North Juarez Wastewater Treatment Plant

Odor Control Project
Hydrogen Sulfide Emission Control

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Phase I & Phase II Report

Alec Felhaber
President
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Executive Summary

The Junta Municipal de Agua y Saneamiento (JMAS) of the City of Juarez, Chihuahua Mx. and Degremont SA de CV the plant concessionaire and operator have been at the forefront of a bi-national effort to address concerns regarding foul odors emanating from the Planta Norte Wastewater Treatment plant. The Planta Norte abuts the Rio Grande international boundary and is located less than a mile from densely populated residential developments and schools in the El Paso Lower Valley and is also surrounded by dense residential developments on the Mexican side of the border. These subdivisions have recently organized to petition local, state and federal agencies on both sides of the border to correct the problems.

A solicitation for companies with various odor-controlling technologies was begun in early 2002 and respondents submitted technical proposals, which included injection of magnesium hydroxide into collectors throughout the city, scent masking perfumes, and ultraviolet odor decontamination systems. The technologies were tested in actual applications at the treatment plant and sewer systems. The effectiveness of the technologies in reducing the odors, specifically hydrogen sulfide (H₂S) was established and ranked. Due to funding limitations, cost was also an important consideration.

An analysis of the performance as well as costs associated with the system installation, maintenance and operation indicated that the ultraviolet air decontamination system was the best performing and least costly option. Applied Environmental Services (AES), an El Paso Environmental Consulting and Laboratory firm represented the Sol Air Systems, Inc. ultraviolet air decontamination system. Sol Air Systems, Inc. is a Canadian firm that designs, manufactures and installs air decontamination and odor controlling systems in wastewater treatment plants, rendering plants and rural hospitals.

Once the Sol Air System was accepted, technical personnel and city officials visited the company headquarters in Kelowna BC Canada. The system design, performance and production were demonstrated in detail. Additionally, the group visited wastewater treatment plants where the Sol Air systems were installed in the cities of Vancouver, Victoria, Kelowna and Vernon. At these cities, the Sol Air systems were installed and functioning with total elimination of H₂S both in the treatment plants and in the surrounding areas. Officials provided guided tours of the different processes and areas of treatment utilizing the Sol Air system.

Because of the limited funding for this project, JMAS and Degremont chose to only treat a portion of the Planta Norte, the areas requested for treatment were the pretreatment canal, lift screws and fine screed areas. These were areas previously identified by JMAS and Degremont as historically having greater odor problems. Applied Environmental Services identified other areas of the treatment plant as contributing to the odor problem but were directed not to consider these areas at this phase of the work, they included the sludge tank, sludge dewatering area, bio-solids storage and other canals and process areas.
Our Phase I contract for this project included:

- air monitoring to establish existing levels of H₂S
- installation of a temporary cover in order to contain the emissions and establish the number of ultraviolet units required to reduce the H₂S
- treatment with demo units transported from Canada and finally
- the permanent installation of two C16 L UV units and the permanent cover at the pre treatment canal

This work was accomplished and completed in February of 2003. At this time, the analysis was completed and the total recommended number of units to treat these areas were established and proposed for installation at Phase II of the contract, as well as recommendation for the permanent cover at the lift screws.

In July of 2004, Phase II began and consisted of installing a temporary cover at the lift screws in order to contain the emissions and measure the H₂S concentrations, followed by the installation of the permanent cover at the lift screws and finally placing the recommended UV units. The UV units to be placed were one C48L and one C32L at the entrance to the pre-treatment canal, one C48L and one C32L at midway of the pretreatment canal, one C32L at the base and one C32L at the top of the lift screws and two C16Ls’ at the fine screed area, in addition to the two Phase I C16Ls’. Once the temporary cover was placed, measurements indicated higher levels of H₂S gases than were measured at the design portion of Phase I. The cause of the elevated levels is suspected to be changes in the waste stream and/or changes in the process, although this has not been studied. Regardless of the elevated levels, the Sol Air system was able to perform as originally designed due to the installation of the advanced third generation lamps provided to the client at no additional cost, and the safety factors calculated in the design to handle peaks in the H₂S levels.

The system was completely installed for a September 29, 2004 meeting held on site between the bi-national agencies, the system was performing as designed with supplemental electrical generators and cords and measured levels of H₂S were at acceptable levels.

Finally, a verification H₂S measurement protocol was designed by AES and accepted by JMAS and Degremont. It consisted of measuring H₂S levels under the permanent covers and upwind and downwind of the treatment areas. All three parties participated in the verification and the results indicate the system reduced the H₂S levels to near zero around the treatment areas and significantly lowered levels under the permanent covers.

A project completion ceremony and signing of the project turnover was conducted on January 12, 2005. All systems are currently functioning and all contractual obligations by AES have been met and/or surpassed.
Planta Norte Wastewater Treatment Plant Aerial Photograph

1.) Entrance to pretreatment canal
2.) Coarse Bar screen
3.) Pre-Treatment Canal
4.) Archimedes Lift Screws
5.) Fine Screen
6.) Sand & grease remover
7.) Flocculation canals
8.) Sludge Tank
9.) Sludge Dewatering press
10.) Chlorination
11.) Bio-solids storage area
INTRODUCTION

Facility Background:
The Planta Tratadora Norte de Aguas Residuales in Cd. Juarez, Chihuahua, (Planta Norte) is located in the Juarez Valley community, on a 23.6-hectare lot and is situated abut the Rio Grande, bordering the city of El Paso, Texas. The facility is designed to treat 52.5 million gallons per day (MGD) or 2.3 cubic meters per second (m³/s). The purpose of this facility is to provide primary treatment to the northwest section of the city. The facility consists of coarse grid screen filters, lift screws, fine grid screen filters, sand/grease removal canals, flocculation canals, sludge tanks, sludge dewatering and chlorination canals. The sludge generated from the treatment plant is conveyed on a belt drive into waiting trucks and hauled off-site for disposal.

Conflict:
Odors emanating from treatment plants are usually attributed to the decomposition of fats, protein and carbohydrates often under anaerobic conditions, which lead to the release of volatile or semi volatile compounds into the atmosphere. Sulfite production, a bi-product from the reduction of available sulfate, produces the recognizable pungent hydrogen sulfide (H₂S) emission, which is the source for complaints.

The nuisance odor has become more apparent as nearby land is utilized for residential housing on the Mexican side of the border. Prevailing winds, which tend to flow from southwest to northeast for a large portion of the year, carry the emissions to densely populated residential developments just north of the plant on the American side located less than a mile from the treatment plant.

These residential subdivisions have organized and petitioned local, state and federal representatives to find a solution to this growing public health concern. Bi-national agencies, and especially the Public Utility Department of the City of Juarez (Junta Municipal de Agua y Saneamiento-JMAS) as well as Degremont, the plant concessionaire, have been actively pursuing a viable solution.

At this facility, this progression is further amplified due to the antiquated sewer design in the older section of northwest Juarez. Sewer systems are designed with a specified slope in order for gravity to rapidly dispose of wastewater and bio-solids. However, some of the city’s areas do not have the proper slope. This causes the bio-solids to remain in the sewer lines for longer periods of time, increasing the rate of biodegradation, specifically, raising the levels of H₂S.

As the wastewater reaches the entrance to the pre-treatment canal, the problem becomes evident. Degremont and JMAS indicated that these areas at and near the entrance to the plant consisting of the pretreatment canal, lift screws and fine screen areas are the areas where historically higher levels of H₂S have existed. The untreated water is agitated due to the high velocity with which it enters and the 90° change in direction. As the water is agitated in this fashion, gases are released, primarily H₂S. Once in the pre-treatment canal, the waste stream follows the canal through the coarse bar screens and into the second part of the canal, where it then goes up the Archimedes screws and passes through the fine screen. The installation of the Sol Air Ultraviolet Decontamination system is limited to
only these portions of the plant, although other areas have been monitored and indicate the presence of H$_2$S emissions and contribute to the complaints from the surrounding residential developments.

**Technologies Considered:**
The coordination between JMAS and Degremont resulted in the solicitation and testing of various technologies to attempt to reduce the odor emitted from the Planta Norte. They established a plan to monitor the zone and determine the levels of H$_2$S. Technological approaches considered consisted of the following:

- injection of magnesium hydroxide in drainage collectors throughout the city
- use of diverse scent masking products
- utilization of Sol Air Systems Ultraviolet Air Decontamination System

Additionally, an extensive forestation plan consisting of planting approximately 600 trees along the perimeter of the treatment plant, has been completed with additional seeding planned in the near future.

Upon completion of the solicitation and testing process, JMAS and Degremont concluded that Sol Air Systems Ultraviolet Decontamination System was the most effective in reducing H$_2$S emissions and was considerably less costly to install and maintain. As the U.S. and Mexico border region representative of Sol Air Systems, Inc. Applied Environmental Services (AES) utilized its expertise in the field of air testing and analysis as well as emissions reduction system implementation to successfully reduce the H$_2$S levels to near zero in the vicinity of the areas where the system was implemented.

**Sol Air Systems:**
Sol Air Systems Inc. (SAS), based in Canada, presented a highly advanced technological system that eliminates atmospheric contaminants through ultraviolet air decontamination and purification. Their system utilizes patented and patent-pending technology that harnesses the ultraviolet light ranges known as oxidizing ultraviolet (UVV) and germicidal ultraviolet (UVC) rays. The wavelength frequencies of these two ranges neutralize a wide variety of biological pathogens and chemical pollutants. This combination is especially effective in deodorizing and oxidizing undesirable air born gases and particulates, including H$_2$S, organic sulfides, bacteria, mold and odor causing volatile organic compounds.

**Ultraviolet Units:**
Sol Air’s patented combination of UVV and UVC rays is the primary reason for its success. The contaminated air is first directed into the ultraviolet light chamber where it is irradiated with combined UVV and UVC frequencies, which are then injected into the treatment area, that is a volume of air in the treatment canals, lift screws and other areas contained with at permanent cover to allow treatment.

The way in which the units work is that ultraviolet energy catalyzes the breakdown of ambient air, ambient water vapor and other molecules into a chain of reactions that ultimately and quickly degrade the contaminant. The UV oxidation process is as follows:
The ultraviolet light catalyses the breaking of ambient oxygen and water vapor molecules into O⁻ and OH⁻ hydroxyl radicals. These short-lived free radicals go on to do oxidation over the more complex molecules of the contaminants, with the radicals themselves getting used up in the process. The end result is a sequential and instantaneous gas breakdown with very little byproduct, in the form of odor and elemental traces, but mostly simple, harmless CO₂, water vapor, molecular oxygen, trace ozone, elemental forms of N, S, Cl, and weak mineral acids.

**Canada Case Studies:**
As part of the technical solicitation, AES arranged for technical and management representatives of the JMAS and Degremont to visit Sol Air Systems, Inc.’s headquarters and manufacturing facility located in Kelowna, BC. The technical and production aspects of the system were demonstrated in a classroom setting. Additionally, this team visited wastewater treatment plants in the cities of Vancouver, Victoria, Kelowna and Vernon where the Sol Air system was implemented. The visits to the plants, observations and air measurements indicated complete elimination of H₂S and the associated odors from the plants and the surrounding communities. Plant operators and city officials expressed the success of the system and the political/social benefits of working with the affected populations.

**Case Studies:**

**Case 1:**
- **Location:** Vernon, B.C.
- **Wastewater Treatment and Reclamation**
- **Problem:** Citizens complained about offensive odor
- **Solution:**
  1. Sol-Air placed four modified UV units having four lamps each in the grit room and headworks
  2. In the case of the trickling filter, Sol-Air placed four larger custom units with 11 lamps each
- **Results:** Odors eliminated at a fraction of the cost of other odor technology

**Case 2:**
- **Location:** Summerland, B.C.
- **Summerland Wastewater Treatment Plant**
- **Problem:** Sulfurous odors were escaping from a lift station into lakeside park, prompting complaints by recreationists
- **Solution:** Sol-Air installed a portable four lamp unit, with its own fan
- **Results:** Odor problem near lake eliminated
Case 3: Kelowna, B.C.
Water & Wastewater Operations

Problem:
1. Overbearing fumes inside dewatering facility
2. Strong odors in the grit room and headworks

Solution:
1. A single 40 lamp unit with an industrial fan with additional ductwork
2. A couple of portable, four lamp units at the grit room and headworks

Results: Offensive odors eliminated at dewatering room, grit room and headworks

Applied Environmental Services:
Applied Environmental Services, based in El Paso, Texas, is an environmental consulting firm and the representative for Sol Air Systems. It offers a full range of consulting and laboratory services specializing in indoor air and emission sampling and analysis. Applied Environmental Services was hired by JMAS and Degremont to test, install, maintain and study the performance of the Sol Air system.

Once contracted, AES proceeded to propose Phase I of the project. Phase I consisted of installing ultraviolet units as demos to demonstrate the effectiveness of the system in the Planta Norte. Based on findings, it was determined that H$_2$S concentrations had been significantly reduced. Phase I concluded with JMAS purchasing two C16L units and the installation of the permanent cover at the pre-treatment canal.
PHASE I

Procedure:
Initial baseline measurements were taken to establish current hydrogen sulfide (H$_2$S) levels at the pre-treatment canal, where the client indicated the majority of the foul odors were centralized. Readings at the pretreatment canal and surrounding areas averaged between 20 and 30 parts per million (ppm) of H$_2$S with peak readings measuring near 50 ppm.

After initial measurements were taken, a plan to enclose the pre-treatment canal, which measures approximately 160 feet long and 17 feet wide, was developed. This area was covered temporarily with a polyethylene plastic containing nylon reinforcement. In this manner, the odor was encapsulated in a confined area where the neutralization process would be much more effective. (See Figure 1 in Appendix D)
Due to the large size of the canal, it was divided into two sections by installing vertical curtains that dropped to the water level. The entrance was selected as Test Area #1 and the area after the coarse bar screens as Test Area #2. Test Area #1 is approximately 20 feet long by 17 feet wide. Hydrogen sulfide measurements were taken with peak readings reaching up to 260 ppm. Two vertical polyethylene plastic curtains were placed on the lateral air registers to further seal the entrance. With Test Area #1 completely enclosed, additional H$_2$S measurements were taken producing results of up to 260 ppm. (See Figure 2 in Appendix D)

Test Area #1, identified as generating the highest H$_2$S concentrations, required additional ultraviolet units, in comparison to Test Area #2, for effective treatment. During Phase I of this project, several combinations of ultraviolet units were taken into account. With the last relocation of units, the levels of H$_2$S were reduced approximately 90% inside the pre-treatment canal and eliminated in the surrounding areas.
Testing and Measuring Equipment:
The equipment utilized at the Planta Norte for Phase I is summarized in Table 1.

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Equipment Name</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>Unit of 48 lamps</td>
<td>C48LF</td>
<td>1</td>
</tr>
<tr>
<td>Unit of 16 lamps</td>
<td>C16LF</td>
<td>1</td>
</tr>
<tr>
<td>Units of 8 lamps</td>
<td>C8LF</td>
<td>2</td>
</tr>
<tr>
<td>H₂S meter</td>
<td>Draeger PAC III Single Gs</td>
<td>1</td>
</tr>
<tr>
<td>H₂S meter</td>
<td>GT-2400 Gas Tech</td>
<td>1</td>
</tr>
<tr>
<td>H₂S meter</td>
<td>Ashtead Sensors T82 (ISC T82-H2S) Single Gas</td>
<td>2</td>
</tr>
</tbody>
</table>

+ During H₂S measurements, meter concentrations varied by 2 to 3 ppm
Results:

February 15, 2003 Results

Table 2: H$_2$S Measurements for February 15, 2003

<table>
<thead>
<tr>
<th>Time</th>
<th>Area</th>
<th>Measurement Location</th>
<th>H$_2$S Levels (ppm)</th>
<th>Action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 AM</td>
<td>Test Area #1</td>
<td>Air Register #1</td>
<td>65</td>
<td>Without treatment and without curtains</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>Test Area #1</td>
<td>Air Register #2</td>
<td>77</td>
<td>Without treatment and without curtains</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>60</td>
<td>Without treatment and without curtains</td>
<td></td>
</tr>
<tr>
<td>10:40 AM</td>
<td>Test Area #1</td>
<td>Air Register #1</td>
<td>37</td>
<td>Without treatment and with curtains</td>
<td>Vertical curtains installed but without treatment</td>
</tr>
<tr>
<td>10:40 AM</td>
<td>Test Area #1</td>
<td>Air Register #2</td>
<td>35</td>
<td>Without treatment and with curtains</td>
<td></td>
</tr>
<tr>
<td>10:40 AM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>200</td>
<td>Without treatment and with curtains</td>
<td>(Significant increase in concentrations)</td>
</tr>
<tr>
<td>11:00 AM</td>
<td>Test Area #1</td>
<td>Corner #1</td>
<td>216</td>
<td>Without treatment and with curtains</td>
<td></td>
</tr>
<tr>
<td>11:00 AM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>260</td>
<td>Without treatment and with curtains</td>
<td></td>
</tr>
<tr>
<td>11:30 AM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>140</td>
<td>With a C16LF unit operating</td>
<td>Introduction of UV unit in Test Area #1 and with vertical curtains installed</td>
</tr>
<tr>
<td>12:10 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>190</td>
<td>With a C16LF unit operating</td>
<td>(Decrease in overall concentrations)</td>
</tr>
<tr>
<td>12:10 PM</td>
<td>Test Area #1</td>
<td>Corner #1</td>
<td>190</td>
<td>With a C16LF unit operating</td>
<td></td>
</tr>
<tr>
<td>12:50 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>30</td>
<td>With a C16LF unit operating</td>
<td></td>
</tr>
<tr>
<td>12:50 PM</td>
<td>Test Area #2</td>
<td>Peak (yellow platform)</td>
<td>45</td>
<td>With a C16LF unit operating</td>
<td></td>
</tr>
<tr>
<td>2:00 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>149</td>
<td>32 Lamps operating</td>
<td></td>
</tr>
<tr>
<td>2:00 PM</td>
<td>Test Area #1</td>
<td>Corner #1</td>
<td>55</td>
<td>32 Lamps operating</td>
<td></td>
</tr>
<tr>
<td>3:25 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>120</td>
<td>32 Lamps operating</td>
<td></td>
</tr>
<tr>
<td>3:25 PM</td>
<td>Test Area #1</td>
<td>Corner #1</td>
<td>46</td>
<td>32 Lamps operating</td>
<td></td>
</tr>
<tr>
<td>3:25 PM</td>
<td>Test Area #1</td>
<td>Outside Canal</td>
<td>19</td>
<td>32 Lamps operating</td>
<td></td>
</tr>
<tr>
<td>4:00 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>120</td>
<td>64 Lamps operating</td>
<td></td>
</tr>
<tr>
<td>4:05 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>25</td>
<td>64 Lamps operating</td>
<td></td>
</tr>
<tr>
<td>4:25 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>125</td>
<td>64 Lamps operating</td>
<td></td>
</tr>
</tbody>
</table>

+ Temporary cover was installed throughout the day

Applied Environmental Services
### Table 3: H₂S Measurements for February 16, 2003

<table>
<thead>
<tr>
<th>Time</th>
<th>Area</th>
<th>Measurement Location</th>
<th>H₂S Levels (ppm)</th>
<th>Action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:30 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>55</td>
<td>64 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>12:40 PM</td>
<td>Test Area #1</td>
<td>Air Register #1</td>
<td>30</td>
<td>64 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>12:45 PM</td>
<td>Test Area #1</td>
<td>Outside Canal</td>
<td>13</td>
<td>64 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>12:55 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>8</td>
<td>64 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>1:35 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>9</td>
<td>64 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>1:40 PM</td>
<td>Test Area #2</td>
<td>Air Register #1</td>
<td>55</td>
<td>64 Lamps operating with curtains</td>
<td>UV units installed in Test Areas #1 and #2 with vertical curtains (Decrease in overall concentrations)</td>
</tr>
<tr>
<td></td>
<td>Test Area #2</td>
<td>Air Register #2</td>
<td>27</td>
<td>64 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>2:10 PM</td>
<td>Test Area #2</td>
<td>Air Register #1</td>
<td>3</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>2:10 PM</td>
<td>Test Area #2</td>
<td>Air Register #2</td>
<td>7</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>2:10 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>67</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>2:25 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>13</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>2:50 PM</td>
<td>Test Area #2</td>
<td>Water Spicket</td>
<td>54</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>2:50 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>13</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>2:50 PM</td>
<td>Test Area #1</td>
<td>Outside Canal</td>
<td>9</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>3:15 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>63</td>
<td>80 Lamps operating and without curtains</td>
<td>Vertical curtains lifted</td>
</tr>
<tr>
<td>4:00 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>77</td>
<td>80 Lamps operating and with curtains</td>
<td>UV units rearranged and vertical curtains installed</td>
</tr>
</tbody>
</table>

+ Temporary cover was installed throughout the day
### February 17, 2003 Results

**Table 4: H₂S Measurements for February 17, 2003**

<table>
<thead>
<tr>
<th>Time</th>
<th>Area</th>
<th>Measurement Location</th>
<th>H₂S Levels (ppm)</th>
<th>Action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 AM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10:00 AM</td>
<td>Test Area #1</td>
<td>Corner #1</td>
<td>30</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>10:00 AM</td>
<td>Test Area #1</td>
<td>Corner #2</td>
<td>27</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>10:00 AM</td>
<td>Test Area #1</td>
<td>Air Register #1</td>
<td>53</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>10:00 AM</td>
<td>Test Area #1</td>
<td>Air Register #2</td>
<td>47</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>10:00 AM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>16</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>10:00 AM</td>
<td>Test Area #1</td>
<td>Outside Canal</td>
<td>0</td>
<td>80 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>1:00 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>70</td>
<td>Without Treatment and with curtains</td>
<td>(Increase in concentrations)</td>
</tr>
<tr>
<td>1:00 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>27</td>
<td>Without Treatment and with curtains</td>
<td>(Increase in concentrations)</td>
</tr>
<tr>
<td>1:45 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>15</td>
<td>32 Lamps operating with curtains</td>
<td>C16LF and 2-C8LF units operating in Test Area #2</td>
</tr>
</tbody>
</table>

+ Temporary cover was installed throughout the day

### February 18, 2003 Results

**Table 5: H₂S Measurements for February 18, 2003**

<table>
<thead>
<tr>
<th>Time</th>
<th>Area</th>
<th>Measurement Location</th>
<th>H₂S Levels (ppm)</th>
<th>Action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 AM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>200</td>
<td>32 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>11:25 AM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>27</td>
<td>32 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>11:30 AM</td>
<td>Test Area #1</td>
<td>Outside Canal</td>
<td>17</td>
<td>32 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>12:15 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>27</td>
<td>32 Lamps operating with curtains</td>
<td></td>
</tr>
<tr>
<td>12:50 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>12</td>
<td>64 Lamps operating with curtains</td>
<td>2-C8LF, 1-C16LF, and 1-C48LF units operating in Test Area #2 with curtains</td>
</tr>
</tbody>
</table>

+ Temporary cover was installed throughout the day
### February 19, 2003 Results

**Table 6:** H$_2$S Measurements for February 19, 2003

<table>
<thead>
<tr>
<th>Time</th>
<th>Area</th>
<th>Measurement Location</th>
<th>H$_2$S Levels (ppm)</th>
<th>Action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 AM</td>
<td>Test Area #1</td>
<td>Air Register #1</td>
<td>130</td>
<td>64 Lamps operating without curtains</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Test Area #1</td>
<td>Air Register #2</td>
<td>130</td>
<td>64 Lamps operating without curtains</td>
<td></td>
</tr>
<tr>
<td>10:15 AM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>50</td>
<td>64 Lamps operating without curtains</td>
<td></td>
</tr>
<tr>
<td>10:20 AM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>160</td>
<td>64 Lamps operating without curtains</td>
<td></td>
</tr>
<tr>
<td>11:10 AM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>65</td>
<td>48 Lamps operating without curtains</td>
<td></td>
</tr>
<tr>
<td>11:20 AM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>215</td>
<td>48 Lamps operating without curtains</td>
<td></td>
</tr>
<tr>
<td>11:25 AM</td>
<td>Test Area #1</td>
<td>Air Register #1</td>
<td>170</td>
<td>48 Lamps operating without curtains</td>
<td></td>
</tr>
<tr>
<td>12:20 PM</td>
<td>Test Area #1</td>
<td>Water Spicket</td>
<td>170</td>
<td>48 Lamps operating without curtains</td>
<td></td>
</tr>
<tr>
<td>12:20 PM</td>
<td>Test Area #2</td>
<td>Yellow Platform</td>
<td>100</td>
<td>48 Lamps operating without curtains</td>
<td></td>
</tr>
<tr>
<td>12:30 PM</td>
<td>Test Area #1</td>
<td>Outside Canal</td>
<td>25</td>
<td>48 Lamps operating without curtains</td>
<td></td>
</tr>
</tbody>
</table>

+ Temporary cover was installed throughout the day

With 2-C8LF, 1-C16LF, and 1-C32LF units operating without curtains

Several UV units disconnected

1-C16LF, and 1-C32LF units operating without curtains

(Increase in concentrations)

*Applied Environmental Services* 14


**Conclusion:**

After having observed and studied the pretreatment canal, it was determined that the entrance is where the H$_2$S levels were the highest. With the help of the temporary cover and vertical curtains, the entrapment of the H$_2$S emissions was accomplished and treatment/elimination of H$_2$S was much more efficient. In this area of the canal, the H$_2$S levels reached 260 ppm without any ultraviolet unit functioning, and 30 ppm in the surrounding areas outside the canal. The area mentioned above began to be treated with a unit of 16 lamps. After observing the reduction in the levels, we then proceeded to increase the number of lamps and the position of the units. All the units available at the time (80 lamps) were then positioned to inject treated air into Test Area #1. The results were successful, as levels dropped to 26 ppm in the entrance to the canal, 16 ppm in the canal, and 0 ppm outside with the last relocation of the ultraviolet units. Figure 1 visually illustrates the reduction in the concentration of H$_2$S with the number of ultraviolet lamps. It was concluded that additional ultraviolet units were needed in Test Area #1, eliminating 90% of H$_2$S levels, and eliminating levels outside the contained structure.

![Figure 1: No. of UV Lamps vs. H$_2$S Levels](image)

Following these results, two C16LF units were permanently installed at the entrance to the canal after the coarse bar screens. In addition, the temporary cover, which sat at the top of the canal, was removed and a permanent cover installed two meters above the waste stream. The remaining ultraviolet units were to be installed when funding was available.
**Recommendations:**

Based on the results obtained during the test performed at the Planta Norte, SAS and AES made the following recommendations:

1. For Test Area #1 (Entrance), it was recommended to have 2, C48LF units (96 total lamps), due to the fact that this is the area with the highest H₂S concentrations.
2. For Test Area #2, it was recommended to have, at all times, 2, C32LF units (64 total lamps), with the purpose of rounding the work performed in Test Area #1, assuring lower levels flow down.
3. For the area below the Archimedes screws, and the screws themselves, it is recommended to place 2, C32LF units (64 total lamps) as well as the previously purchased 2, C16LF units (32 total lamps).
4. For the area of fine screening, it is recommended to use 2, C16LF units (32 total lamps) in order to assure the entire elimination of odors.
5. The installation of ventilators (without UV) injecting air down the screening areas can contribute to maintain the odors encapsulated.
6. Install permanent covers, due to the fact that they prove to maintain the contaminants encapsulated. Also, it is recommended to place the covers at a height no greater than two (2) meters above the waste stream.
PHASE II

Applied Environmental Services (AES) was contracted by Degremont S.A de C.V (DSA) and Junta Municipal de Agua y Saneamiento (JMAS) to further install, maintain and study the performance of the Sol Air Odor Control Ultraviolet Systems. The purpose was to duplicate the performance demonstrated in Phase I of the project. Phase I was completed in February of 2003 and was followed by Phase II in September of 2004.

Phase II consisted of the installation of several units in the pre-treatment area together with the lift screws and fine screen area. During this phase of the project, a temporary, followed by a permanent cover was installed at the Archimedes Screws. Although AES identified other areas of the facility as contributing significant hydrogen sulfide (H_{2}S) emissions, we were contracted only to test and treat the above-mentioned areas for this phase of the work.

Procedure:
Prior to the beginning of Phase II, it was determined that the areas to focus on were the pre-treatment canal, lift screws and the fine screen area. These general locations were established in the preliminary design phase of the project as the areas where maximum reductions in H_{2}S could be achieved based on preliminary testing utilizing electrochemical H_{2}S monitors.

Testing during Phase II indicated significantly higher levels of H_{2}S at the pre-treatment canal and lift screw areas than were recorded in the preliminary phase (See Appendix C for H_{2}S monitoring logs). Although we were not aware of any changes to the waste stream, we were informed by Degremont that an alteration to the treatment process had been made. In order to accelerate the coagulation process at the entrance to the pre-treatment canal, aluminum sulfate was added at the entrance to the plant. It was not in our scope of work to verify or test the new process and this may or may not be the reason for higher levels H_{2}S.
This increase in concentrations at the lift screws may have been the result of larger particles or clusters of biosolids being impacted and mechanically altered by the screws. This prompted a change to the original design, which consisted of installing an air duct distribution system at the base and at the top of the lift screws. This divided the injection process equally among the three canals and distributed treated air containing hydroxyl radicals to both the operating screws as well as the standby screw.

Initial baseline measurements to establish current H$_2$S levels for Phase II began on September 8, 2004. Hydrogen sulfide monitors were placed inside the pre-treatment canal and along the north boundary fence line. The purpose for placing the monitors in these areas was to measure current levels inside the canal with the permanent cover in place but without vertical curtains to restrict emissions from emanating and following established wind patterns. The monitors at the fence line were in the direction of the northern U.S./Mexico border and correlates to the complaints generated by residents and officials on the U.S. side of the border.

Applied Environmental Services then proceeded with the installation of a temporary cover over the lift screws. This was to assist in determining the levels of H$_2$S at different locations of the pretreatment canal, lift screws and fine screen areas. It also helped to determine the best placement for the ultraviolet units. The installation of the temporary cover was completed on September 11, 2004. Units were then installed along the pretreatment canal to establish odor reductions in this area and the optimal placement of units. Subsequently units were added at the lift screws and at the fine screen areas.
The following unit configuration was installed:

- One C48L and one C32L at the pretreatment canal entrance
- One C48L and one C32L midway of the pretreatment canal
- One C32L at the base of the lift screws
- One C32L at the top of the lift screws
- Four C16L at the fine screen area

Before testing could be completed using the temporary cover, AES was asked to change the work plan and install the permanent cover and all of the purchased units for a demonstration. Federal, state, and local officials from U.S. and Mexican agencies were scheduled to have a September 29, 2004 meeting and observe the full implementation of the ultraviolet system. At this point, the temporary cover was removed and the installation of the permanent cover began.
At this time, the electrical system which was to be installed by the client, was not in place. Temporary generators and extension cords were used to demonstrate the performance of the units. Prior to the demonstration, all permanent covers, ultraviolet decontamination units and temporary air ducts were fully installed and operating for a 48-hour period.

The system performed as designed and achieved greater reductions in H₂S levels than was originally planned. After the meeting, several U.S. regulatory agencies as well as AES, measured H₂S levels indicating near zero ppm outside the containment. The temporary generators were then removed and replaced by electrical cords. The current electrical grid was not of sufficient capacity and several of the circuits failed, causing approximately half of the units to be without service until permanent electrical service was installed on November 15, 2004. At this time, all units were functioning as designed and with the exception of minor modifications to the air ducts, the system was complete.
Testing and Measuring Equipment:
The equipment utilized at the Planta Norte for Phase II is summarized in Table 8.

Table 7: Equipment Utilized During Phase II

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Equipment Name</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit of 48 lamps</td>
<td>C48LF</td>
<td>2</td>
</tr>
<tr>
<td>Unit of 32 lamps</td>
<td>C32LF</td>
<td>4</td>
</tr>
<tr>
<td>Units of 16 lamps</td>
<td>C16LF</td>
<td>4</td>
</tr>
<tr>
<td>H₂S meter</td>
<td>Odalog</td>
<td>3</td>
</tr>
<tr>
<td>H₂S meter</td>
<td>GT-2400 Gas Tech</td>
<td>1</td>
</tr>
</tbody>
</table>

+ During H₂S measurements, meter concentrations varied by 2 to 3 ppm

Results:

Table 8: H₂S Measurements for Phase II

<table>
<thead>
<tr>
<th>Time</th>
<th>Event No.</th>
<th>Measurement Location</th>
<th>H₂S Levels (ppm)</th>
<th>Action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 AM</td>
<td>1</td>
<td>Perimeter Fence</td>
<td>2.6</td>
<td>Without treatment and without curtains</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>1</td>
<td>Pre-treatment Canal</td>
<td>51</td>
<td>Without treatment and without curtains</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>1</td>
<td>Downwind from Canal</td>
<td>1.1</td>
<td>Without treatment and without curtains</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>2</td>
<td>Perimeter Fence</td>
<td>0.7</td>
<td>Without treatment</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>2</td>
<td>Pre-treatment Canal</td>
<td>98</td>
<td>Without treatment</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>2</td>
<td>Canal Entrance</td>
<td>321</td>
<td>Without treatment</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>2</td>
<td>Archimedian Lift Screws</td>
<td>197</td>
<td>Without treatment</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>3</td>
<td>Perimeter Fence NW</td>
<td>0</td>
<td>All units operating</td>
<td>Initial Baseline Measurements without the temporary cover at Lift Screws</td>
</tr>
<tr>
<td>10:30 AM</td>
<td>3</td>
<td>Pre-treatment Canal</td>
<td>24</td>
<td>All units operating</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>3</td>
<td>Perimeter Fence NE</td>
<td>0.2</td>
<td>All units operating</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>4</td>
<td>Pre-treatment Canal</td>
<td>85</td>
<td>Without treatment but with curtains and cover</td>
<td>Temporary cover installed at the Lift Screws on September 11, 2004</td>
</tr>
<tr>
<td>10:30 AM</td>
<td>4</td>
<td>Sludge Tank</td>
<td>673</td>
<td>Without treatment but with curtains and cover</td>
<td></td>
</tr>
<tr>
<td>10:30 AM</td>
<td>4</td>
<td>Ambient Air Sand Trap Area</td>
<td>7.3</td>
<td>Without treatment but with curtains and cover</td>
<td>All units were turned off for verification purposes (Significant increase in levels)</td>
</tr>
</tbody>
</table>

Applied Environmental Services
**Conclusion:** Based on the above measurements of $\text{H}_2\text{S}$, it is clear that the Sol Air Ultraviolet System functioned as designed. In fact, the system reduced the levels of higher average concentrations and substantially higher peaks than those that were tested in February of 2003. These results served as the basis for our design and recommended units. The monitoring illustrates how $\text{H}_2\text{S}$ emissions, when contained with a cover, elevate to levels between 500 and 700 ppm.

After treatment began and the units were functioning, a corresponding reduction in both the trapped, treated air, and ambient air immediately adjacent to the treated area were also significantly reduced, with ambient air levels at the perimeter fence averaging close to zero ppm. Subsequently when the units were turned off, a corresponding increase in $\text{H}_2\text{S}$ levels can be observed.

The ambient air in the vicinity of the fine screen areas had slightly higher averages than in the perimeter fence. We concluded that this was due to cross contamination from adjacent areas, which were not part of our current contract for treatment. Specifically, extremely high levels of $\text{H}_2\text{S}$ emissions were detected at the digester tank (above 1200 ppm) and the sludge dewatering area (above 700 ppm).

According to the measurements obtained and presented in the Table 8, the $\text{H}_2\text{S}$ levels were reduced significantly during ultraviolet lamp treatment inside the contained volume of air and corresponding levels reduced outside the contained areas. Figure 2 visually illustrates the reduction in the concentration of $\text{H}_2\text{S}$ with the number of ultraviolet lamps installed. The data is conclusive to show the operational equipments’ capacity to successfully achieve the purpose of this test.

![Figure 2: No. of UV Lamps vs. $\text{H}_2\text{S}$ Levels](image-url)
**Recommendations:**
Based on tests and results obtained during the implementation of Phase II at the Planta Norte de Cd. Juarez, SAS and AES made the following recommendations:

1. Conduct comprehensive testing of the untreated areas with emphasis on the digester tank and sludge dewatering area, in order to make a recommendation for treatment in these areas.
2. Conduct periodic air monitoring in the covered and contained areas in order to determine if H$_2$S levels continue to increase. Should a significant increase in the level of H$_2$S occur, additional UV units may be required.
The following verification tests are based on the protocol established by Applied Environmental Services (AES) and approved by Degremont S.A. de C.V. and the Junta Municipal de Agua y Sanamiento (JMAS). The sampling was conducted by Alec Felhaber (AES), Orlando Zepeda (Degremont), and Miguel De la Torre (JMAS). The sampling consisted of utilizing Odalog hydrogen sulfide (H$_2$S) gas loggers in the established downwind and upwind areas as well as the air treated under the permanent covers in the pre-treatment canal and Archimedes screws. This monitoring was limited to the treatment area in our contract. It does not include any other previously identified areas with H$_2$S emissions.

**Procedure:**
Initial baseline readings were taken during the first 24-hour period to establish the existing H$_2$S levels in the pre-treatment canal and Archimedes Screws with the permanent cover in place. In addition, all ultraviolet units were installed and functioning with the exception of two C16L units (32 total lamps) that were removed from the area to treat other areas excluded in our contract.

During the second day, all ultraviolet units were turned off to allow the H$_2$S levels to elevate and reach peaks without treatment under normal operations. The wind speed and direction were determined at the beginning of each monitoring period. Readings were taken from the State of Texas MAQS mobile weather monitoring station at the Delphi automotive plant located in Cd. Juarez, Chihuahua. This monitoring station is located approximately 3 miles from the Planta Norte, and to compensate for the distance, a visual reading was taken utilizing the wind cones located in the plant premises. It was proposed to adjust the location of the H$_2$S gas loggers if a significant difference in the wind direction existed between locations. This was never the case during our monitoring periods.

On the third day, all ultraviolet units were turned back on to proceed with the air treatment under the permanent covers. This process continued on the fourth and fifth days to establish base readings, which would formulate statistically significant results. The placement of the monitoring equipment along with the daily data was verified and accepted by all entities involved.
Protocol:

**Day 1:**
The wind speed and direction were determined from the State of Texas MAQS at the beginning of the monitoring period to establish prevailing winds. To compensate for the distance, a visual reading utilizing the wind cones located inside the facility was taken. An Odalog monitor was placed upwind approximately 20 to 30 meters from the pre-treatment canal.

An Odalog monitor was placed underneath the permanent cover to establish the concentration in the treatment area. A 24-hour reading to establish the possible daily concentrations was taken. At this point, we have to be aware that daily averages fluctuate and that this will be utilized only for comparison purposes of real time.

**Day 2:**
The wind speed and direction were determined from the State of Texas MAQS at the beginning of the monitoring period to establish prevailing winds. To compensate for the distance, a visual reading utilizing the wind cones located inside the facility was taken. An Odalog monitor was placed upwind approximately 20 to 30 meters from the pre-treatment canal.

The entire ultraviolet units were disconnected for a period of 24 hours to permit stabilization.

**Day 3:**
The wind speed and direction were determined from the State of Texas MAQS at the beginning of the monitoring period to establish prevailing winds. To compensate for the distance, a visual reading utilizing the wind cones located inside the facility was taken. An Odalog monitor was placed upwind approximately 20 to 30 meters from the pre-treatment canal.

The entire UV units were re-connected in place and left to inject treated air from 24 to 48 hours.

**Days 4 and 5:**
The wind speed and direction were determined from the State of Texas MAQS at the beginning of the monitoring period to establish prevailing winds. To compensate for the distance, a visual reading utilizing the wind cones located inside the facility was taken. An Odalog monitor was placed upwind approximately 20 to 30 meters from the pre-treatment canal.

The Odalog readings were downloaded and a report compiled utilizing the results obtained.
Measurements:

Monday 1/10/2005 - Tuesday 1/11/2005

Wind information was obtained from MAQS:

Time: 1:18 pm   Dominant wind direction: 280°   Wind speed: 4.2 mph
Wind cone verification: same as MAQS

Present: Alec Felhaber - AES, Orlando Zepeda - Degremont, Miguel De La Torre - JMAS, Daniel Licon - AES

We placed the Odalog monitors with serial #1490-upwind, #0176-underneath the permanent cover at the treatment area and #1239-downwind.
All UV units are installed and operating.

Tuesday 1/11/2005 - Wednesday 1/12/2005

Wind information was obtained from MAQS:

Time: 8:35 am   Dominant wind direction: 109°   Wind speed: 1.9 mph
Wind cone verification: same as MAQS

Present: Alec Felhaber - AES, Orlando Zepeda - Degremont, Miguel De La Torre - JMAS, Daniel Licon - AES

We placed the Odalog monitors with serial #1490-upwind, #0176-underneath the permanent cover at the treatment area and #1239-downwind.
All UV units are installed and operating.

9:10 am: We started to obtain the Odalog information utilizing a laptop and infrared sensors.

10:31 am: All Odalog monitors were placed.

10:45 am: All Sol Air UV units were disconnected to permit the H₂S levels to stabilize.
Wednesday 1/12/2005 - Thursday 1/13/2005

Wind information was obtained from MAQS:

Time: 12:01 pm  Dominant wind direction: 269°  Wind speed: 9.0 mph.
Wind cone verification: same as MAQS

Present: Alec Felhaber - AES, Orlando Zepeda - Degremont, Miguel De La Torre - JMAS, Daniel Licon - AES

We placed the Odalog monitors with serial #1490-upwind, #0176-underneath the permanent cover at the treatment area and #1239-downwind.
All UV units are installed and operating.

12:30 pm:  We started to obtain the Odalog information utilizing a laptop and infrared sensors.

1:00 pm:  All Odalog monitors were placed.

1:20 pm:  All Sol Air UV units were connected to treat H₂S levels.

Thursday 1/13/2005 - Friday 1/14/2005

Wind information was obtained from MAQS:

Time: 2:03 pm  Dominant wind direction: 288°  Wind speed: 5.3 mph
Wind cone verification: same as MAQS

Present: Alec Felhaber - AES, Orlando Zepeda - Degremont, Miguel De La Torre - JMAS, Daniel Licon - AES

We placed the Odalog monitors with serial #1490-upwind, #0176-underneath the permanent cover at the treatment area and #1239-downwind.
All UV units are installed and operating.

2:30 pm:  We started to obtain the Odalog information utilizing a laptop and infrared sensors.

3:00 pm:  All Odalog monitors were placed and verification of the UV units’ functionality was completed.

4:00 pm:  Meeting and presentation at the Planta Nor ter Auditorium to discuss obtained results. Federal, state and local officials from U.S. and Mexican agencies were present. Closeout project signed
Wind information was obtained from MAQS:

- **Time:** 11:00 am
- **Dominant wind direction:** 83°
- **Wind speed:** 1.1 mph
- **Wind cone verification:** same as MAQS

Present: Orlando Zepeda - Degremont, Miguel De La Torre - JMAS, Daniel Licon - AES

We placed the Odalog monitors with serial #1490-upwind, #0176-underneath the permanent cover at the treatment area and #1239-downwind. All UV units are installed and operating.

**2:00 pm:** We started to obtain the Odalog information utilizing a laptop and infrared sensors.

**3:00 pm:** All Odalog monitors were removed from the North Juarez Plant, verification readings completed, and all UV units remain operating.
Conclusions:
The data obtained clearly indicates that the H$_2$S levels in the downwind and upwind locations of the treatment areas are at or close to zero ppm (0 ppm), which was the objective of our contract. If necessary, the values established in the downwind areas, which correspond to the section of the plant that is not being treated, would not be taken into account since the prevailing winds would transfer H$_2$S to the treated areas. However, all monitoring periods resulted in H$_2$S concentrations near zero and there was no need to adjust the contamination areas. Furthermore, the H$_2$S levels under the permanent cover in the treatment area were significantly lower than the levels previously recorded.

- Our results for the five monitoring periods in the downwind areas indicate an average of 0.28 ppm.
- The upwind areas for the five monitoring periods indicated an average of 0.28 ppm.
- Finally, the average for the five monitoring periods for the treatment area under the permanent cover indicate a 13.95 average.

Recommendations:
As previously established, only areas indicated under our contract were monitored in our work scope. Moreover, the measured H$_2$S levels were significantly higher than the levels taken in the same areas during Phase I of our contract (February 2003). Even with the current levels of H$_2$S being higher, the result of the monitoring indicates the effectiveness of the Sol Air system. We attribute these positive results to the careful design of the system and the additionally provided "third generation" ultraviolet lamps at no additional cost to Degremont and JMAS.

With the aforementioned in mind, we recommend the following:

1. Sample and monitor the treatment area periodically to establish if H$_2$S levels continue to remain stable or if they elevate. If they elevate, investigate the cause of this change and recommend additional units for treatment.

2. Design and test the Sol Air ultraviolet system in the recommended areas of the facility that were not included in our contract. If the initial readings indicate H$_2$S levels that can contribute to odors and complaints from the residents in the surrounding areas as well as the compliance occupational exposure regulations, administer and install the recommended units in the additional areas.
WIND DIRECTION: 280
WIND SPEED: 4.2 mph

DOMINANT WIND

PRE-TREATMENT CANAL
MONDAY: 1/10/05 - 1/11/05

LEGEND

A
ODALOG SERIAL #1490
UPWIND
0.5 ppm AVERAGE

T
ODALOG SERIAL #10176
TREATMENT AREA
18.8 ppm AVERAGE

B
ODALOG SERIAL #1239
DOWNWIND
0.5 ppm AVERAGE
WIND DIRECTION: 109
WIND SPEED: 1.9 mph

HYDROGEN SULFIDE ELECTROCHEMICAL ODALOG MONITOR

DOMINANT WIND

PRE-TREATMENT CANAL
TUESDAY: 1/11/05 - 1/12/05

HYDROGEN SULFIDE ELECTROCHEMICAL ODALOG MONITOR

PANEL NO. 1
PANEL NO. 2
PANEL NO. 3
PANEL NO. 4
PANEL NO. 5
PANEL NO. 6

B
0.1 ppm

T
27.4 ppm

A
0.3 ppm

LEGEND

ODALOG SERIAL #1490
UPWIND
0.3 ppm AVERAGE

ODALOG SERIAL #0176
TREATMENT AREA
27.4 ppm AVERAGE

ODALOG SERIAL #1239
DOWNWIND
0.1 ppm AVERAGE
WEDNESDAY: 1/12/05 - 1/13/05

WIND DIRECTION: 269
WIND SPEED: 9.0 mph

DOMINANT WIND

PRE-TREATMENT CANAL

HYDROGEN SULFIDE ELECTROCHEMICAL ODALOG MONITOR

COARSE BAR SCREENS

ARCHIMEDIAN SCREWS

FINE SCREEN

PRE-TREATMENT CANAL

ODALOG SERIAL #0176
UPWIND 0.2 ppm AVERAGE

ODALOG SERIAL #1239
DOWNWIND 0.0 ppm AVERAGE

ODALOG SERIAL #1490
TREATMENT AREA 15.6 ppm AVERAGE

LEGEND

A
ODALOG SERIAL #1490
UPWIND 0.2 ppm AVERAGE

T
ODALOG SERIAL #0176
TREATMENT AREA 15.6 ppm AVERAGE

B
ODALOG SERIAL #1239
DOWNWIND 0.0 ppm AVERAGE
DOMINANT WIND

WIND DIRECTION: 288°
WIND SPEED: 5.3 mph

PRE-TREATMENT CANAL
THURSDAY: 1/13/05 - 1/14/05

HYDROGEN SULFIDE ELECTROCHEMICAL ODALOG MONITOR

LEGEND

A 0.3 ppm UPWIND
B 0.2 ppm DOWNWIND
T 9.7 ppm TREATMENT AREA

ODALOG SERIAL #0176 TREATMENT AREA 9.7 ppm AVERAGE
ODALOG SERIAL #1239 DOWNWIND 0.2 ppm AVERAGE
ODALOG SERIAL #1490 UPWIND 0.3 ppm AVERAGE
PRE-TREATMENT CANAL
FRI: 1/14/05 - 1/15/05

WIND DIRECTION: 83°
WIND SPEED: 1.1 mph

HYDROGEN SULFIDE ELECTROCHEMICAL ODALOG MONITOR

LEGEND
A
B
T

ODALOG SERIAL #0176
TREATMENT AREA
11.7 ppm AVERAGE

ODALOG SERIAL #1239
UPWIND
0.1 ppm AVERAGE

ODALOG SERIAL #1490
DOWNWIND
0.4 ppm AVERAGE
APPENDICES

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Appendix B   GRAPHS
Appendix C   ODALOGS
Appendix D   ILLUSTRATIONS
Appendix E   FINAL VERIFICATION TEST CALCULATIONS
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(No longer in process)
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Pre-Treatment Canal: Test Area #2

<table>
<thead>
<tr>
<th>Date</th>
<th>Conditions</th>
<th>H₂S Concentration (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/15/03</td>
<td>C16LF Unit Operating in Test Area #1</td>
<td>50</td>
</tr>
<tr>
<td>2/16/03</td>
<td>64 Lamps Operating in Test Areas #1 and #2</td>
<td>40</td>
</tr>
<tr>
<td>2/17/03</td>
<td>64 Lamps Operating in Test Area #1 and 16 Lamps in Test Area #2</td>
<td>30</td>
</tr>
<tr>
<td>2/18/03</td>
<td>80 Lamps Operating in Test Area #1 With Curtains</td>
<td>30</td>
</tr>
<tr>
<td>2/19/03</td>
<td>Units Disconnected</td>
<td>40</td>
</tr>
<tr>
<td>2/17/03</td>
<td>32 Lamps Operating in Test Area #2</td>
<td>30</td>
</tr>
<tr>
<td>2/18/03</td>
<td>32 Lamps Operating in Test Area #2</td>
<td>30</td>
</tr>
<tr>
<td>2/19/03</td>
<td>64 Lamps Operating in Test Area #2 With Curtains</td>
<td>40</td>
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<tr>
<td>2/19/03</td>
<td>64 Lamps Operating in Test Area #2 Without Curtains</td>
<td>50</td>
</tr>
<tr>
<td>2/19/03</td>
<td>48 Lamps Operating in Test Area #2 Without Curtains</td>
<td>100</td>
</tr>
</tbody>
</table>
Outside Treatment Area

<table>
<thead>
<tr>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/15/03</td>
<td>No Treatment No Curtains</td>
</tr>
<tr>
<td>2/16/03</td>
<td>No Treatment With Curtains</td>
</tr>
<tr>
<td>2/17/03</td>
<td>C16LF Unit Operating in Test Area #1</td>
</tr>
<tr>
<td>2/18/03</td>
<td>64 Lamps Operating in Test Areas #1 and #2</td>
</tr>
<tr>
<td>2/19/03</td>
<td>80 Lamps Operating in Test Area #1 With Curtains</td>
</tr>
<tr>
<td></td>
<td>No Reading in This Area</td>
</tr>
<tr>
<td>2/19/03</td>
<td>64 Lamps Operating in Test Area #2 With Curtains</td>
</tr>
<tr>
<td>2/19/03</td>
<td>48 Lamps Operating in Test Area #2 Without Curtains</td>
</tr>
</tbody>
</table>

H₂S Concentration (ppm)

0 50 100 150 200 250
Perimeter Fence

<table>
<thead>
<tr>
<th>Date</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/15/03</td>
<td>32 Lamps Operating in Test Area #1</td>
</tr>
<tr>
<td>2/16/03</td>
<td>64 Lamps Operating in Test Areas #1 and #2</td>
</tr>
<tr>
<td>2/17/03</td>
<td>64 Lamps Operating in Test Area #1 and 16 Lamps in Test Area #2</td>
</tr>
<tr>
<td>2/18/03</td>
<td>80 Lamps Operating in Test Area #1 With Curtains</td>
</tr>
<tr>
<td>2/19/03</td>
<td>32 Lamps Operating in Test Area #2</td>
</tr>
<tr>
<td></td>
<td>48 Lamps Operating in Test Area #2 Without Curtains</td>
</tr>
</tbody>
</table>
64 Lamps Operating in Test Areas #1 and #2

No Treatment
No Curtains

0

2/15/03
2/16/03
2/17/03
2/18/03
2/19/03

H2S Concentration (ppm)

Pre-Treatment Canal: Test Area #1
Pre-Treatment Canal: Test Area #2
Outside Pre-Treatment Area
Perimeter Fence

80 Lamps Operating in Test Area #2

64 Lamps Operating in Test Area #2

32 Lamps Operating in Test Area #2

48 Lamps Operating in Test Area #2 Without Curtains

32 Lamps Operating in Test Area #2 With Curtains

32 Lamps Operating in Test Area #2 Without Curtains
Appendix B-2: Phase II Graphs
Perimeter Fence

H2S Concentration

- Baselines Without Temporary Cover
- All Areas Covered
- September 29th Demonstration
- Electrical System Disconnected
Perimeter Fence Facing NW Towards El Paso/Juarez Border

Daily Average

H$_2$S Concentration

Perimeter Fence Facing NE Towards El Paso/Juarez Border

Daily Average

H₂S Concentration
APPENDIX C: ODALOGS
Appendix C-1: Phase II Odalogs

* Note: Representative graphs are provided for report. Complete graphs of all monitoring events are available upon request.
Pre-Treatment Canal (OdaLog: OL45071496)

Period displayed: Sat Sep 11 - Mon Sep 13 (Oda File: 45071496AREA00132004.oda)

- **INST**: Min (7 ppm) Max (585 ppm)
- **Day Transition**
- **Average** (97.7 ppm) **Action** (97 %)
- **Temperature**
Downwind from Pretreatment Canal (Odalog: OL45022832)

Hydrogen sulfide exposure (ppm)

Period displayed: Thu Sep 09 - Fri Sep 10 (Odalog File: 45022832DWNWND03102004.oda)

- INST: Min (0 ppm) Max (16 ppm)
- ▼ Day Transition
- Average (0.7 ppm) Action (0.1 %)
- Temperature
Downwind from Pretreatment Canal (OdaLog: OL45022832)

Period displayed: Fri Sep 10 - Sat Sep 11 (File: 45022832DWNW/ND09/11/2004.oda)

Graph shows hydrogen sulfide exposure and temperature over a day with specific periods and actions indicated.
Archimedes Screw at 5' Depth (OdaLog: OL45022832)

Period displayed: Mon Sep 13 - Tue Sep 14

INST : Min (6 ppm) Max (495 ppm) ▼ Day Transition — Average (128.9 ppm) Acion (98 %) Temperature

Temperature (Degrees F)
Archimedes Screw at 5’ Depth (OdaLog: OL45022832)

Period displayed: Wed Sep 15 - Thu Sep 16 (Oda File: 45022832AREA5FT09I62004.oda)

- **INST**: Min (17 ppm) Max (424 ppm)
- **Average**: 152.3 ppm
- **Day Transition**
- **Temperature**
Archimedes Screw at 5' Depth (OdaLog: OL45022832)

Period displayed: Thu Sep 16 - Fri Sep 17 (OdaFile: 45022832AREA5FT09172004.oda)
Archimedes Screw at 5’ Depth (OdaLog: OL45022832)

Period displayed: Fri Sep 17 - Sat Sep 18 (Oda File: 45022832AREAaFT09132004.oda)

Graph showing hydrogen sulphide exposure and temperature over time.
Archimedes Screw at 5' Depth (OdaLog: OL45022832)

Period displayed: Sat Sep 19 - Mon Sep 20 (OdaFile: 45022832AREA3FT0922004 oda)

- Blue line: Hydrogen sulphide Exposure (ppm) with Min (1 ppm) and Max (337 ppm)
- Yellow line: Temperature
- Green line: Day Transition
- Dotted line: Average (82.1 ppm) Action (84 %)
Archimedes Screw Lift #3 - Bottom Section (OdaLog: OL45022832)

Period displayed: Mon Sep 20 - Tue Sep 21 (OdaFile: 45022832ARCHBOT05212004.oda)

- **INST**: Min (6 ppm) Max (106 ppm)
- **Temperature**
- **Day Transition**
- **Average (27.3 ppm) Action (60%)**
Archimedes Screw Lift #3 - Bottom Section (ODA Log: OL45022832)

Period displayed: Tue Sep 21 - Wed Sep 22 (ODA File: 45022832ARCHBOT05222004.oda)

- **Hydrogen sulphide Exposure (ppm)***
  - **INSTR:** Min (5 ppm) Max (200 ppm)
  - **Day Transition**
  - **Average (49.5 ppm) Action (88%)**
  - **Temperature**
Archimedes Screw Lift #3 - Bottom Section (OdaLog: OL45022832)

Period displayed: Wed Sep 22 - Thu Sep 23 (OdaFile: 45022832ARCHBOT05232004.oda)

- Min [25 ppm] Max [652 ppm]
- Day Transition
- Average [79.8 ppm] Action (100%)
- Temperature
Perimeter Facing NE Towards El Paso/Juarez Border (OdaLog: OL45022832)

Period displayed: Wed Sep 29 - Thu Sep 30

- **Hydrogen sulphide Exposure (ppm)**
- **Temperature (Degrees F)**

Graph showing hydrogen sulphide exposure and temperature over a period of time. The graph indicates variations in exposure and temperature throughout the specified period.
Appendix C-2: Verification Test Odalogs
Upwind - Session: 1 (OdaLog: OL02011239)

Period displayed: Mon Jan 10 - Tue Jan 11 (Oda File: inup1112005.oda)

- **INST**: Min (0 ppm) Max (13 ppm)
- **Day Transition**
- **Average** (0.5 ppm) **Action** (0 %)
- **Temperature**
Upwind - Session: 2 (OdaLog: OL45071490)

Period displayed: Tue Jan 11 - Wed Jan 12 (Ode File: frup1132005.oda)

- **INST**: Min (0 ppm) Max (6 ppm)
- **Day Transition**
- **Average** (0.3 ppm) **Action** (0 %)
- **Temperature**
Downwind - Session: 2 (OdaLog: OL02011239)

Period displayed: Tue Jan 11 - Wed Jan 12 (Oda File: indw1122005.oda)

- **INST**: Min (0 ppm) Max (3 ppm)
- **Day Transition**
- **Average (0.1 ppm)**
- **Action (0 %)**
- **Temperature**
Downwind - Session: 4 (OdaLog: OL02011239)

Period displayed: Thu Jan 13 - Fri Jan 14 (Oda File: Indv1142005.oda)

- **INST**: Min (0 ppm); Max (6 ppm)
- ▼ Day Transition
- •• Average (0.2 ppm); Action (0 %)
- Temperature
Appendix C-3: Untreated Areas Odalogs
Sludge Tank (OdaLog: OL4500013)

Period displayed: Wed Oct 20 - Thu Oct 21  (Oda File: 4500013SLG1NK10212004.oda)

- Hydrogen sulphide Exposure (ppm)
- Temperature (Degrees F)

- INST: Min (35 ppm) Max (1000 ppm)
- Average (484.3 ppm) Action (100 %)
- Day Transition
- Temperature
Figure 1: Pre-Treatment Canal
Figure 2: Phase I Test Areas
APPENDIX E: FINAL VERIFICATION TEST CALCULATIONS
Example Calculation:

Pretreatment Canal
18.8
15.6
9.7
11.7

AVERAGE = 13.95

\[ SD = \sqrt{\frac{\sum (x - \bar{x})^2}{(n-1)}} \]

\[ (18.8 - 13.95)^2 + (15.6 - 13.95)^2 + (9.7 - 13.95)^2 + (11.7 - 13.95)^2 = 49.37 \]

\[ SD = \sqrt{\frac{49.37}{3}} = 4.06 \]

SD = 4.06

<table>
<thead>
<tr>
<th></th>
<th>Upwind</th>
<th>Pretreatment</th>
<th>Downwind</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>0.5</td>
<td>18.8</td>
<td>0.5</td>
</tr>
<tr>
<td>0.2</td>
<td>0.2</td>
<td>15.6</td>
<td>0.2</td>
</tr>
<tr>
<td>0.3</td>
<td>0.3</td>
<td>9.7</td>
<td>0.2</td>
</tr>
<tr>
<td>0.1</td>
<td>0.1</td>
<td>11.7</td>
<td>0.4</td>
</tr>
</tbody>
</table>

**AVERAGE**

0.28  13.95  0.28

**STANDARD DEV.**

0.17  4.06  0.22