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MEMPHIS
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Corrective Measures Study Report For Cypress Creek Sub-Area III

Prepared For:

Velsicol Chemical Corporation
Memphis, Tennessee

Prepared By:

Memphis Environmental Center, Inc.
Memphis, Tennessee

May 2006

MEMPHIS ENVIRONMENTAL CENTER, INC.
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May 19, 2006

Mr. J. M. Mike Apple, Director
Tennessee Department of Environment and Conservation
Division of Solid Waste Management
L & C Tower, 5th Floor
401 Church Street
Nashville, Tennessee 37243-1535

Re: Corrective Measures Study Report for Cypress Creek Sub-Area III
Velsicol Chemical Corporation, Memphis Facility
Facility Identification No. TND 00 701 4664
Tennessee Permit No. THHW-109

Dear Mr. Apple:

Enclosed, on behalf of Velsicol Chemical Corporation, is the Corrective Measures Study (CMS) report for residential properties along Cypress Creek. This report contains alternatives evaluation information and findings that were presented by Velsicol at the Remedial Action Level and Corrective Measures Evaluation Workshop, which was held in your office on April 26, 2006.

Please note that the report reflects some changes from what was presented on April 26th. The most significant changes are as follows:

- The excavated soil volumes and costs estimates presented at the meeting were based on an average size property. Those values have been revised herein to reflect estimated soil volumes and costs for each individual property and are based on an approximation of the surface area that might be excavated at each property. This improves the accuracy of the soil volumes and cost estimates.

- A 20% expansion factor, which was inadvertently not used in calculating certain of the soil volumes and cost estimates presented at the meeting, has been included herein. The meeting soil volumes were based on in-place conditions, prior to excavation. Soil volume expands when excavated, so the soil volumes were adjusted by the 20% factor to reflect that increase in estimating the transportation and consolidation costs.

- The soil volume, number of properties, and cost estimate values presented at the meeting included the three properties on Edward Avenue and Vollintine Cove, which were cleaned up during 2005. The enclosed report includes only properties that may be remediated in the future.

- The indicated numbers of impacted properties per RAL grouping has also been adjusted to include properties with representative dieldrin values rounded to the nearest 0.1 mg/kg, as were presented on Table 12 of the recently submitted May 10, 2006 report on Human Health Risk assessment and Development of Remedial Action Levels for Cypress Creek Sub-Area III.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

If you have any questions or comments on this status report, please call me at (901) 380-9995, extension 120.

Sincerely,

Memphis Environmental Center, Inc.

Gary J. Hermann, P.E.
Senior Environmental Projects Manager

c: Mike Apple, TDEC (three hard copies and one electronic copy)
Jon Johnston, EPA
Ron Loving, Velsicol
Chris Saranko, GeoSyntec Consultants

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TABLE OF CONTENTS

1. PURPOSE 1

2. REMEDIAL ALTERNATIVES 1

2.1 Alternatives Description 1

2.2 Soil Volumes 3

2.3 Corrective Measure Cost Estimates 3

3. CORRECTIVE ACTION ALTERNATIVES EVALUATION CRITERIA 4

4. ALTERNATIVES EVALUATION 5

1. Protect Human Health and the Environment 5

2. Attain Media Cleanup Standards 6

3. Control Sources of Releases 6

4. Comply with Applicable Standards for Management of Wastes 6

5. Long-term Reliability and Effectiveness 7

6. Reduction of Toxicity, Mobility, or Volume 7

7. Short-term Effectiveness 7

8. Implementability 8

9. Cost 8

5. SUMMARY AND RECOMMENDATIONS 9

FIGURES

1 Excavation Details

1. PURPOSE

The purpose of this Corrective Measures Study (CMS) report is to present Velsicol's evaluation of corrective action design alternatives for remediation and to propose final corrective measures for residential properties along Cypress Creek. The evaluation was performed using the nine criteria in Section E. of Appendix 9-3-5 of the Facility's Hazardous Waste Permit No. TNHW-109. These design requirements will apply to corrective action work that is performed on properties where soil test results exceed the Remedial Action Level (RAL) that is also being established as part of the Final Remedy. This report was prepared by Velsicol with support from GeoSyntec Consultants.

The remainder of this document is organized as follows:

Section 2 – describes the remedial alternatives under consideration, including design criteria common to all alternatives, potential soil volumes to be handled by each alternative and costs;

Section 3 – presents the evaluation criteria consistent with the Facility's Hazardous Waste Permit;

Section 4 – presents a comparative analysis of each corrective action alternative against the evaluation criteria; and

Section 5 – presents a summary of the evaluation and recommendations.

2. REMEDIAL ALTERNATIVES

2.1 Alternatives Description

Two alternatives were developed to eliminate potential human health risks at the subject properties. These are based on the application of a protective soil barrier consisting of either a 1-foot or a 2-foot minimum thickness of clean soil over the contaminated soil to cut off the human exposure pathway. Due to the generally flat nature of the subject properties, the remedial work will usually include excavation to remove a like depth (either 1-foot or 2 feet) of contaminated soil from the subject properties so as to match original landforms and to not adversely impact stormwater drainage conditions.

Other major remedial design features and implementation requirements common to both alternatives are listed below:

- Install a marker over the contaminated soil at the bottom of the excavation to indicate the depth of clean cover soil. Orange plastic construction fencing, or similar materials that will be long lasting and visible if uncovered, will be used as the marker.

- Where more than one composite soil sample was used in calculating the Representative dieldrin value or Hazard Quotient, which was the basis of identifying a property for remediation, only the backyard sub-areas that exceed the RAL will require excavation. In addition, Velsicol may chose to perform additional soil testing to more precisely identify the portions of properties that will require remediation.

- Place, compact and prepare the protective soil barrier to re-establish landscape vegetation.

- In backyards where the land slopes steeply toward the Creek (these are few in number), the backfill design will include design features, such as using terraces or gentler slopes, to prevent stormwater erosion of the protective soil barrier.

- Re-establishment of landscape vegetation will include placement of new sod on disturbed areas and planting of replacement trees, shrubs and other plants in accordance with site restoration plans developed with input from the property owner.

- The contaminated soil will be trucked to Velsicol properties at Warford Street in Memphis for consolidation utilizing the Area of Contamination (AOC) policy as described in the EPA Region 4 guidance document entitled Management of Contaminated Media, dated September, 1999. The truck beds will be covered and sealed to prevent spillage onto public roadways.

- The soil consolidation cell will be designed to prevent human contact and releases to the environment by wind or stormwater erosion.

- Air monitoring will be performed to provide a quantitative measure of impacts and to determine the need for dust control. Watering will be used as the primary means of dust control.

- Requirements for excavation setbacks from building foundations, trees and other site features are indicated on Figure 1. The building set-backs are necessary to prevent damage to the structures and to avoid removing soil containing termiticides that were applied to protect the structures. Set backs will also be required around trees that are not removed so that trees and their roots are not injured by contaminated soil excavation or clean soil cover.

- TDEC has directed that a deed notification be made on properties where soils below the depth of excavation have contamination above the established RAL. It will be a rebuttable presumption that soils below the soil barrier are above the RAL. Velsicol, at its election, may conduct soil testing to determine if the soil contaminant levels are below the RAL, and therefore not required deed notification. Note that in past communications with TDEC, Velsicol has taken the position that such deed notification should be made by the State of Tennessee.

Certain of above-noted remedial design criteria were developed with input from TDEC staff during development of the Interim Measure Work Plans that were implemented at three properties (1978 and 1984 Edward Ave. and 2478 Vollintine Cove) during 2005.

It is noted that the City of Memphis has a 10-foot wide maintenance easement outside of the concrete liner along both sides of the Creek. This should generally preclude excavations by residents in that area for purposes of building permanent structures and planting trees. This maintenance easement area is the portion of the backyards that generally has the highest contaminant levels.

2.2 Soil Volumes

The volume of contaminated soil to be excavated and managed depends on both the alternative thickness of the protective soil barrier and the number of properties to be remediated, which will depend upon the established RAL. The following table presents information on soil volume and number of properties per protective soil barrier depth alternative (1 foot or 2 feet) and RALs (representative dieldrin values of 3, 2, 1.5 and 1 mg/kg). The soil volumes are based on preliminary estimates of surface area to be excavated, which were developed based on measurements taken from aerial photographs and multiplied by the protective soil barrier depth.

Soil Barrier Depth	RAL (mg/kg dieldrin)	No. of Affected Properties	Volume of Excavated Soil* (cubic yards)	Estimated Initial Remediation Cost
1 Foot	3	10	1,600	$540,000
	2	17	3,600	1,060,000
	1.5	22	4,200	1,300,000
	1	31	6,500	1,950,000
2 Feet	3	10	3,200	790,000
	2	17	7,100	1,610,000
	1.5	22	8,300	1,940,000
	1	31	13,100	2,950,000

*In-place volumes prior to excavation (i.e., without 20% expansion factor).

2.3 Corrective Measure Cost Estimates

Cost estimates for the corrective measure alternatives were developed based on the 2005 Interim Measures cost experience and recent informal quotes obtained from remedial contractors. The estimates are presented in the preceding table and include oversight; site preparation; contaminated soil excavation, transportation and consolidation; clean soil backfill; and site restoration. The costs are based on the two alternative protective soil barrier depths and the noted range of RALs. These costs include the development of the consolidation area on Velsicol's property, placement of the contaminated soil into the consolidation area and installation of a cover. Note that the estimates do not include costs for subsequent management of the consolidated soil or development of Velsicol's outlying property for consolidation. Any

such additional costs would be approximately proportional to soil volumes. However, they cannot be reliably estimated at this time.

3. CORRECTIVE ACTION ALTERNATIVES EVALUATION CRITERIA

Each alternative was evaluated against the following criteria consistent with the Facility's Hazardous Waste Permit:

- Overall protection of human health and the environment
- Attain media cleanup standards
- Control sources of releases
- Comply with applicable standards for management of waste
- Long term reliability and effectiveness
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost

Descriptions of the criteria, as used in performing the evaluations, follows:

- *Overall Protection of Human Health and the Environmental* – Corrective action remedies must be protective of human health and the environment. The remedy may consider any other measures that will be required to be protective, but not directly related to media cleanup, source control or management of wastes. An example would be deed notices.

- *Attain Media Cleanup Standards* – This criterion evaluates whether the proposed corrective action alternative will achieve media cleanup standards and remediation objectives. An estimate of the timeframe necessary to achieve the goals shall be discussed as well as contingent remedies to be implemented if there is doubt the initial remedy will not work.

- *Control Sources of Releases* – This criterion evaluates how well the proposed corrective action alternative reduces or eliminates further releases that may pose a threat to human health and the environment.

- *Comply with Applicable Standards for Management of Waste* – This criterion evaluates how and if the corrective action alternatives will comply with state, Federal, or other regulatory requirements for management of the contaminated soil.

- *Long-Term Reliability and Effectiveness* – The primary focus of this criterion is to consider whether the alternative technology has been used effectively in the past, whether failure of the technology results in any immediate impact on receptors, and whether the alternative would have any flexibility to deal with uncontrollable changes at the property. Also considered are the operation and maintenance requirements and complexity and the useful life of the remedy.

- *Reduction of Toxicity, Mobility, or Volume* – The primary focus of this criterion is to evaluate whether the corrective action alternative is capable of substantially reducing the potential for contaminated media to cause future environmental releases and to estimate the reduction in the toxicity, mobility and/or the volume of the contaminated soils compared to initial site conditions.

- *Short-Term Effectiveness* – The primary focus of this criterion is to evaluate the protectiveness of each alternative as it relates to human health and the environment during construction and implementation. Short-term effectiveness is assessed through the means of protection of employees and construction workers, the ability to mitigate potential environmental impacts, and the amount of time it takes to implement the corrective action.

- *Implementability* – This criterion evaluates the technical and administrative feasibility of implementing the corrective action alternative and the availability of contractors and materials. This criterion also considers time required to implement and to achieve beneficial results.

- *Cost* – This criterion compares the alternatives on the basis of costs for the initial remedial construction work and soil consolidation.

4. ALTERNATIVES EVALUATION

A comparison of each alternative using the evaluation criteria follows.

1. Protect Human Health and the Environment

Both of the corrective action alternatives are considered to be fully protective of human health and the environment. Installation of the protective soil barrier at the remediated properties will cut off the exposure pathway, effectively eliminating risk to human health. Because of the low solubility of the contaminants of concern and their high affinity to adhere to soil, potential migration is limited to transport by surface water erosion or wind erosion. However, the

installation and maintenance of the protective soil barrier will eliminate the possibility of such erosion of contaminated soil at the remediated properties. Human health and environmental impacts of the consolidation and any subsequent management of the contaminated soils at the Velsicol Facility will be the same for both alternatives.

Measures that are potentially needed to be protective of human health but that are not directly related to media cleanup, source control or management of wastes would include awareness of the current property owners/residents and notification or future property owners of site conditions via deed notice. This is the same for both alternatives.

2. Attain Media Cleanup Standards

Both of the alternatives will attain the media cleanup standard (i.e., the RAL), which will be used to identify properties requiring cleanup. The use of a protective soil barrier is a proven technology that will achieve the cleanup standard as soon as the soil barrier installation is complete. However, more time will be required to complete the installation of the protective soil barrier at a particular property for the 2-foot-depth alternative because of the larger soil volumes to be handled. This increased time frame will be in terms of a number of days, which will depend on accessibility and increased volume of soil to be excavated and backfilled. Therefore, the 1-foot alternative is considered slightly better with respect to this evaluation criterion.

3. Control Sources of Releases

The contaminants of concern have generally low solubility and volatility such that releases from impacted properties would primarily be though wind or water erosion. However, installation of the protective soil barrier will prevent migration by erosion. Maintenance of the protective barrier will be by normal landscape practices, including lawn and landscape maintenance and preventing soil erosion by stormwater runoff. The marker will serve as a warning in the unlikely event that the protective soil barrier is compromised. Most of the properties are relatively flat such that deep erosion channels are not anticipated. A few properties may have steeper topographic relief adjacent to Cypress Creek. In those instances, special landscape design features (i.e. terraces or more gently sloping the land surface) will be used to reduce the potential for erosion regardless of depth of protective soil barrier depth. Therefore, the two alternatives are considered equal in regards to source control.

4. Comply with Applicable Standards for Management of Wastes

Both of the corrective action alternatives are anticipated to comply fully with the applicable standards for the management of waste, which for this evaluation relates primarily to the transportation and consolidation of the contaminated soils. Since the post-excavation management of contaminated soils is the same for both alternatives and is not specifically related to the depth of excavation, there is no difference in the alternatives under this evaluation criterion.

5. Long-term Reliability and Effectiveness

Each alternative utilizes the same proven technologies (excavation of contaminated soil with offsite management, and installation of a protective soil barrier to human exposure) so there is no differentiation between the alternatives with respect to the long term-reliability and effectiveness of the technology.

Failure of the technology would not result in any immediate impact to potential receptors since the potential risks are considered long-term (chronic) risks versus short term (acute) risks for either of the corrective action alternatives. Failure would be considered a breach in the protective soil barrier via stormwater erosion or via purposeful penetration of the protective soil barrier. Considering these types of failure, the two-foot protective soil barrier would be better than the one foot protective soil barrier since it would provide a thicker cover. However, the type of events in which the protective soil barrier would be purposefully penetrated (i.e. fencepost installation or planting trees) tend to minimize the difference in the evaluation since the exposure to soils below the barrier during these infrequent events would only be for a limited duration. Additionally the marker would indicate the depth of the protective soil barrier thereby minimizing accidental digging into the underlying soils.

Since each corrective action alternative employs the same technology, each will have the same flexibility to deal with uncontrollable changes at the site. Further, each alternative will have the same minimal maintenance requirements (requiring only usual landscape maintenance).

Each corrective action scenario will have long useful life since they do not rely on any electrical/mechanical equipment prone to failure. However, if failure is defined as a breach in the protective soil barrier, then the two foot barrier alternative might be considered slightly better due to having a thicker buffer of protective soil barrier. However, the vegetated barrier soil, use of the marker, and the site design to preclude gully erosion diminish any significant difference in the comparative evaluation with respect to long term reliability and effectiveness.

6. Reduction of Toxicity, Mobility, or Volume

Neither alternative impacts the toxicity of the contaminated soil. The two alternatives are equally effective in reducing mobility of the soil contaminants by means of the protective soil barrier. The 2-foot alternative will remove more soil from the backyards than the 1-foot alternative. However, the volume of contaminated soil is not changed; it is just moved to a different location. Therefore, the two alternatives are considered equal with respect to this evaluation criteria.

7. Short-term Effectiveness

The 1-foot protective soil barrier thickness alternative was determined to provide much better short-term effectiveness since it will generate smaller volumes of soil which results in shorter implementation durations and results in less exposure to employees, workers, or the public during the project. In addition to shorter project duration, the smaller soil volume also results in fewer trucks moving over public roads and therefore less risk of traffic accidents and

injuries to workers in and around the trucks and potential for spillage and related environmental impacts. As an example of the impact of soil volume, the table below estimates the number of truckloads of contaminated soil that would have to be transported from the remediated properties, plus the number of trucks required to backfill an equivalent volume of soil for the two barrier depths and for the noted RALs.

Soil Barrier Depth	RAL (mg/kg dieldrin	No. of Truckloads* (@10 cubic yards per load)
1 Foot	3	390
	2	860
	1.5	1,000
	1	1,570
2 Feet	3	770
	2	1,710
	1.5	2,000
	1	3,140

* Includes loads of contaminated soil hauled out, plus loads of clean soil hauled in and 20% expansion factor for excavated soil.

8. Implementability

Each alternative uses the same technology, which has been effectively implemented at sites across Tennessee and the United States and is one of the most common soil remediation technologies. Available contractors, services and materials are the same for each alternative, essentially differing only in quantity of material excavated and backfilled.

The primary differentiator between the remedial alternatives is the depth of excavation. The one-foot excavation alternative can be completed quicker due to the smaller volume of soil that is handled. The lower volume of soil also reduces the number of truckloads of contaminated soil that would be transported on public roadways, the volume of soil to consolidate and cover, and the number of truckloads of clean soil to deliver and place on the sites. All of these factors will result in less risk to human health and the environment under the one-foot alternative. Therefore, the 1-foot alternative is considered to be much better with respect to this evaluation criterion.

9. Cost

The estimated remediation-related costs for each protective soil barrier depth alternative were presented in Section 2. As indicated, the costs are expected to be significantly higher with the thicker protective soil barrier depth. These estimates were also presented relative to RAL. The estimated costs will also be significantly higher with a lower RAL because of the impact of the increased number of properties and increased volume of soil to be addressed.

5. SUMMARY AND RECOMMENDATIONS

The comparison of alternatives, based on the nine criteria, is summarized in the following table:

Evaluation Criteria	Alternatives Comparison
1. Protect Human Health and the Environment	The alternatives are equally protective.
2. Attain Media Cleanup Standards	Both alternatives will attain the RAL standard. The 1-foot depth alternative is slightly better because it will take less time to attain the standard.
3. Control Sources of Releases	The alternatives provide equal control.
4. Comply with Standards for Waste Management	The alternatives both and equally comply with waste management standards.
5. Long-term Reliability and Effectiveness	The 2-foot alternative is slightly better because it will provide a thicker barrier.
6. Reduction of Toxicity, Mobility or Volume of Wastes	The alternatives equally reduce contaminant mobility and volume.
7. Short-term Effectiveness	The 1-foot alternative is much better because it will generate half the volume of contaminated soil that will require excavation and management.
8. Implementability	The 1-foot alternative is much better because less soil volume will improve implementability.
9. Cost	Costs will be significantly less with the 1-foot soil barrier depth.

The 1-foot protective soil barrier alternative was determined to be most favorable with respect to four of the criteria (i.e., attaining media clean-up standards, short-term effectiveness, implementability, and cost). The two alternatives are rated equal with respect to four other criteria (i.e., protection of human health and the environment, source control, complying with

waste management standards, and reduction of contaminant toxicity, mobility or volume). The 2-foot alternative was found to be slightly better with respect to only one of the nine criteria (i.e., long-term reliability and effectiveness).

The conclusions of this evaluation are as follows

- Alternatives based on the use of a protective soil barrier are appropriate as corrective measures for residential properties along Cypress Creek.

- The 1-foot protective soil barrier alternative is better than the 2-foot alternative primarily because it will be more effective in the short-term, is more implementable and will have lower costs which, combined, outweigh the slight increase in long term effectiveness and reliability achieved by the 2-foot protective soil barrier alternative.

- Short-term effectiveness, implementability and cost effectiveness improve significantly with higher RALs.

Velsicol's recommendations for implementing corrective measures on residential properties near Cypress Creek are as follows:

- Provide a minimum of 1-foot of protective soil barrier to human exposure.

- Establish the highest RAL that is protective of human health. As presented in the May 10, 2006 report Human Health Risk Assessment and Development of Remedial Action Levels for Cypress Creek Sub-Area III, which was prepared by GeoSyntec Consultants on behalf of Velsicol, this equates to a representative dieldrin concentration of 3 mg/kg. This value is based on a cumulative excess cancer risk of 5.6×10^{-5} and a cumulative hazard index of 1.

- Initiate a RCRA Permit modification to define the corrective measures as described and recommended in this report as the Final Remedy for residential properties along Cypress Creek. This process will include opportunities for community input.

Note: This page was revised per direction of TDEC on June 28, 2006. gl