pursuant to § 121(c) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (“CERCLA”), 42 U. S. C. § 9621(c); § 300.400(f)(4)(ii) of the National Oil and Hazardous Substances Pollution Contingency Plan, 40 C. F. R. Part 300 (as amended); and OSWER Directives 9355.7- 02 (May 23, 1991), 9355.7- 02A (July 26, 1994) and 9355.7- 03A (December 21, 1995). It is a statutory review. The purpose of a five-year review is to ensure that a remedial action remains protective of public health and the environment and is functioning as designed. This document will become a part of the Site file. This is a Type I review since remedial action construction has been completed and the site is the Operations and Maintenance (“O&M”) phase.

B. Site History and Characteristics

The U. S. Titanium Superfund Site (“Site”) is located approximately 40 miles south of the City of Charlottesville, at the southern border of Nelson County, Virginia. The Site is bordered by VA Route 151 to the west and the Piney River to the south. The site lies just east of the town of Piney River, Virginia which has an estimated population of 200 people. The site is situated on a 175-acre property which includes a former titanium dioxide manufacturing plant. The Superfund Site comprises approximately 50 acres of the plant property.

Between 1931 and 1971, titanium dioxide was produced at the site from ilmenite ore using a sulfate-based leaching process. The site was originally owned by the Virginia Chemical Corporation and was sold to American Cyanamid Corporation (now Cytec Industries, Inc.) which operated the facility until it closed in 1971. Following plant closure, the various ownerships included the U. S. Titanium Corporation from which the site received its name. The ore was obtained from mining operations directly south of the Piney River, then transported by rail across the river to the manufacturing plant where it was treated with sulfuric acid to dissolve the titanium dioxide byproduct. Waste streams generated from this process include unreacted ore contaminated with sulfuric acid, spent sulfuric acid and solid ferrous sulfate called “copperas.”

Following plant closure, several areas containing stockpiles of copperas and unreacted ore remained on-site in addition to several sedimentation and evaporation ponds. Between 1977 and 1981, six major fish kills occurred in the Piney River, as documented by the Virginia State Water Control Board (“VSWCB”) which were attributed to acidic discharges from the site. In excess of 200,000 fish died during these events.

A fish kill in 1979 prompted the VSWCB to request the Circuit Court of Nelson County to order the Site to bury the copperas by December 31, 1980. In response to this court order, American Cyanamid contracted for the disposal of the copperas waste. The stockpiles of copperas in Area 2 were excavated and subsequently buried in Area 1. This work was completed in
December 1980. The ultimate failure of the cap placed over this material and the lack of source controls in other areas resulted in continued acidic discharge into surface water and ground water. Elevated concentrations of metals including iron, aluminum, cadmium, chromium, nickel, and zinc have been detected. In December 1982, the site was proposed for inclusion on the National Priority List (“NPL”) pursuant to Section 105 (8) of CERCLA.

In August 1983, an EPA contractor submitted what was termed the “Remedial Action Master Plan” similar to an RI/FS Work Plan. In addition, a Focused Feasibility Study which evaluated possible remedial alternatives based on the documented nature and extent of contamination at the site was performed. This report was issued by EPA in October 1985.

A civil action was filed by the Commonwealth of Virginia (“Virginia”) against American Cyanamid in State Court, based on a nuisance action for fish kills and environmental degradation resulting from site contamination. A liability judgement was rendered against American Cyanamid in November 1985. In April 1986, American Cyanamid and Virginia signed a stipulation and order establishing a schedule for completion of temporary source controls for the copperas, burial pit, and a supplemental remedial investigation and feasibility study for the site. Results of these studies confirmed that the buried copperas and resulting contaminated groundwater posed an unacceptable risk to human health and the environment, thus necessitating remedial action. It was also verified that cap failure and the lack of source controls resulted in the continued discharge of acidic runoff to groundwater and the Piney River.

During the remedial investigation, seven areas1 designated 1, 2, 3, 4, 5, 7 and groundwater (sitewide) were identified as possible sources of contamination. The seven areas of contamination are shown on the attached map (Attachment 1) and described as follows:

Area 1: Two acre clay lined and capped copperas burial pit.

Area 2: Eight acre former copperas stockpile area.

Area 3: Two acre former evaporation pond.

Area 4: One acre unreacted ore waste pile.

Area 5: Two sedimentation basins containing unreacted ore, filter cake and gypsum covering a seven acre area.

Area 7: Drainage area receiving most of the surface water runoff from the site.

Groundwater: Contaminated groundwater due to acidic discharges from buried copperas (Areas 1 - 4).
On November 21, 1989, the EPA issued the Record of Decision ("ROD") for the site. The remedy selected in the ROD addressed all known sources of contamination found in the seven areas of concern. These seven areas comprise one operable unit for the site. The major components of the selected remedy include:

- In-situ dissolution of buried copperas waste and above ground treatment of leachate (Area 1).
- Implementation of drainage controls and establishment of final vegetative cover to stabilize the site (Areas 2, 3, 4 and 5).
- Groundwater collection and treatment using a combination of chemical and biological processes including passive wetlands treatment.
- Neutralization of acidic soils through lime addition in areas associated with the implementation of groundwater collection and treatment (Area 7).
- The diversion of surface runoff from groundwater treatment areas and former sedimentation ponds (Areas 5 and 7).
- Installation of 100-year flood protection around the former sedimentation ponds and groundwater treatment areas (Areas 5 and 7).
- Installation of security fencing around waste and groundwater treatment areas (Areas 1 and 7).
- Performance of environmental monitoring to ensure the effectiveness of the remedial action.

During negotiations with American Cyanamid, review of additional information resulted in a potential change in the method of treating the buried copperas in addition to changes in the requirements for discharge of treated water to the Piney River. Preliminary design studies revealed that the remedial alternatives selected had major problems and might prove ineffective. Therefore, American Cyanamid began investigating other alternatives. EPA evaluated these new alternatives and determined that changes to the original remedy were warranted. These changes are described in an Explanation of Significant Differences ("ESD") issued on September 20, 1990. Specifically, this ESD changed the selected remedy by:

- Providing the option of treating Area 1 soil and copperas by above ground dissolution rather than in-situ dissolution.
- Clarification of objectives for design and operation of the groundwater collection and treatment system. The changes included the design of auxiliary treatment units should the passive wetlands treatment system proves incapable of treating the full capacity flow and concentration of iron in the groundwater.
- Modification of effluent limitations and monitoring requirements for the discharge of treated groundwater to the Piney River.

Following the issuance of the ESD, major difficulties in the ground water and soil components of the remedy were again identified. Field testing confirmed that the chosen remedy was ineffective in treating levels of copperas present in the soil. It was
also determined that the groundwater treatment alternative identified in the ROD (passive wetlands) would not effectively treat the contaminated groundwater. Therefore, the decision was made to again modify the selected remedial alternative for contaminated groundwater. These changes are reflected in a second ESD issued on February 3, 1995. Specifically the ESD incorporated the following changes to the remedy:

- Area 1 soils and copperas were to be treated by ex-situ neutralization.
- Groundwater would be treated using an above ground treatment system followed by precipitation of iron-rich sludge in a surface impoundment prior to effluent discharge to the Piney River.

Pursuant to a Consent Decree, dated February 18, 1991, executed with the EPA and Virginia, American Cyanamid agreed to conduct the Remedial Design/Remedial Action (“RD/RA”) for the site. The RD/RA was implemented in accordance with the ROD as modified by the two ESDs. This activity was conducted under the direction of the EPA and Virginia Department of Waste Management (now Department of Environmental Quality). The RD was divided into three distinct phases indicated as follows:

- Area 1 and 3 - Onsite soil dissolution and disposal of treated soil in a waste cell capped with soil and revegetated.
- Area 4 and 5 - reggrading, soil cover, and revegetation
- Area 2 and 7 (soil neutralization) and Groundwater Collection & Treatment (Areas 2 and 4, and Areas 1 and 3)

The RA was divided into seven separate construction phases. RA construction was initiated in August 1994 and was completed in October 1996. A Superfund Preliminary Close Out Report (PCOR) documenting the completion of RA construction for the site (OU-1) was issued by EPA in August 1997. The site is presently in the Operations and Maintenance (“O&M”) phase of activities. The groundwater collection and treatment system remains in operation. A description of each phase of site remediation is described in Section II.

II. Remedial Objectives; Areas of Compliance/Non-compliance

The comprehensive objective of the remedial action is to reduce the concentration of Site related contaminants such that: (1) the potential carcinogenic risk to people exposed to the Site is within the 10^-6 risk range; and, (2) the potential for adverse health effects from exposure to chemicals exhibiting noncarcinogenic effects is reduced to acceptable levels (i.e., a Hazard Index less than 1.0). The site-wide remedial objectives identified above were not achieved before construction at each of the operable units was completed in August 1997. Refer to the 1989 ROD and the 1990 and 1995 ESDs for a discussion of applicable or relevant and appropriate requirements (“ARARs”). A review of ARARs was conducted to determine if any had changed since the ROD and ESDs were issued and whether the remedial actions would still be protective of human health and the environment. It was determined that none had changed.

The status of RA activities in each area is based upon review of PRP monthly O&M Reports and a site visit conducted April 7, 1999. This site visit was conducted jointly by the EPA and VDEQ and included a visual inspection of each area. Significant observations are provided for each site-specific area. A description of remedial objectives and major components of each area specific remedy are presented in Subsections A through G which follow.
A. Areas 1 and 3 (Soil Neutralization)

1. Remedial Objectives - prevent the threat of direct contact with contaminated soils and minimize leaching of hazardous substances to the ground water.

2. Outline of Selected Remedy

- On-site soil/copperas neutralization through lime addition and mixing (Area 1) at batch treatment plant.
- Placement and compaction of treated material in waste stockpile/cell (Area 3).
- Soil cover placement, regrading and revegetation of waste cell.
- Placement of clay subbase and soil backfill/cover followed by regrading and revegetation of Area 1.

3. Status of Construction Activities

The remedial action for Areas 1 and 3 was initiated in August 1994 and completed in September 1995. The final excavated volume of soil/copperas from Area 1 was approximately 65,000 cubic yards. The actual volume of treated material placed in the Area 3 waste cell was 69,714 cubic yards. The increase in volume was due to soil swelling during handling and the addition of treatment additives. The dimensions of the waste cell are 440 feet by 180 feet. The final surface topography of Area 1 resembles a valley on three sides and open to the west. Surface drainage from the area is directed to a ravine located on the west side. Final vegetative cover has been established and both areas appear well maintained.

4. Observations

Areas 1 and 3 are well maintained with final vegetative cover established. Initially, areas of stormwater ponding were identified along the base of the waste cell. These areas were within a stormwater diversion ditch which encircled the cell. The problem was corrected by stabilizing ditch slopes (geonet) and regrading the channel such that it drains and no longer allows water to collect.

B. Areas 4 and 5 (Sedimentation Basins)

1. Remedial Objectives - prevent the threat of direct contact with wastes and contaminated soils; minimize leaching of hazardous substances to the ground water.

2. Outline of Selected Remedy

   Area 4 (spent ore wastepile)

   - Slope stabilization and erosion control
   - Regrading
   - Placement of soil cover and revegetation
Area 5 (sedimentation basins)

- Improve Flood Protection (Piney River)
- Rebuild/Repair dike containment system
- Regrading
- Placement of soil cover and revegetation

3. Status of Construction Activities

Area 4 and 5 construction activities were initiated in December 1994 and completed in December 1996. The slopes of the Area 4 wastepile were highly unstable and eroded allowing for surface transport of exposed waste material to nearby surface waters. A key component of this action was the construction of a concrete crib retaining wall to provide long-term slope stabilization. The retaining wall protects the vulnerable south side of the waste pile which drains to the Piney River.

The former plant sedimentation basins in Area 5 contained unreacted ore and other waste products from plant operations. The existing dike containment system had been breached by erosion allowing the release of contaminated pond sediments to the Piney River during precipitation events. To prevent this from recurring, the earthen dikes were rebuilt and stabilized. A breach in the southeast corner of the dike was repaired and another section of dike was raised approximately 3 feet to provide improved flood protection. The existing sediments in the basins were regraded and covered with a layer of compacted clay. Due to extremely wet weather work was suspended in fall 1995 and resumed in spring 1996 when placement of topsoil and revegetation was conducted. Stable vegetative cover was established in Spring 1997 following overseeding to improve growth in areas of sparse cover.

4. Observations

During the site visit it was noticed that permanent vegetative cover had been established and drainage controls were in place and fully operational. Follow-up seeding of areas of sparse vegetation was recommended, this activity was completed in June 1999.

C. Area 2 Ground Water Collection

1. Remedial Objectives - Prevent the discharge of contaminated groundwater to Piney River. Collect and treat recovered groundwater prior to surface water discharge.

2. Outline of Selected Remedy

- Construction of a 1300 foot section of 6 inch HDPE perforated (subsurface) groundwater collection pipe and associated manholes and cleanouts.
- Connection to Area 4 groundwater collection system.
- Reconstruction of Area 2 slope, regrading and revegetation.
3. Status of Construction Activities

This section of the groundwater collection system was completed and opened for operation (water collection) in April 1996. Slope stabilization activities occurred during Spring and Summer 1996.

D. Area 4 Groundwater Collection

1. Remedial Objectives - Prevent discharge of contaminated groundwater to Piney River. Collect and treat recovered groundwater prior to surface water discharge.

2. Outline of Selected Remedy

- Installation of 500 feet of 6 inch diameter solid removal pipe for transport of collected groundwater from Area 2 to pumping station.
- Construction of Area 4 groundwater collection system consisting of 500 feet of 4 inch diameter perforated HDPE pipe and associated manholes and cleanouts.
- Connection of solid discharge pipe to pumping station

3. Status of Construction Activities

Remedial action construction was initiated in December 1994 and completed in March 1996. Shortly thereafter, this section of the ground water collection system was placed in service. Final regrading and seeding along the backfilled trench line was completed in Summer 1996.

E. Area 1 and 3 Groundwater Collection

1. Remedial Objectives - Prevent the discharge of contaminated groundwater to the Piney River. Collect and treat recovered groundwater prior to surface water discharge.

2. Outline of Selected Remedy

- Installation of 640 feet of 4-inch diameter HDPE perforated collection system pipe
- Installation of 450 feet of 6-inch diameter HDPE solid removal pipe
- Construction of collection and removal system manholes and cleanouts

3. Status of Construction Activities

Remedial action construction was initiated in December 1994 and completed (final grading) in September 1996. The construction area was hydroseeded in September 1996 and overseeded in April 1997.
F. Groundwater Treatment Plant and Pumping Station

1. Remedial Objectives - Collect and treat recovered groundwater prior to surface water discharge.

2. Outline of Selected Remedy

   Groundwater to be treated (neutralized) in an above ground system followed by precipitation of iron rich sludge in a surface impoundment prior to effluent discharge to the Piney River.

3. Status of Construction Activities

   The groundwater treatment plant (“GWTP”) and pumping station were constructed as designed with no critical unknown conditions encountered. Timely completion of the GWTP was delayed due to late delivery of the lime feed system (summer 1995). Construction of the treatment system was completed in March 1996. GWTP startup and commissioning was conducted in March and April 1996. At the same time, final construction of ancillary treatment units including sedimentation basins was completed. The lime feed system required the most time and effort to adjust the programming and timing settings for proper operation. These adjustments were completed in May 1996.

   The official start date of the GWTP was March 12, 1996. The plant processed collected groundwater for several days before being stopped to verify ARARs for treatment and discharge to the Piney River. The ARARs for the plant discharge were formally issued by VDEQ on March 22, 1996 and groundwater treatment restarted on March 25, 1996. The plant has been in full operation since that date and consistently meets the ARARs for the plant discharge. The GWTP treats 30,000 - 40,000 gallons/ day depending on seasonal variation in groundwater recharge. The most recent monthly O& M Report (November 1999) indicates that during the month of October 990,000 gallons of groundwater was processed for an average of 31,950 gallons per day. The pH of the influent is in the 2.9-3.1 range and total iron varies from 480 mg/l to 760 mg/l. Typically the pH of the discharge varies from 6.9-7.5 and total iron 0.6-1.4 mg/l. The pH and iron readings are meeting discharge limits on a consistent basis.

G. Areas 2 and & 7 (Soil Neutralization)

1. Remedial Objectives - Restore degraded wetlands and stressed vegetation along drainage pathways due to acidic discharges from former copperas stockpile area though neutralization. In addition provide erosion and drainage controls in these areas.

2. Outline of Selected Remedy

   - Neutralization of stream bed sediments through lime addition
   - Neutralization of acidic soils along base of the slope.
   - Revegetation of areas of stressed or nonexistent vegetation.
   - Install drainage and erosion control features
3. Status of Construction Activities

RA construction activities commenced in August 1996 and neutralization of Area 2 stream bed sediments occurring during the month of September 1996. The clearing of Area 7 began in September 1996 and the work was performed during October 1996. In Area 2, a total of 639 cubic yards of acidic soil/sediment was removed for treatment and then returned to its original location. The thickest accumulations of sediment were neutralized first and followed by thinner deposits which were mixed with crushed limestone.

4. Observations

It was observed that vegetation is returning to the wetlands and drainage areas formerly devoid of plant life. It may take several growing seasons before native vegetation fully returns although significant improvement was noted.

III. Document Review

1. Ground Water Monitoring Program

Groundwater monitoring has been conducted on a quarterly basis from a system of thirteen wells strategically located throughout the site. Quarterly monitoring was initiated upon completion of all major remedial activities in March 1997 (1st Quarter). In September 1997, two monitoring wells (MW-2 and MW 5-5) were installed as replacements for original wells which were abandoned during RA construction. Analytical parameters include field pH, field temperature, dissolved iron and total iron. The wells are situated both inside and outside the groundwater collection system. The program called for monitoring on a quarterly basis for a period of two years starting in March 1997 after which a reduction in sampling frequency would be considered pending data review. Groundwater monitoring continues on a quarterly basis although the two year monitoring period ended in March 1999. At this time, Cytec has not requested a reduction in the sampling frequency.

It has previously been documented that contaminated groundwater (pH < 4 and elevated iron concentrations) is present beyond the limits of the groundwater collection system in Area 2. By creating a containment system around the site perimeter, acidic discharges are prevented from migrating off-site. By isolating the source, it is anticipated that regional groundwater quality should improve over time. An evaluation of results from monitoring wells 1 and 7 (outside collection system) which have historically exhibited low pH and elevated iron has not shown any significant change in pH (i.e., increase) since the collection system was installed. In addition, concentrations of dissolved and total iron have fluctuated up and down with no clear trend being observed. It can be concluded from this evaluation that an improvement in groundwater quality outside the collection system has yet to be evidenced.

2. Piney River Monitoring Program

The monitoring program consists of semiannual water quality sampling and benthic macroinvertebrate surveys at three sample stations along the Piney River. Monitoring is typically conducted in April and September of each year with the first samples collected in April 1997. The program will run for a minimum period of three years. The sample stations are located upstream, adjacent to and downstream of the site. Field measurements are taken for temperature, dissolved oxygen, pH and specific conductance. In addition, samples are collected for laboratory analysis of alkalinity (CaCO3) and total hardness. It is noted that pH is higher and specific conductance and hardness lower in the upstream sample location when compared to the other two
stations. However, all recorded values were within normal seasonal ranges.

The results of the river habitat survey were evaluated using EPAs Rapid Bioassessment Protocols (1989). The results indicate that the overall habitat quality rating at the downstream stations is comparable to upstream reference station 3 as evidenced by comparability percentages of greater than 90% for the given parameters. The primary objective of the survey is to evaluate the success of the remedial measures as they affect biological conditions in the Piney River. Survey data suggests some degree of improvement in attributes of the benthic macroinvertebrate community.

3. Surface Water Discharge Monitoring Program

The VDEQ Water Program issued revised effluent discharge criteria for outfall 001 from the groundwater treatment system which became effective January 1, 1997. It specified a maximum discharge of 80,000 gpd and required monthly measurements of flow, pH and COD (mg/l). The pH must be within the range of 6.0 - 9.0 SU. In addition, monitoring for hexavalent chromium, mercury, selenium (dissolved) and hardness is required once every five years. Data from monthly operational reports indicate that the discharge is in compliance with the criteria.

In addition, biological monitoring of the surface water discharge is performed on a quarterly basis. Specifically, acute toxicity tests are performed using the organism (ceriodaphnia dubia). Recent quarterly reports indicate that results are within acceptable parameters. Earlier results exhibited routine test failures but the cause was ultimately attributed to either the test method or the addition of excess lime to the discharge.

IV. Recommendations

The physical construction of all components called for in the 1989 ROD, as amended by the 1990 and 1995 ESDs is complete. The ongoing operation and maintenance of these components should continue. In addition, the efforts to monitor the conditions of the groundwater, the Piney River and the surface water discharge should also continue.

The 1989 ROD referenced the need for “deed restrictions” to prevent excavation at any areas of the site. Since wastes remain on-site, EPA will take steps to ensure that appropriate institutional controls are in place to prevent exposure to site-related contamination.

V. Statement of Protectiveness

The remedy is, at this time, protective of human health and the environment. The remedy called for in the ROD, as amended by the 1990 and 1995 ESDs, is in place and has reduced the risks posed by the site. While the current remedy is protective, EPA plans to take further steps to ensure long-term protectiveness by implementing institutional controls to reduce the potential for exposure to site-related contaminants.

VI. Next Five-Year Review.

The next five-year review will be conducted no later than five years from the date of this review.