ONONDAGA LAKE

SEDIMENT MANAGEMENT WINTER 2013 ADDITIONAL ODOR MITIGATION PLAN
Syracuse, New York

Prepared For:

Honeywell

301 Plainfield Road
Suite 300
Syracuse, NY 13212

Prepared By:

PARSONS

301 Plainfield Road, Suite 350
Syracuse, New York 13212
Phone: (315) 451-9560
Fax: (315) 451-9570

and

O'BRIEN & GERE

333 W. Washington St
Syracuse, NY 13202
Phone: (315) 956-6408
Fax: (315) 463-7554

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LIST OF ACRONYMS

cfm	Cubic feet per minute
DMA	Debris Management Area
FDA	Food and Drug Administration
Honeywell	Honeywell International Inc.
NYSDEC	New York State Department of Environmental Conservation
PSI	Pounds per square inch
ROD	Record of Decision
SCA	sediment consolidation area
SUNY ESF	College of Environmental Science and Forestry
USEPA	U.S. Environmental Protection Agency
VGAC	vapor granular activated carbon
WTP	water treatment plant

EXECUTIVE SUMMARY

Sediment dredging and capping activities were initiated at Onondaga Lake in July 2012 consistent with the Record of Decision (ROD). Ensuring community safety has at all times been at the forefront of the Onondaga Lake cleanup program, from design of the lake remedy through its implementation. The focus on safety includes development and implementation of a comprehensive air quality management and monitoring program.

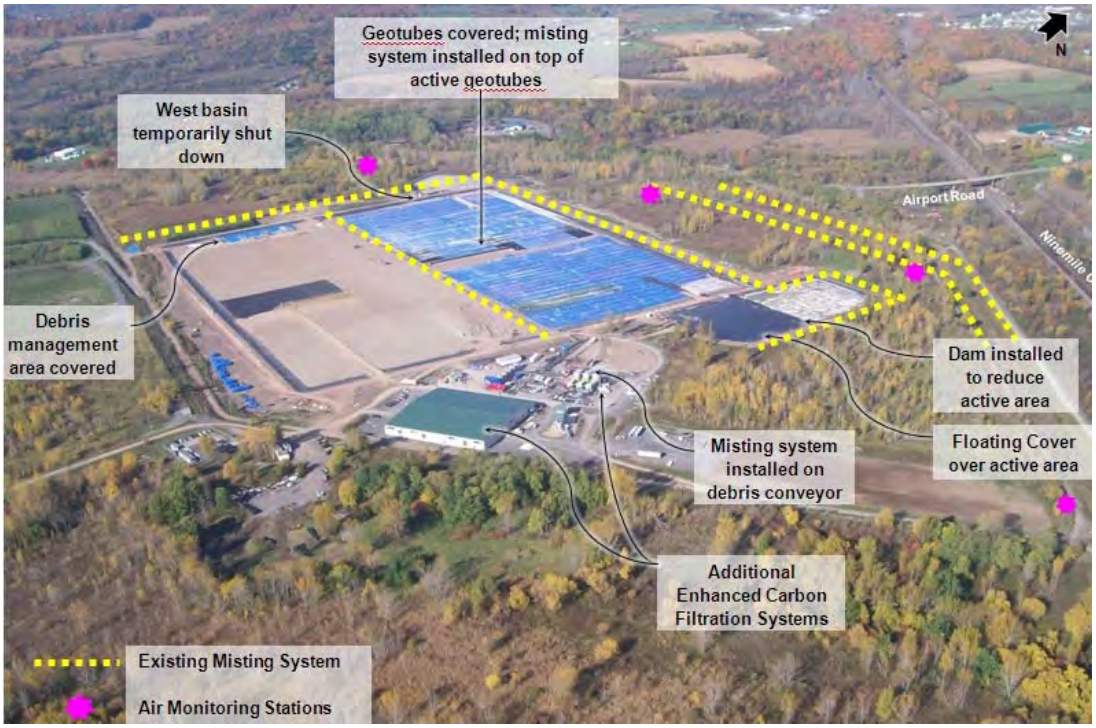
The project design incorporated numerous measures to minimize emissions and odors, including:

- Hydraulic dredging and a double-walled pipeline system to prevent exposure of dredged material to air during removal and transport to the Sediment Consolidation Area (SCA)
- Using geotubes rather than open basins for sediment dewatering, which results in a smaller footprint for dewatering operations, reduces air exposure, and expedites closure of the SCA
- Adding polymers and using gravity thickeners to reduce the volume of water sent to geotubes, thus reducing odor potential from dewatering operations
- Capturing and treating air emissions from sediment screening, gravity thickener and water treatment plant operations

Air monitoring conducted for this program has demonstrated that the emissions control provisions incorporated into the design have been successful in reducing emissions and odors. Following odor reports that began in late August 2012, Honeywell voluntarily shut down all sediment dredging and dewatering activities for a three-week period in September/October 2012 and implemented the following additional odor mitigation measures:

1. Covering active and inactive geotubes to further limit emissions
2. Temporarily shutting down one of two temporary water storage basins
3. Significantly reducing temporary standing water in the active water storage basin
4. Covering the basin used to temporarily hold water discharged from geotubes prior to water treatment
5. Refining procedures to minimize emissions associated with debris handling, including covering of debris piles
6. Installing a misting system to control odorants in the air
7. Enhancing the capture of vapors from the thickeners and water treatment plant (WTP) by installing additional stand-alone carbon filtration systems

These emission mitigation measures are depicted below.



Odor mitigation measures completed in 2012

Although these mitigation measures were effective in further reducing odor emissions when dewatering activities were resumed in October 2012, some odors were reported following restart. The sources and types of odor-causing materials have been characterized and are understood. While air quality at the perimeter of the work site complies with the standards established for protecting public health, New York State Department of Environmental Conservation (NYSDEC) and Honeywell have been working with engineers, scientists, and odor experts from across the country during the winter to identify additional measures to further reduce any potential odors from the remediation operations.

Studies and monitoring data show that the highest potential for emissions is when the geotubes are being filled, particularly from water flowing down the sides into valleys between the geotubes and then into the SCA perimeter channels. Therefore, a great deal of time and emphasis went into working with the geotube manufacturer to develop a significantly better cover system.

The following measures have been/are being deployed in 2013. These measures were developed in consultation with engineers, scientists, and national technical experts and included bench-scale studies and field trials.

- Substantial upgrades to geotube cover system:
  - In cooperative effort with the manufacturer, an alternative cover system was developed that is being integrated as part of the geotubes manufacturing process. A prototype was successfully tested offsite, and unused geotubes have been sent back to the manufacturer for retrofitting.
  - The integrated cover system will also incorporate covers over channels between geotubes or alternate means to reduce water surface area exposure to the extent possible.
- Enhanced water management, including several upgrades to thickener system
- Improvement and expansion of the odor control misting system
- Covering areas of flowing water from the geotubes to the extent possible
- Enhancements to further improve the off-gas capture and treatment systems from sediment thickeners and water treatment operations
- Containment or covering of oversized material screened from the slurry during transportation and covering stockpiles
- Use of wind screens to enhance the performance of the misting systems by interrupting air flow from the sediment dewatering area

This plan details the additional odor mitigation studies completed (i.e., field studies to evaluate additional odor reduction achieved by implementing the supplemental odor mitigation measures and testing to verify the primary compounds that are contributing to odors from SCA operations) and the comprehensive program to further minimize odors in 2013. While Honeywell is confident the additional odor mitigation controls will further reduce potential off-site odors, there is no guarantee that all odors will be eliminated completely. Honeywell is committed to continually evaluating the effectiveness of the existing and these new measures, and in consultation with the NYSDEC to make adjustments as appropriate to maximize their effectiveness.

SECTION 1

INTRODUCTION

1.1 INTRODUCTION

Sediment capping and dredging activities were initiated in July 2012 consistent with the Record of Decision (ROD). The New York State Department of Environmental Conservation (NYSDEC) and the U.S. Environmental Protection Agency (USEPA) selected the lake remediation plan, and all design and construction activities are being completed under their oversight.

Ensuring community safety was at the forefront of the lake remedy design and continues to be at the forefront as the remedy is implemented. As part of the remedial design process, the Onondaga Lake Remedial Operations Community Health and Safety Plan was developed and made available for public review and input prior to approval by the NYSDEC and USEPA and commencement of in-lake remedial activities. This plan details all aspects of protecting the community, including air quality management and monitoring. The project design incorporated numerous measures to minimize emissions and odors. Air monitoring conducted during implementation of the remedy has demonstrated that these emissions control provisions have been successful in complying with the standards for protecting public health established for this project. However, following odor reports beginning in late August 2012, Honeywell voluntarily shut down all sediment dredging and active dewatering activities for a three-week period in September/October 2012 and implemented several additional emission mitigation measures. While these mitigation measures were effective in reducing odor emissions when operations resumed in October 2012, odors continued to be reported by neighbors of the nearby community.

Additional control measures have been extensively evaluated during the 2012-2013 winter shutdown. This evaluation process started with the formation of a task force comprised of key operations, safety, and air monitoring staff, as well as third party technical experts. Task force activities included:

- The 2012 operations and odor mitigation measures were evaluated.
- Potential improvements to implemented odor control measures and potential additional measures were identified. As part of this process, the entire sediment operation was divided into potential odor source areas, with a list of potential additional odor mitigation measures to be considered for each area. Chemical, physical, and operational measures were all considered, and a comprehensive list was developed.
- Technical review meetings were held with the NYSDEC, and the comprehensive list was expanded to incorporate their input.

- Evaluations on individual list items included considerations for:
  - Effectiveness
  - Operational impacts
  - Feasibility
  - Health and safety

  The evaluations included forming technical work groups to research, consulting with national experts, and conducting bench-scale studies and field trials of potential odor mitigation measures.

This report documents supplemental odor mitigation studies that have been completed to identify any additional potential odor sources and to develop measures to mitigate them. It also describes the additional measures and enhancements to previously implemented measures that will be implemented to further minimize odors during 2013 operations.

1.2 REPORT ORGANIZATION

The report is organized as follows:

- Section 1 provides an overview of the odor mitigation measures implemented to date and summarizes additional studies that have been completed to facilitate the selection and implementation of additional odor mitigation measures.
- Section 2 presents additional odor mitigation measures to be implemented in 2013.
- Appendix A includes a summary table of evaluations and recommendations from the comprehensive list of potential mitigation measures considered. Supplemental assessments warranted by the complexities of the measures considered are also summarized in this appendix.

1.3 EMISSION MITIGATION MEASURES INCORPORATED INTO THE DESIGN

Multiple studies were performed during the design to evaluate which sediment constituents needed to be considered for air quality management and measurement and the appropriate approaches to minimize the potential for emissions. These studies included wind tunnel testing, air dispersion modeling, and sediment odor characterization. Emission minimization measures were incorporated into the design as a result of these studies and feedback received through the community participation process. For example, although the ROD was developed based on the use of a large open settling basin for sediment dewatering, the final design incorporated geotubes as the specified sediment dewatering method because they resulted in a smaller footprint, reduced air exposure and facilitated quicker closure of the Sediment Consolidation Area (SCA) following completion of dredging. Odor control design elements include:

- Hydraulic dredging and a closed pipeline to prevent exposure of dredged material to air during removal and transport to the treatment facility

- Adding polymers and using gravity thickeners to reduce the volume of water sent to geotubes, thus reducing odor potential from dewatering operations
- Capturing and controlling air emissions from sediment screening, gravity thickener and water treatment plant operations

1.4 SUPPLEMENTAL 2012 ODOR MITIGATION MEASURES

Despite these measures, off-site odor complaints resulted in a three-week voluntary curtailment of dredging operations in September/October 2012 to complete additional odor mitigation measures. Odor mitigation measures implemented prior to and during the three-week shut down in 2012 include:

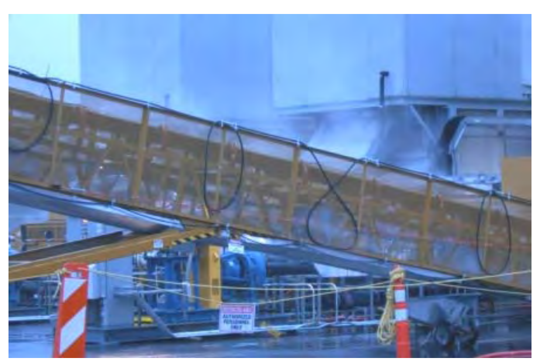
1. Covering active and inactive geotubes to reduce exposure of water to air and thus limit emissions.

Covered geotubes

2. Improving the basins used to temporarily hold water discharged from the geotubes prior to water treatment. These improvements included installation of a dam to reduce the active area of the East Basin and installation of a floating cover over the active half to minimize emissions. Discharge piping was also reconfigured so water discharged below basin water levels and under the cover system. The West Basin was temporarily taken off line.

Floating covers on East Basin

3. Modifying screened debris handling procedures to include discharging directly from the conveyor system to haul trucks, covering debris piles in the SCA (referred to as debris management area or DMA), and operating misting systems on truck loading operations and along the conveyor in the sediment processing area.



Misters on debris conveyor

SCA perimeter misting system

4. Installing over 3.2 miles of misting systems, including around the perimeter of the SCA, the perimeter of the East Basin, on top of active geotubes, and along sections of the upper and lower perimeter roads. The misting system controls odorants in the air and includes use of a biodegradable, FDA-approved additive to enhance the effectiveness of odorant removal.

Thickener on VGAC system

5. Upgrading the exhaust system from the thickener used to remove water from the slurry prior to discharge to the geotubes with a dedicated vapor-phase granular activated carbon system (VGAC) for removal of compounds. The air flow capacity was increased ten-fold, and the enclosures were inspected to ensure openings and penetrations were sealed to ensure capture and containment of emissions.

WTP VGAC

6. Upgrading the water treatment plant (WTP) to include a second VGAC system, installing intake ducts at tank and vessel vent locations, and relocating the material testing areas and venting them to the VGAC system.

Supplemental studies were completed to quantify the effectiveness of the mitigation measures that were implemented and to verify the primary odorants associated with the sediment dewatering operations. Based on these studies, the compounds contributing to odors are understood, and mitigation measures implemented to date have been effective in further reducing odors. Results from these studies facilitated development and implementation of the additional odor mitigation measures discussed in Section 2. An overview of these studies and the findings is presented below.

1.5 SUPPLEMENTAL MITIGATION MEASURE EFFECTIVENESS EVALUATION

As discussed above, numerous measures were incorporated into the original design to minimize odors and emissions, including the use of geotubes instead of open basins. Although it is not possible to precisely determine the effectiveness of the controls incorporated into the design, these controls are believed to have provided a significant reduction of emissions over the original approach of open basin dewatering. When operations resumed after the voluntary shutdown in 2012, field studies were completed to evaluate any additional odor reduction achieved by implementing the supplemental odor mitigation measures described in Section 1.4. Detailed evaluation methods and results have been presented in a technical memorandum submitted to NYSDEC. The studies concluded that implementing the additional odor mitigation measures listed below was effective, further reducing individual source odor emissions in addition to odor reductions that had already been achieved:

- Geotube covers
- Water storage basin modifications
- Misting systems enhancements
- Screened debris modification
- Thickener upgrades
- Water treatment plant upgrades

1.6 ODORANT CHARACTERIZATION

Significant field studies and engineering evaluations were completed during the design to understand and mitigate potential odors. Additional studies were completed in 2012 and early 2013 to supplement this information and verify the primary compounds that are contributing to odors from SCA operations. Samples were collected and analyzed for compounds in the headspaces above three potential odor sources: (1) freshly–filled geotubes, (2) geotube effluent water, and (3) sediment slurry. Study findings have been submitted to the NYSDEC as a separate report.

Compound concentrations in the air above these potential odor sources were measured and compared to their respective odor thresholds to rank the top odorants. Sampling results showed that the top five odorants in each sample were indene, xylenes, trimethylbenzenes, naphthalene and cumene. These odorants are aromatic hydrocarbons, the same class of compounds for which the program's odor controls have been designed. Since the air monitoring conducted during implementation of the remedy has demonstrated that emission control provisions have been successful in complying with standards established for protecting public health, the additional mitigation measures detailed in Section 2 focus on reducing odors resulting from these compounds.

SECTION 2

PROPOSED MITIGATION MEASURES

As part of a continuous improvement process to identify, monitor, and mitigate odors associated with sediment dewatering operations, a comprehensive program of additional mitigation measures has been developed and will be implemented in 2013. These measures (depicted individually in the sections below) are designed to further reduce odors from active and inactive geotubes as well as other identified potential odor sources. The measures were developed based on a series of brainstorming sessions; consultation with engineers, scientists, and national technical experts; bench-scale studies; and field trials. Adjustments or changes to these measures, if warranted, will be coordinated through the NYSDEC as they are implemented on a full scale basis.

2.1 COMPREHENSIVE INTEGRATED SCA COVER SYSTEM

The additional odor mitigation measures will include a significantly expanded and improved cover system for active and inactive geotubes and the SCA perimeter channels, which are expected to result in additional odor reductions. Based on evaluations conducted during the design phase of the project and odor measurements taken during 2012 operations, one of the sources of odors from the geotube dewatering operation is filtrate water from the geotubes. Emissions occur when the water is exposed to the ambient air. Monitoring data shows the highest potential for emissions occur when the geotubes are being filled, specifically from:

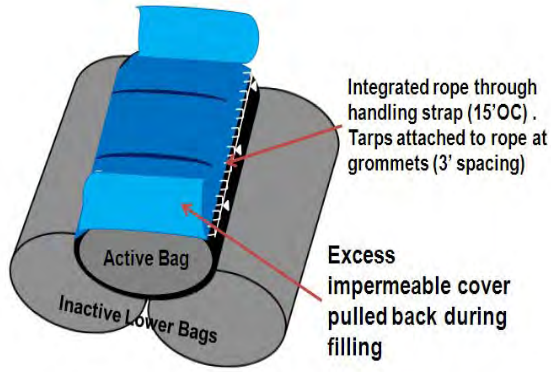
- Flow down the sides of the geotubes
- Channel flow in the valleys between two geotubes
- Cascades off the sides and ends of geotubes
- Channel flow in the SCA perimeter channel

The winter 2012/13 evaluations therefore focused on these aspects of the dewatering operations to identify the most effective way to reduce the water exposure to ambient air, thereby reducing potential odors. The results of this evaluation are summarized below.

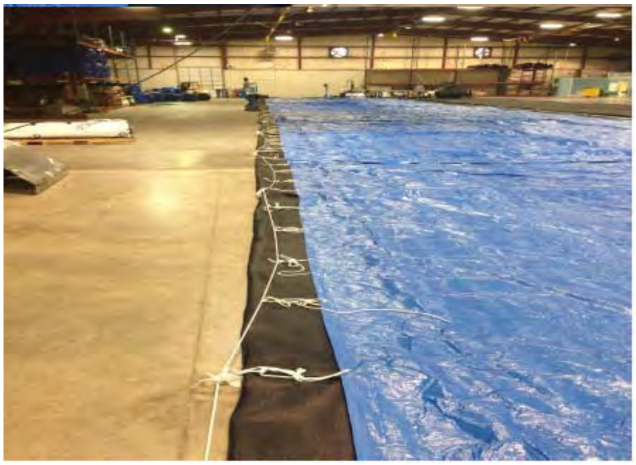
2.1.1 Integrated Geotube Cover System

As dredge slurry is pumped into the geotubes, the solids remain in the tube while the carry water, or filtrate, is passed through the tube fabric. Based on the dynamics of the tube, a majority of the flow comes out of the top half of the tube and flows down the top of the tube surface. During 2012 operations, the actively filling geotubes were identified as a contributing source of odors, which was mitigated by covering the tubes with tarps during filling. Based on measurements taken during 2012 operations, the tarps were very effective in reducing the odors being generated by the actively dewatering tubes. However, the large number of sand bags required to anchor the tarps presented several worker safety challenges. The deployment and presence of the tarps also hindered geotube dewatering operations and altered the drainage pathways for the filtrate, leading to pooled filtrate and poor drainage.

Since covers on the geotubes were effective in 2012, this concept will continue to be implemented by integrating a cover system into the geotubes as they are assembled by the manufacturer. In a cooperative effort, such an alternative integrated cover system was developed with the manufacturer. This system will continue to help reduce potential odors from the geotubes while alleviating the labor and safety issues associated with deploying and managing tarps. A prototype of the integrated cover system was fabricated and shipped to another geotube project in Plymouth, North Carolina, for testing. The prototype deployment was successful, and unused geotubes from the SCA have been sent back to the manufacturer to be retrofitted with the cover system. New tubes fabricated and delivered to the site are planned to include the integrated tarps. Helical screw anchors or equivalent will supplement connection points to keep the tarp securely attached to the tube. The performance of these tubes will be verified in spring 2013 to determine if additional modifications or enhancements are required. The covers will be left in place after the tubes are filled to provide odor mitigation for the aging geotubes.



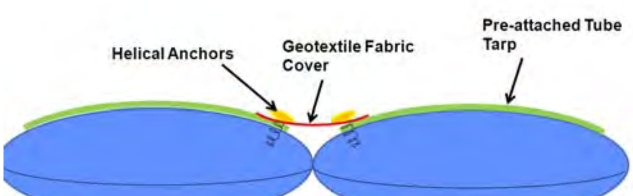
Pre-installed geotube cover concept



Manufacturer installs cover for field trial

2.1.2 Geotube Channel Covers

The integrated geotube cover system discussed above will also allow incorporation of covers over the channels between geotubes to further reduce odors. When two geotubes are filled side by side, they push together to form a valley. Filtrate draining off the top of the tubes collects in the valley and flows to the ends of the geotubes. Based on measurements taken during 2012 operations, water flowing in these valleys was identified as a potential source of odors. The tarps used in 2012 to cover the geotubes initially extended across these valleys but would often get weighed down with precipitation and could eventually sink to the bottom of the valley. This resulted in a lined



Geotube valley cover concept

channel with open filtrate flow. Alternative means for covering these valleys were evaluated during winter 2012/13. Covering the valleys with a permeable geofabric was identified as the most effective alternative. The permeable nature of the fabric should allow precipitation to flow into the valley, which will prevent the cover from being weighed down and sinking while limiting air flow over the channels. Helical anchor screws or equivalent will be used to anchor the valley covers. It is anticipated these covers will provide enough flexibility to accommodate the changing height of active geotubes. The performance of these covers will be verified in spring 2013 to determine if additional modifications or an alternate approach is required.

2.1.3 SCA Perimeter Channel Covers

A cover system will be installed over the SCA perimeter channel to minimize potential odors from water within the channel that carries geotube filtrate water and precipitation collected from within the SCA. Based on 2012 observations, this perimeter channel periodically fills with water, particularly during precipitation events, and has been identified as a potential odor source. Several alternatives were considered for mitigating channel odor potential, including filling the channel with drainage gravel and using liner material to cover the channel.

SCA channel cover system concept

The floating modular cover system that has been successfully deployed in the East Basin was determined to be the most effective alternative and therefore will be implemented. The panels are approximately 7 ft wide and will be installed end-to-end along the distance of the channel, anchored with sand tubes. This cover system will be installed on the west, north, and east sides of the SCA where practical (e.g., excluding locations of pipe or road crossings). The south side is the high side of the SCA and is not anticipated to have standing or flowing water based on 2012 observations. As the geotube operation progresses, the south side will be monitored for water conditions and a floating cover will be added to this area if needed. Adjustments or changes to this measure, if warranted, will be coordinated through the NYSDEC.

2.2 ENHANCED SCA WATER MANAGEMENT

Water management enhancements will include reducing the flow of water to the geotube field and modifying the water flow pattern to reduce potential odor emissions, as detailed below.

2.2.1 Reduced Water Flow to the SCA

Several upgrades will be made to the slurry thickener system operations in an attempt to reduce the amount of water in the slurry that enters the geotubes. The benefits of reducing the amount of water to the geotubes are two-fold. First, the volume of filtrate weeping from the geotubes will be reduced. The number of active geotubes required should also be reduced as a secondary benefit. The lower volume of water generated from the geotubes and the smaller area of actively dewatering geotubes will reduce the potential for odors. The thickener process is an enclosed system, including the screening process that takes place on top of the thickener. Emissions are captured and treated with a carbon filtration system.

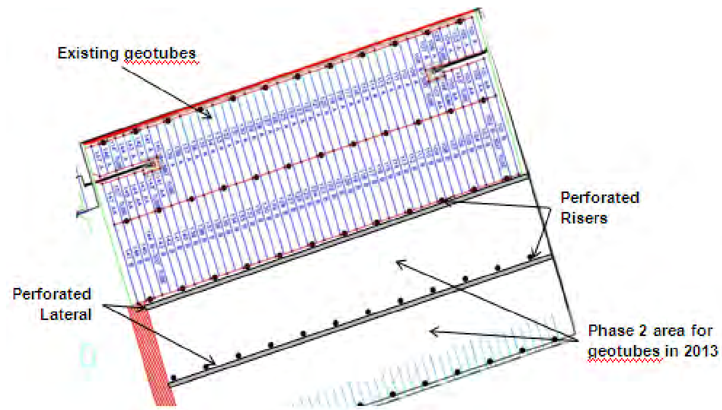
The 2012 thickener operation was impacted by foam that accumulated in the thickeners while dredging the material from Remediation Area D. Several alternative defoaming products were injected into the slurry flow to counteract the foam, with moderate success. As a result, the volume of water removed by the thickeners was limited at times. During the winter 2012/13 shutdown, anti-foamer and defoamer products were further assessed, and a potentially more effective product was identified for use in 2013. In addition, a series of spray bars were installed within the thickeners to spray defoamer directly on the foam, which is expected to be a more effective means of reducing foam.

Additional operational enhancements will be implemented in 2013 to increase the amount of water removed as part of the thickener process, including improvements to the polymer measurement approach and addition system. These enhancements have been developed in collaboration with the WTP operators to ensure there are no adverse impacts to WTP operations. These procedures will be initiated upon dredge startup and will be assessed for effectiveness, and will be maintained as appropriate throughout the dredge season to maximize the water removal efficiency of the thickeners and thus reduce potential odors generated during dewatering.

As described in Section 1.5, the thickener vapor capture system was upgraded in 2012 to significantly increase its capacity. To further improve the system in 2013, a demister and an in-line heater will be installed to lower the relative humidity of the air stream. This will increase the adsorptive capacity of the carbon, thereby increasing its removal efficiency.

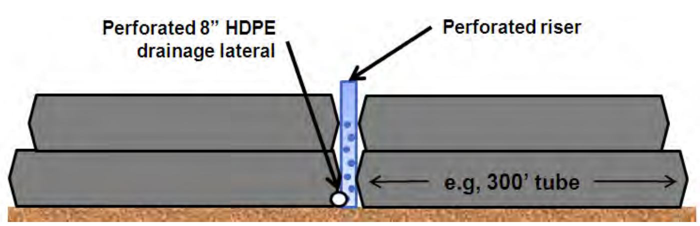
2.2.2 Cascading Water Minimization

In addition to reducing the water discharged to the geotubes, the pattern of water flow after discharge from the geotubes will be altered to reduce potential exposure to air and the water's turbulence, thus reducing potential odor emissions. The majority of the water discharged from dewatering geotubes flows into the valleys between the geotubes and then to the end of the geotube field, where it cascades down to the geotube layer or SCA gravel drainage layer below. Based on measurements collected during 2012 operations, this cascading water was identified as a potential odor source. Several measures will be implemented in 2013 to reduce this cascading water and thus reduce odor emissions.

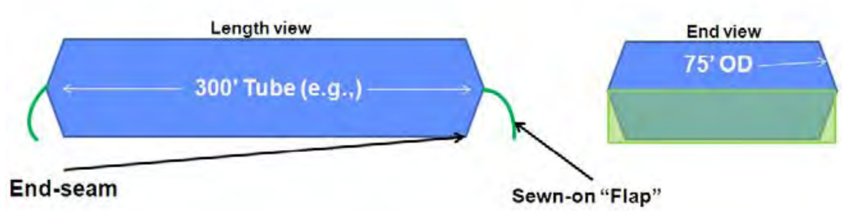


Enhanced geotube drainage system

Preferential vertical flow paths will be created within the center of the geotube field to allow water to flow directly down into the drainage gravel, thereby reducing the amount of water that flows to the ends of the geotube field. Locations have been identified where downward flow paths (essentially downspouts) will be installed and maintained within the geotube field, taking into consideration the requirement to overlap the geotubes for stability. These locations are co-located with settling monument poles that have been installed in the SCA. Perforated risers will be placed over or adjacent to these monuments and extended up with the geotube stack as additional tubes are placed. These downspouts will be installed in two rows of 12. A perforated lateral will be installed at the base of the downspouts across the entire SCA to provide additional gravel area for the filtrate to drain into. This system will divert a substantial portion of the flow directly to the gravel and help to minimize standing water within the central portions of SCA, thus reducing potential odors from actively dewatering geotubes.



Perforated riser concept



Flap at end of geotube concept

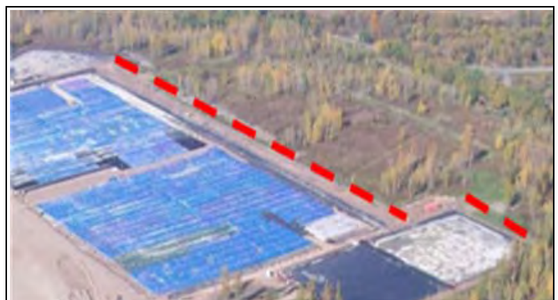
Mitigation measures will also be implemented to reduce potential odors from the remaining water that cascades off the end of the geotubes, which typically encounters the tube's end seam and must follow that flow path. A "flap" of fabric will be sewn into the end seam to help control this cascading off of retrofitted and new geotubes. This will facilitate a sheet flow effect, which will reduce the water turbulence and thus lower the potential odor emissions. In addition, the valley covers described in Section 2.1.2 will be extended over the tube ends onto the gravel or underlying tube surface below. These extensions will provide a controlled flow path to the gravel layer below. The pre-attached geotube covers described in Sections 2.1.1 will be extended over the tube ends onto the gravel or underlying tube surface below after filling of the geotubes.

2.3 WIND SCREEN

The combination of covering of the geotubes and use of misting systems has significantly reduced odor emissions from SCA operations. Additional reductions will be achieved by the system upgrades and mitigation measures detailed above. Constructed and vegetative wind screens will be installed to further reduce the potential for fugitive odors to impact offsite receptors. Wind screens and other means of increasing the roughness of terrain will reduce wind speeds and disrupt the natural flow of air. This will improve dispersion and reduce potential odor impacts at off-site locations. It will also allow the mister system described in Section 2.4 to operate more efficiently.

2.3.1 Constructed Wind Screen

Wind screens are a common means of reducing wind speeds for control of particulates. The wind screen will reduce winds speeds to enhance the effectiveness of the misting system (Section 2.4), as well as disrupt wind flow and improve dispersion, reducing potential odor impacts at off-site locations. The wind screen will be approximately 35 ft high and run the entire length of the SCA north berm (approximately 1600 ft) and the north side of the East Basin (approximately 300 ft). The wind screen height will extend above the final height of the geotubes when dredge operations are completed to provide effectiveness throughout the dewatering process. The fabric will have a porosity of approximately 50% which is consistent with optimum porosity based on studies for dust control[1].

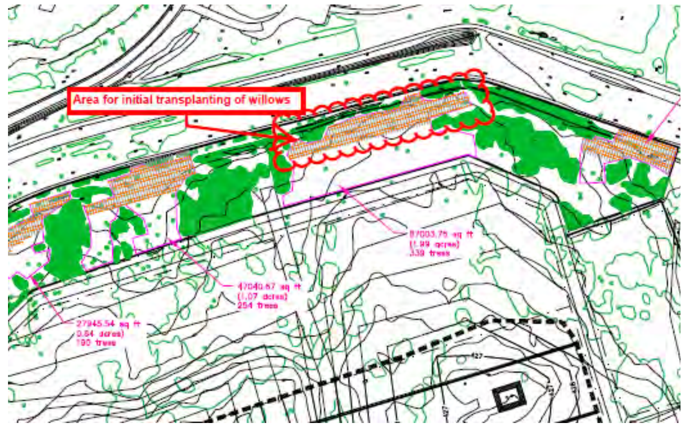


Wind screen layout and features

[1] EPA Handbook EPA/540/2-85/003 dated November 1985, Dust Control at Hazardous Waste Sites.

2.3.2 Vegetative Barrier

Vegetative barriers are another common means of reducing wind speed, and can be seen along sections of Interstate 81 for control of snow drifts. Based on 2012 field measurements, existing vegetation, where present, helps to disrupt wind flow and reduces potential off-site odor impacts. To supplement the benefits of the existing vegetation and the constructed wind screen described above, a vegetative barrier will be planted north of the SCA along a portion of the upper perimeter road. Mature willows will be transplanted from existing willow plots to the west of the SCA. Prior to transplanting, the willows will be cut back to improve survivability, facilitate handling, and encourage bushier growth. Site preparation and planting will be done in a manner consistent with ongoing planting operations with support from the College of Environmental Science and Forestry (SUNY ESF).



Location for willow transplants

2.4 MISTING SYSTEM ENHANCEMENTS

Use of misting systems was proven to be an effective means of controlling odors related to the dredge slurry processing and geotube operations in 2012. Several enhancements will be implemented in 2013 to further improve their effectiveness in minimizing site odors.

Misting systems are a common odor control tool that has been proven effective on numerous remediation projects. Several misting systems were evaluated for potential use at the SCA prior to implementation in 2012, including Piian's Odor Neutralizer, OMI's Ecosorb, and Veteran Enterprises, LLC. The Piian system was selected based on its demonstrated effectiveness at other sites, as well as the system's capacity and flexibility to meet the

Misting systems throughout the site

requirements for this application. It uses FDA-approved surfactants to enhance the system's effectiveness in removing odors.

The Piian system operates using a high pressure pump that adds Piian Odor Neutralizer to the water supply and pressurizes the fluid mixture to about 800 pounds per square inch (PSI). The fluid is pumped along hydraulic hoses with atomization nozzles from which the water and additive mix is sprayed as a mist (5 to 10 micron droplet size) that controls odorants in the air. Enhancements to the existing misting system that will be implemented in 2013 are described below.

2.4.1 Odor Control Additive

An extensive search of misting additives was conducted based on recommendations from odor control experts and through discussions with odor control vendors to identify the additives with the greatest potential for effectiveness. Tests were conducted to evaluate the effectiveness of these additives, including the additive used in 2012.

Four different additives were identified as having the highest potential effectiveness, including the additive used in 2012. Each of these additives was tested at varying dilutions, along with water that contained no additive. The testing demonstrated that three of the additives had similar odor reduction capabilities, including Piian Odor Neutralizer, the additive used during the 2012 dredging season. The fourth additive and water without additive were less effective. Based on the results and the proven effectiveness during 2012 operations, misting operations will continue with the use of the Piian additive.

Testing of mister additives

2.4.2 Misting System Expansion

The misting system was expanded during 2012 operations to include double rows along the north berm, west berm, the north and east sides of the east basin and on top of geotubes being filled and single rows down the center of the SCA, the south berm, and along the upper and lower perimeter roads. This layout will be further expanded to include additional rows along the north berm and north side of the East Basin (for a total of three rows attached to the wind screen supports), and a second row will be added to the south berm. The result will be a multi-layer misting system (both vertically and stepping out from the perimeter of the SCA) to intercept potential odors that are not captured by the comprehensive cover system and enhanced SCA water management system. With implementation of the comprehensive cover system, the active bag misting systems will not be necessary and will be discontinued because of worker safety concerns.

2.4 LARGE CAPACITY FANS

Large capacity fans will be evaluated when dredging restarts in the spring of 2013 to enhance dispersion and reduce the potential for off-site odor migration. Large fans are used to mix air in fruit orchards, lifting cooler air from the surface and mixing it with warmer air above to increase the surface air temperature. The condition when air near the surface is cooler than air at higher altitudes is called an inversion. Under inversion conditions, wind speeds are calm and atmospheric dispersion is near its lowest. During the 2012 dredging season, off-site odors were observed primarily during inversion conditions and with calm south winds. South winds were more prevalent at the SCA during inversions conditions because there is a 60-foot elevation drop immediately north of the SCA, and cold air preferentially moves to lower ground. Winds also move downward during inversions, rather than upward; thus potential air emissions from the SCA stay close to the ground as they travel downwind. A large fan will be used primarily during inversion and south wind conditions. It is expected the fans will mix the air at the ground and give it some vertical upward movement, thereby increasing odor dispersion.

Although fans are proven to enhance dispersion based on orchard use for frost protection, it is not possible to predict and quantify the additional dispersion. Manufacturers have not conducted these types of studies, and no atmospheric dispersion models have been identified that include the use of fans. Therefore, use of a large fan will be field-tested to evaluate whether it will enhance dispersion sufficiently to further reduce off-site odors.

2.5 DEBRIS MANAGEMENT OPERATIONS

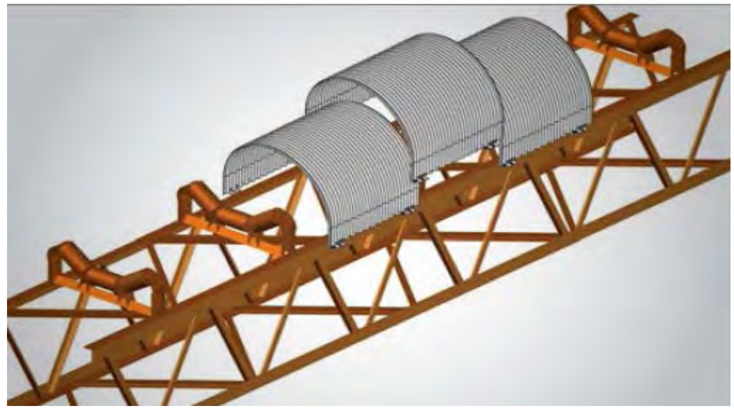
Based on monitoring of 2012 operations, over-sized debris generated from screening the dredge slurry was identified as a potential minor odor source after leaving the thickener enclosure and during handling for placement in the SCA. Debris management enhancements during the 2012 operations included direct load into haul trucks, operation of misters on the conveyor, and covering of piles in the SCA. These improvements will be expanded for the 2013 season as warranted based on trial of the following additional measures:

Debris water spray bars

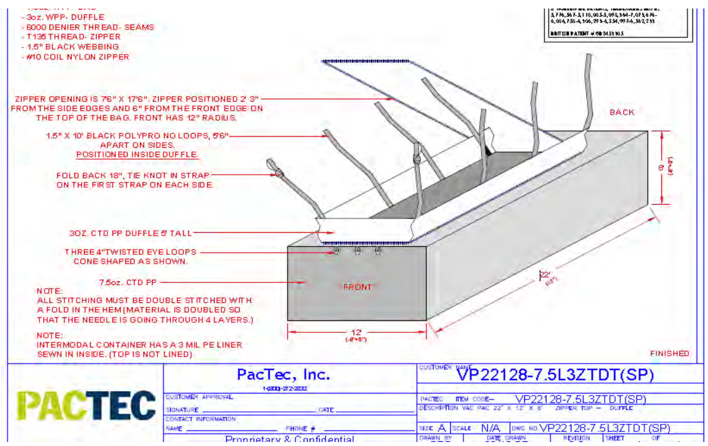
- Activation of water spray bars over debris within the thickeners to remove fines.

- Installation of a modular cover system over the conveyor in place of the conveyor misting system.
- Discharge of debris from the conveyor into haul truck rather than stockpiles. The haul truck material will be covered for transport to the debris management area. The covers would consist of bed liners that can be zippered closed or truck bed covers. For the latter, use of spray foam and/or continued use of covers would be done to minimize areas of exposed debris in the debris management area.

These improvements should provide greater reduction in potential odors associated with handling of oversized material screened from the sediment slurry.



Debris conveyor cover system



Debris bag

2.6 EMISSION REDUCTIONS AT SEDIMENT PROCESSING AREA

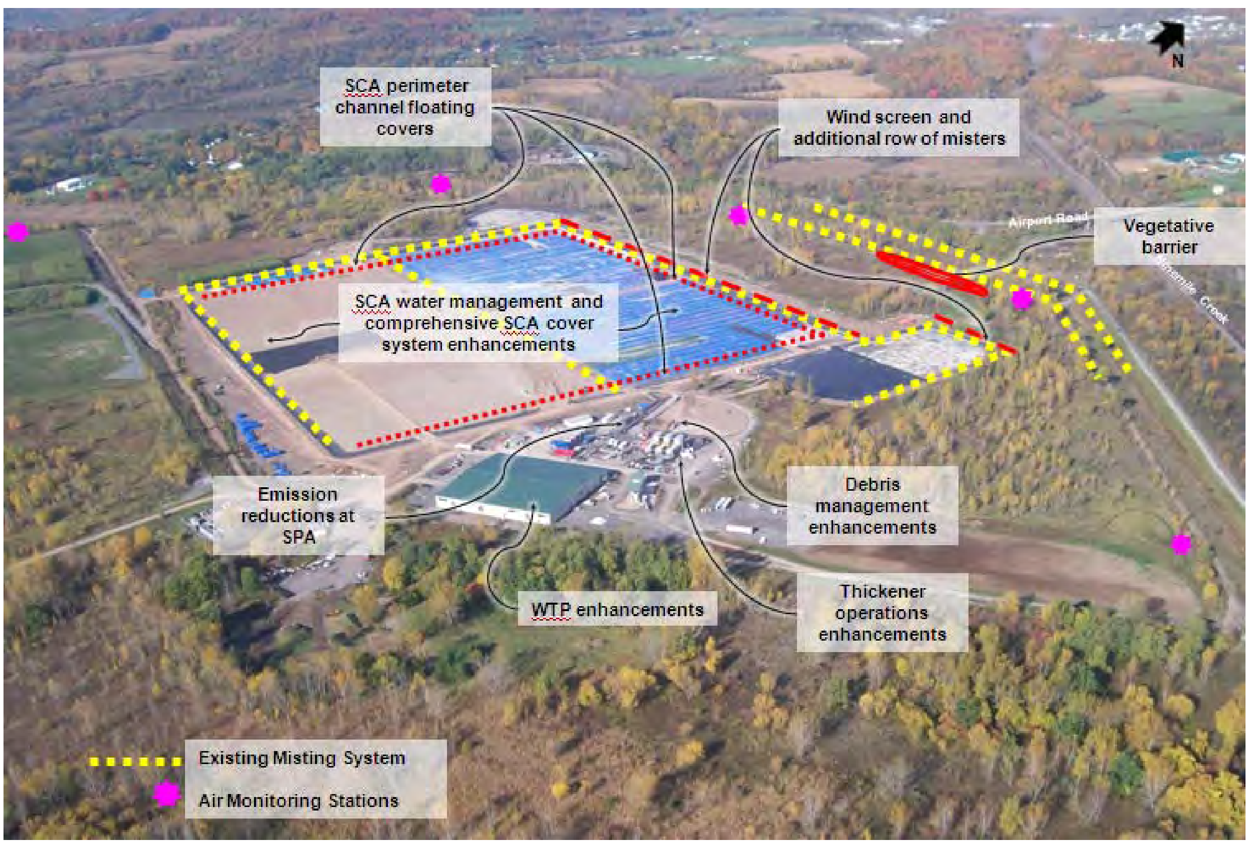
The polymer mixing system and holding tanks were identified as potential minor odor sources during monitoring of 2012 operations. Odor mitigation measures will therefore be implemented in 2013 to reduce potential odors from these sources. These two sources are considered to be a relatively minor contributor to odors. The make-down system is contained within a freight container, and the tanks are closed-top fiberglass tanks. The polymer itself was not identified as a potential odor source.

The polymer system consists of a hopper that feeds the dry polymer pellets into a mixing chamber, where they are mixed with water and discharged into three small mix tanks contained within an enclosure. These three mix tanks were designed as open-topped tanks. The open-topped tanks were found to be the source of odors within the enclosure, and hinged lids have since been installed on them. These lids will remain closed under normal operations except for brief periods during the polymer mixing process when site workers need to inspect the quality of the polymer.

Five fiberglass polymer holding tanks are used to allow the polymer to complete the aging process. Although the tanks are covered, they do have expansion vents that allow air to enter/exit during the tank filling/draining process. These vents have been identified as minor odor sources. To control odors from this source, the air will be routed through a carbon filtration step to remove potential odorous compounds from the air stream before it is discharged to the open atmosphere.

2.7 WATER TREATMENT PLANT EMISSION REDUCTION

During the 2012 dredge season, the odor collection system at the WTP was upgraded with the addition of a 4,000-cubic-foot-per-minute (cfm) VGAC system. The upgraded system included new collection and exhaust ductwork, two VGAC vessels, and a new 4,000 cfm blower. An odor survey was conducted at the WTP subsequent to the installation of the 4,000 cfm VGAC system but prior to dredge shut-down. The survey identified the area used for polymer monitoring and testing as a potential source of odors. Therefore, a fume hood was installed and the associated duct was connected to the new VGAC system.



Comprehensive additional odor mitigation measures to be implemented in 2013

Subsequent to the completion of 2012 dredge activities and odor collection system upgrades, the existing 1,000 cfm VGAC system was repurposed to collect air flow from multi-media filters during backwash operations. Backwash operations involve removal of solids from the WTP and pumping the solids back to the thickeners. Odor monitoring at the WTP will be conducted when 2013 dredge operations start to monitor the effectiveness of the odor collection system upgrades.

APPENDIX A

POTENTIAL ODOR MITIGATION EVALUATION RESULTS SUMMARY

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#	Potential Odor Mitigation Method	Description	Recommendations
1	Windscreen	A barrier such as wind screens would enhance the misting systems and serve as a break for air migration during calm conditions. The potential for vegetative or manmade breaks along the SCA perimeter, specifically for areas with gaps in trees, was also considered.	This item will be implemented. Refer to Section 2.3.1 for discussion on implementation of the constructed windscreen. Refer to Section 2.3.2 for discussion on the implementation of a trial vegetative barrier.
2	Improved or Alternative geotube covers	The current method of tarping the geotubes creates challenges with health and safety as well as placement and maintenance during wind conditions. Alternate approaches for different materials (gore-tex), methods of deployment, and anchoring were considered, including soil cover of inactive tubes and use of landfill-type tarps.	This item will be implemented. Refer to item 13 below for planned implementation of geotube cover system enhancements. Alternative materials were considered, including those discussed under items 3 and 21 below. As discussed under item 13, tarps will be integrated into the geotube construction by the geotube manufacturer using materials similar to what was successfully used during the latter part of the 2012 operations. This will be done in conjunction with other enhancements under the comprehensive integrated SCA cover system discussed in Section 2.1.
3	Spray-on geotube cover application	Spray application systems such as "posi-shell" and foams were considered as an alternative means of covering the geotubes.	This item would not be effective for the following reasons: 1. Foam application would not be effective because foam would be washed away with flowing water from geotubes. 2. A posi-shell-type material would not hold up to required operations on top of the bag, and resulting debris could interfere with water flow in the drainage stone and/or damage the geotubes. 3. Applying film to the geotubes would interfere with water draining from the geotubes. This item will not be implemented because the planned cover system enhancements provide a more effective means of covering the active geotubes. However, these options may be considered for inactive geotubes depending on how the tarping holds up.

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#	Potential Odor Mitigation Method	Description	Recommendations
4	Alternative (or no) additives for misting system	Changes to additives used thus far and use of other potential additives may be warranted based on additional data collected on the chemical makeup of the slurry odorants. Use of substances that counteract odor, surfactants, water only, or use of odorless surfactants (given odors associated with Piian system) were considered.	This item will be implemented. Water only and alternate additives were tested and evaluated. Refer to discussion in Section 2.4 for planned procedural improvements in the use of misting system additives.
5	Expand and/or enhance misting system	Changes to overall placement and operations of misters based on data obtained during 2012 operations may be warranted to enhance effectiveness. Consider snow cannons, horizontal fences, overhead misters, and a rain-down system.	This item will be implemented. Planned enhancements to misting system operations are discussed in Section 2.4.2. The existing misting system will be expanded to include an additional row of misters on the windscreen to provide a more effective means of controlling potential odors. Use of snow cannons would not be effective because of the water droplet size. Misting system effectiveness is based on droplet size to maximize potential contact with malodor compounds, with a targeted droplet size typically 5 microns or smaller. Typical snow cannon droplet size is in the 100 micron plus range. Horizontal fences, and overhead and rain down systems were determined to be impractical because of safety concerns for workers who would be working continuously in wet conditions and because of challenges in constructing system supports over the entire SCA.

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#	Potential Odor Mitigation Method	Description	Recommendations
6	Reduce cascading water on geotubes	Cascading and flowing water off the ends and along the sides of geotubes has been identified as a potential contributor to odors from the SCA. Methods to create pathways between geotubes for upper tubes to drain directly to the gravel drainage area as opposed to cascading over the sides of the tubes were considered. These included drop pipes, downspouts, or catch basins, and adding mats, fabric, gravel, or other mechanical means to minimize cascading water over the surface of multiple layers of geotubes.	This item will be implemented to reduce the potential for cascading water. Refer to discussion in Section 2.2 on planned SCA water management enhancements.
7	Optimize dredging with seasonal meteorology	Modify sequencing of the dredge locations to align the dredging of materials that are anticipated to be the most odorous with expected favorable seasonal meteorological conditions. Extending the dredge season into colder months was also considered.	The potential benefits of this approach are uncertain, and implementation could extend the dredge schedule because of down time to reposition the dredge. In addition, a significant level of coordination and notification to impacted organizations would be required (e.g., Canal Corps, Notice to Mariners) to minimize disruptions of other activities in the lake. This concept continues to be evaluated as operational sequencing plans are advanced. Extending the dredging operations into the colder months is not feasible because of potential for equipment freeze damage and the extended shut down process that includes the need to complete capping of dredged areas prior to winter shutdown. Therefore, the corresponding portion of this item will not be implemented.

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#	Potential Odor Mitigation Method	Description	Recommendations
8	Modify dredging to short-term meteorological conditions	Shutting down dredge operations or changing dredge locations were considered for times when adverse meteorological conditions exist (e.g., wind direction, temperatures, or other conditions that would increase potential for off-site odors). Changing the locations where the geotubes are being filled was also considered.	This item would not be effective because it takes a day or more for the changes in dredge material to be observed at the SCA since the material will continue to dewater for a period of time after pumping to the geotubes regardless of whether dredging operations are stopped or relocated. Additionally, meteorological conditions are varied throughout the day and are not accurately predictable. If real time changes of dredge operations were made to respond to meteorological conditions, the dredge schedule would be extended because it can take several hours to relocate the dredge. Changing the location of the geotubes being filled is not feasible, given the required fill progression. Based on these factors, this item will not be implemented.
9	Modify geotube layout/ sequencing	Modification of geotube layout and filling sequencing, as follows: • Consider wind direction in managing the SCA. For example, use the SCA area furthest from the north boundary filing geotubes during south winds. • Lay out the next layer of tubes early to act as additional covering for the inactive tubes. • Minimize stack height for most heavily contaminated material to reduce water cascade height for these materials	• As discussed under item 8, short-term operation changes would not be effective because of the lag time in controlling water flow from the geotubes. Therefore this item will not be implemented. • The intent of this item will be addressed by way of the more effective cover system discussed under item 13 below. • This item will be implemented to the extent practical.

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#	Potential Odor Mitigation Method	Description	Recommendations
10	Combine high and low odor material during dredging	When operating a dredge in an area with highly contaminated materials, operating a second dredge in a lesser contaminated area was considered so that the two different slurry streams are blended together prior to reaching the SCA.	This item would not be feasible because only the two smaller dredges can be operated simultaneously. Neither of the smaller dredges has the power to handle the ILWD material. Even if this concept could be implemented, resulting operational impacts could extend the dredge schedule. Therefore this item will not be implemented.
11	Sediment slurry treatment	Treatment involves reducing odorants within the slurry prior to discharge to the geotubes and may be applied before or after the thickener. Options include VOC stripping (potentially at the thickener), chemical oxidation, and sorption. The chemical composition of odor generation, chemicals that can counteract potential odor and delivery methods for injection must all be understood. A soaker hose in geotubes and in line or surface application on geotubes was also considered. Alternatives for management of resultant emissions (such as collection and treatment) may also be needed.	In-line slurry treatment would not be effective as discussed Appendix A.1. For the same reasons, alternate means of applying treatment would not be effective. Therefore this item will not be implemented
12	Enclosures or hoods over geotubes	Enclosures for geotubes that enable collection of emissions (such as a sprung structure, air supported enclosure or movable hood) with air treatment (as needed) prior to discharge were evaluated, as follows:	

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#	Potential Odor Mitigation Method	Description	Recommendations
		• Enclosing only active geotubes with no active ventilation	• As discussed below, enclosure of a geotube would not be feasible. In addition to the structural limitations, enclosure of the active bags without active ventilation and air treatment would not be effective because odorous compounds would accumulate in the airspace within the structure and would eventually escape from the enclosure. The integrated cover system discussed in Section 2.1 will be equivalent to this item. It has the advantage of minimizing potential release of odorous compounds to the air by way of reducing direct exposure of water to the air and avoids extending the dredge schedule.
		• Enclosure of active geotubes with active ventilation to a stack such that air treatment would not be required and use of air treatment prior to discharge • Permanent (during remainder of project) building or enclosure to be used for active geotubes during most unfavorable conditions (when off-site odor impacts are predicted to be greatest).	• This item would not be feasible for a number of reasons, including crane reach limitations within the SCA and ventilation requirements. Refer to Appendix A.2 for an evaluation summary. Enhancements to the cover system and SCA water management will be a more effective means of controlling potential odors from the SCA operations without extending the dredge schedule. • This item would not be effective given structural limitations related to the SCA liner. In addition, a set location would interfere with the specified geotube filling progression. This item will therefore not be implemented.

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#	Potential Odor Mitigation Method	Description	Recommendations
		• Enclose entire SCA (active and inactive geotubes)	• This item is not feasible because of site subsurface conditions and the size of the SCA (approximately 50 acres). Primary feasibility concerns include: 1. **<u>Enclosure Size Limitations</u>** - The structure would need to be open span construction and designed to resist wind and snow loads. For comparative purposes, the Carrier Dome covers 7.7 acres. 2. **<u>Soil Strength Challenges</u>** - The SCA soils are also highly compressible and susceptible to considerable differential settlement. The SCA WTP building is 1.3 acres with interior column construction. An SCA structure could not have interior columns. 3. **<u>Air Handling Limitations</u>** - The interior volume of a structure would exceed 150 million cubic feet, with air handling capacity requirements of over 30 million cfm (fully enclosed structure). For comparative purposes, the largest air-handling unit in the world has a capacity of 0.34 million cfm.
13	Geotube design optimization	Geotubes with potential favorable attributes for reducing potential odors such as inclusion of an integrated cover, fewer drain openings and/or with aspects to make covering simpler, coatings on the geotubes (for specifically addressing potential odors), smaller bags to facilitate covering and/or enclosing.	This item will be implemented as discussed in Section 2.1, including pre-installed covers by the geotube manufacturer.
14	SCA perimeter channel emission reduction	Options include a liner, floating cover, culvert, or additional gravel. Portable pumps to reduce amount of standing water were also considered.	A floating cover system will be installed as part of the SCA cover system as discussed in Section 2.1. The channel water levels will be monitored and pumped as necessary to meet design water level limits.

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#	Potential Odor Mitigation Method	Description	Recommendations
15	Orchard fans	Large air movement with orchard fans within the dispersion area of the geotubes could help to dissipate the inversions. Consider these with and without heat augmentation.	This item will be assessed on a trial basis at the start of operations. Refer to Section 2.4.
16	Reduce active operating area of bag field	This would include reducing the flow to the SCA to the extent practical given the required production rates for the project schedule, additional procedures to more aggressively cover/close geotubes as soon as can be achieved based on dewatering and next geotube placements, and additional thickener capability. This could also include additional clarifier capacity for weir overflow water to increase amount of weir overflow, thereby reducing the quantity of water to the geotube field and potentially decreasing the area of active geotubes.	This item will be implemented to the extent practical as part of operational improvements. Refer to discussion under Section 2.2.1.
17	Optimize wet weather operations	This would involve means for continuing dredge operations during METRO rain event shutdowns when rain will naturally mitigate potential odors. Options include adding storage of WTP effluent during METRO shutdowns (including West Basin conversion or new basin construction).	Additional storage capacity requirements would be highly variable based on the storm event and would not reduce odors during normal operations. However, this method continues to be explored.
18	Reduce dredge schedule	This would involve increasing productivity through methods such as dredging on Sundays or other operational methods to reduce the overall duration of dredging.	This item will be implemented to the extent practical as part of operational improvements, including system adjustments to reduce downtime and increase efficiencies.
19	Geotube channel cover system	This item would include containing potentially odorous vapors from flowing water between geotubes through a cover system discrete to the valley area (i.e., an "A" frame).	This item will be implemented. Refer to discussion in Section 2.3 on planned SCA water management enhancements.

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#	Potential Odor Mitigation Method	Description	Recommendations
Debris Stockpile Management Area			
20	Reduce oversize material generation at SPA	Reducing the amount of oversize material (primarily ILWD "chunks") will reduce the odor potential from debris management. Options include additional debris removal prior to dredging, an inline grinder, and modifying the dredge cutter head. Also consider sideline grinder after removal (e.g., frac tank with macerator).	This item would not be implementable or effective. Refer to Appendix A.3 for an evaluation summary. Alternative methods for further reducing potential odors associated with management of oversized material will be implemented. See item 22.
21	Alternative debris cover	Consider improved cover systems for the debris area beyond the current tarping system such as earthen material, or foam. Also considered chemical application to counteract odor (e.g., lime).	Earthen material would wash off and impact the drainage stone; foam would have a limited life and not provide additional odor control over what is already provided by tarping. However, use of foam in conjunction with tarping may be considered depending on the evaluation results for item 22.
22	Contained debris transport	This would include products for covering or encapsulating the debris in the transport truck and for unloading to avoid need for tarps in debris stockpile area.	This item will be implemented by way of use of debris bags on a trial basis at the start of 2013 operations. Refer to Section 2.5.
Sediment Processing Area			
23	Modify debris management system in SPA	Options include covering the conveyor and a covering (shroud or sprung structure) over the loading operation or revising the loading operations.	This item will be implemented. Refer to debris management enhancements discussed in Section 2.5.
24	Enclose SPA	Building or enclosure (or implementing other mitigative measures) with air control/treatment around the sediment processing area/thickeners and SMMA/conveyor, if it is determined that the air controls in this area are not adequate.	The incremental potential improvement of this item would not be effective given the other mitigation measures that collectively will provide more effective odor reduction, including: enhancement of air capture within the thickeners, installation of lids on the polymer vessels, installation of carbon filters on the polymer tank vents, and installation of covers on the debris conveyor system. This item will not be implemented since it would not be effective.

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#	Potential Odor Mitigation Method	Description	Recommendations
25	VGAC System optimization	Optimize vapor capture around the screen and thickener. Consider segregating the screen and thickener for consistent capture. Perform additional testing (i.e., smoke) to identify areas that may need additional sealing. Evaluate operations and monitoring methods (i.e., additional instrumentation, SOPs) to ensure no system breakthrough will occur during operations. Analyze system for potential to optimize carbon life (i.e., preheater to reduce humidity).	This item will be implemented as part of operational improvements, including installation of a VGAC pre-heater and demister, development of standardized procedures for carbon change-outs, and testing to monitor system effectiveness.
26	Emission reduction at polymer makedown area	Odor has been identified during polymer makedown when using effluent recycle water. Options for enhanced capture and control at polymer tank vents, makedown area, and frac tanks were evaluated. Use of potable water instead of recycled WTP effluent water was also considered.	This item will be implemented. Refer to Section 2.6 for discussions on operational improvements at the polymer makedown area, including use of carbon filters on expansion vents for continued use of recycled WTP water.
Water Treatment Plant			
27	Capture/reduce WTP fugitive emissions	The area used for polymer testing has been identified as a potential odor source within the WTP. Alternatives for testing operations, including use of areas with existing emission controls or installing a hood to capture potential odors if operations cannot be moved, were evaluated. Also evaluated whether there are other potential odor sources that can be addressed.	This item was implemented in late 2012, including relocation of testing operations, installation of a fume hood and upgrades to the WTP VGAC system.
28	Optimize WTP VGAC operations and system monitoring	Operations and monitoring methods were evaluated (i.e., additional instrumentation, SOPs) to ensure no system breakthrough will occur during operations.	This item was implemented in 2012, including preparation of an SOP for VGAC operations and carbon change-out and installation of air monitoring instruments.

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#	Potential Odor Mitigation Method	Description	Recommendations
29	Adjust WTP building air	Evaluate after item 27 is complete. Consider addition of building exhaust carbon filters.	This item will be implemented. An additional evaluation will be conducted after start of 2013 operations.

APPENDIX A.1

SEDIMENT SLURRY TREATMENT EVALUATION

APPENDIX A.1
SEDIMENT SLURRY TREATMENT EVALUATION

Treatment alternatives were evaluated for dredged sediment slurry to see whether such treatment could provide additional reduction in the odor-generating potential of the sediment dewatering processes. This evaluation included consideration of technologies applicable for environmental remediation projects and treatment of liquid waste streams. In general, three main treatment categories were considered:

- Chemical oxidation
- Air stripping
- Adsorption

The following criteria were considered while evaluating the potential treatment approaches:

- Potential effectiveness for the primary odorants present in the slurry
- Rate of treatment reaction
- Impacts to system materials and other processes, including flocculent effectiveness and water treatment
- Health and safety
- Implementability

For chemical oxidation and adsorption, two potential reagent injection points were considered. The first injection location evaluated was near the lakeshore in the vicinity of booster pump #1. Travel time from the lake to the thickeners located at the SCA is approximately 25 to 30 minutes. This travel time would facilitate better mixing and would provide the greatest residence time for reactions to occur between the injected additive and the slurry. The second injection location evaluated was following the slurry thickening process. The primary potential benefit to this option is that the water removed by the thickeners would be eliminated prior to treatment, which would reduce the volume and contaminant mass requiring treatment. However, travel time from the slurry thickeners to the geotubes is only 5 to 10 minutes, which may limit the opportunity for the injected additive to sufficiently react with the dredged slurry.

Application of chemical oxidants and sorbents to the surface of the geotubes was also considered. However, surface application was not retained because the minimal contact time while water is flowing down the sides of the geotubes would result in minimal effectiveness. In addition, there would be significant potential worker health and safety concerns with continuous exposure to the additives, particularly chemical oxidants.

Based on the detailed evaluation below, significant issues were identified with each of the sediment slurry treatment options. For example, air stripping would not effectively remove the primary odorants from the slurry due to their inherent chemical properties. In addition, the majority of the contaminant mass is sorbed to the particulates and would quickly recontaminate the water even if stripping was able to remove the contaminants from the water. Similar limitations exist for each of the slurry treatment options. Therefore, slurry treatment would not be implementable or effective.

<u>Chemical Oxidation</u>

Chemical oxidation is a chemical reaction in which an oxidizing compound is introduced to destroy and/or change the constituents present. Oxidation is often used in wastewater treatment plants (WWTPs) and *in-situ* to remediate groundwater impacted by chlorinated solvents such as trichloroethene (TCE) or compounds commonly associated with gasoline (e.g., benzene and toluene).

The amount of chemical oxidant required is primarily determined based on the amount of reduced-state compounds, including organic material present. The organic material makes up most of this 'oxidant demand' and includes the target organic constituents as well as any other organic material present. As with most sediment found in aquatic environments, the material that is being dredged for this project contains a large amount of naturally-occurring organic material. The vast majority of chemical oxidant added would therefore be consumed by oxidation of this background organic carbon, which is not believed to be a significant odorant, rather than by oxidation of the target odorants. For example, the average concentration of total organic carbon in the slurry is approximately 175 times greater that the concentration of naphthalene. This means that for every pound of oxidant added to treat naphthalene, approximately 175 pounds would have to be added to account for oxidant demand from the background organic material. This extreme inefficiency combined with the very large slurry flow rates would prevent chemical oxidation from being a practical method to reduce the odor potential of the slurry. In addition, any residual chemical oxidants would likely break down the organic polymers that are used to enhance the ability of the dredge solids to settle and dewater in the thickeners and the geotubes. Therefore, chemical oxidation would not be implementable or effective.

The four oxidants considered for in-line treatment of the slurry and additional site-specific issues for each of these oxidants are summarized below.

Hydrogen peroxide: Hydrogen peroxide is the most commonly used oxidant in chemical oxidation applications and is readily available. In addition, peroxide is highly reactive. That is, it will quickly react with most organic compounds it comes in contact with. The prime products of a hydrogen peroxide-based reaction are water, carbon dioxide and oxygen. A significant site-specific consideration that would adversely impact a peroxide-based oxidation reaction is the pH of the dredge slurry from Remediation Area D, which has a high pH (approximately 10 to 11). This high pH environment reduces the effectiveness of the oxidation reaction and can degrade the peroxide before oxidation reactions can occur. This would significantly increase the demand of the oxidant in order to achieve a significant reduction in the odor-causing compounds.

Permaganate: Permaganate is another oxidant commonly used in groundwater remediation. It is considered a relatively weak oxidant, and is most commonly used to oxidize chlorinated solvents (e.g., TCE). Permaganate is not effective at oxidizing polycyclic compounds such as naphthalene.

Persulfate: Persulfate is a less common but relatively strong oxidant compared to peroxide and permanganate. Comparatively, it is not as readily available, meaning it would likely be difficult to obtain sufficient oxidant to achieve the goal of odor reduction. Persulfate does not react as quickly as peroxide; however, it will quickly corrode many types of materials, including carbon steel, copper, and brass as well as some rubbers. For application on this project, regardless of injection location, this strong corrosivity would have the potential to quickly degrade much of the slurry transportation and dewatering system, including valves, pumps, and seals. While these system components were designed for compatibility with the dredge slurry, injection of persulfate was not considered when specifying the system materials.

Chlorine-based Compounds: Chlorine-based compounds have been used for disinfection (e.g., drinking water) and deodorizing purposes for centuries. Recently, however, its use to treat contaminated water and waste streams that are ultimately discharged back to the environment has drawn concern over the presence of chlorinated byproducts. These byproducts often present potential risks to the environment and typically are not readily removed by treatment processes.

Air Stripping

Air stripping is often used to treat groundwater contaminated by volatile organic contaminants (VOCs) as part of a pump-and-treat system. It is commonly accomplished by passing the water through a media that increases the contact between the water surface area and an air stream, which allows chemical compounds to volatilize from the dissolved phase to the air phase. The air stream is then typically treated prior to discharge to the atmosphere. Air stripping would not result in significant reduction in odor emissions, as detailed below, and therefore is not recommended for implementation.

Some release of volatile compounds from the water to the air occurs during dewatering, which contributes to odors. However, the effectiveness of air stripping in removing the majority of a specific compound from a liquid stream is typically evaluated based on consideration of the Henry's law constant of the compound. The Henry's law constant describes how readily a compound will transfer from the dissolved phase to the gas phase. Compounds with Henry's Law constants greater than 0.01 atmospheres-m^3/mol are considered amenable to stripping[1]. The Henry's Law constants for the primary slurry odorants range from 0.0005 to 0.009 atmospheres-m^3/mol; therefore, air stripping would not be effective in removing a significant percentage of the mass of these compounds from the slurry stream.

Another significant impediment to air stripping of the slurry is that the majority of the odorant mass is sorbed to sediment particulate material rather than dissolved in the slurry water. For example, approximately 83% of the total naphthalene mass is sorbed to the particulate material based on partitioning theory. Even if 100% of the dissolved-phase odorant mass could be removed through an air stripping process, the sorbed contaminant mass would quickly replenish the water with odorants and prevent significant odor reduction during dewatering.

Limited removal of odorants may be occurring during slurry screening at the sediment processing area. Based on the removal theory described above and published estimates of the removal efficiencies typically observed in these types of processes, it is not anticipated that these removals are significant. However, to validate this assumption, slurry samples will be collected before and after slurry screening during 2013 operations and analyzed for primary odorants. A work plan for collection and evaluation of these samples will be submitted to the New York State Department of Environmental Conservation for approval prior to implementation.

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[1] Based on the Federal Remediation Technologies Roundtable Remediation Technologies Screening Matrix and Reference Guide (http://www.frtr.gov/scrntools.htm)

Adsorption

Chemical adsorption is commonly applied to remove chemical compounds from a water or air stream, typically by passing the stream through a vessel containing large quantities of activated carbon. In this treatment process, chemical compounds will migrate from the stream and adsorb to the carbon. The application considered for this project was based on injection of a sorbent (such as carbon) into the dredge slurry to allow the odor-causing compounds to adsorb to the sorbent, which would then be retained by the geotubes along with the dredge solids.

Adsorbents considered were activated carbon, natural organic materials such as sawdust or wood chips, and naturally occurring clays and manufactured organoclays that have been demonstrated to sorb organic contaminants. Of these, organic carbon is by far the most effective, is readily available, and therefore was the primary adsorbent considered.

As discussed under chemical oxidation, the majority of the odorant mass is sorbed to sediment particulate material rather than dissolved in the slurry water. Therefore, the chemical mass leaving the dissolved phase to adsorb to the carbon would concurrently be replaced by chemical mass leaving the adsorbed-to-sediment phase as the mixture constantly moves towards chemical equilibrium. This factor, combined with the very high flow rates, would mean that excessive amounts of activated carbon would have to be added.

The rate of the sorbent reaction would also contribute to the impracticality of adsorption. While significant research has been conducted to assess how well specific chemicals will adsorb to carbon, these studies are typically run over 24 hours. There is little empirical evidence on how much contaminant adsorption could be achieved in the 30 to 40 minutes of travel time from the dredge to the geotubes; however, it is unlikely that this would be sufficient time for the activated carbon to fully adsorb.

In addition to the treatment challenges identified above, a clear relationship between slurry VOC concentrations and resulting odor levels has not been established through odor characterization evaluations conducted for this project. This makes it more difficult to assess the effectiveness of injecting carbon to reduce odors. For example, significant odors have been noted from the water leaving the water treatment plant even after VOCs have been removed using activated carbon.

As detailed above, the inefficiency of adsorption combined with the very large slurry flow rates would prevent adsorption from being a practical method to reduce the odor potential of the slurry. Therefore, adsorption would not be implementable or effective.

APPENDIX A.2

GEOTUBE HOOD EVALUATION

APPENDIX A.2
GEOTUBE HOOD EVALUATION

The feasibility of using portable hoods to capture emissions from the geotubes in which sediments are dewatered was evaluated as part of the continuous improvement program to further reduce potential odors from the dewatering process. This evaluation included developing a conceptual operational plan and design for geotube hoods and assessing the feasibility of implementation. As detailed below, significant implementation issues were identified, including:

- No crane was identified in the United States capable of lifting the hood.
- The air handling system necessary for such a hood would be several times larger than the largest air handling system in the world.
- Even if lifting the hood were feasible, planning and executing lifts of the hood would take significant time and could result in extending the remaining dredging schedule from 3 years to 10 years or more.
- Use of hoods would offer minimal if any incremental benefit over the upgraded geotube cover system that will be implemented.

Based on this detailed evaluation, geotube hoods would not be effective or implementable.

Arrangement and Operation

During operation, geotubes measuring 40 feet wide by 300 feet long by 8 feet high are filled with dredged material and allowed to dewater within the Sediment Consolidation Area (SCA). The geotubes will eventually cover approximately 44 acres (an area measuring 1200 feet by 1600 feet) and will be stacked up to five tubes high. During normal operation, the geotubes are filled and then allowed to dewater over time. As the sediments dewater, they compact within the tube, allowing subsequent refilling and dewatering cycles before the geotube is completely filled. A total of six to eight geotubes are typically in the process of being filled and dewatered at one time. Completion of up to four or more geotubes can occur in a single day.

A conceptual design and operational approach was developed for fume hoods over the tubes to evaluate the potential practicality and effectiveness of this application in controlling odors. This conceptual approach includes a movable fume hood that covers one geotube that would be approximately 50 feet wide by 300 feet long. The structure would include sidewalls that are approximately 10 feet high and supporting legs that extend another 10 feet. This height would allow workers to operate under the hood, which is necessary in order to fill the geotube. A total of eight fume hoods would be required to cover all active geotubes. The intent would be to have eight movable fume hoods that are relocated using a crane. The fume hood supports would be adjustable to allow the fume hood to be supported on filled geotubes on both sides or on a filled geotube on one side and the ground or lower geotube level on the other.

Normal geotube filling operations entail filling several geotubes in a row and adding new adjacent geotubes sequentially. Operating geotubes could not be adjacent to each other if fume hoods are used because each fume hood and support structure covers a larger area than the geotube to ensure that emissions are captured.

Conceptual Design

The attached figure depicts a conceptual design for a fume hood that covers an entire 50-foot-wide by 300-foot-long geotube. This conceptual design includes the following elements:

- The structure would be mobile to allow it to be lifted by one crane using four lift points.
- The structure would include 10-foot-high side truss sections running the length of the hood.
- Trusses running the width of the hood would be located at each support and at the center of the side trusses.
- The roof and sides would be constructed of fabric, framed with steel beams running across the width every 30 feet and purlins spanning between the beams to support the fabric roofing
- The structure would be capable of withstanding reasonable wind loads, but not snow loads. In the winter, dredging and filling operations cease, and the fabric roof would be removed. The fabric roofing would be reinstalled in the spring.
- The preliminary design was developed by modeling the fume hood in a structural analysis program. The member forces, reactions, member sizes, and deflections were calculated as well as the weight of the structure.
- The total weight of the structure is estimated to be approximately 120 tons.

Lifting Evaluation

Lifting and placement of the hood would be accomplished using a mobile crane. The SCA is approximately 1200 feet wide parallel to the geotubes and 1600 feet perpendicular to the geotubes. Therefore, the crane must be able to reach at least 600 feet from the edge of the SCA to position a fume hood at all positions.

A Terex CC9800, 1600-ton lifting capacity crawler crane was selected for evaluation because it is the largest production crane identified in the United States. Because of the large footprint of this crane (see attached specifications), it would need to be located such that its center of rotation is approximately 40 feet from the edge of the SCA berm. Therefore, it would need to have the capacity to lift a 120-ton hood at a distance of 640 feet from its center of rotation. However, this crane, which has a 472-foot-long boom and a jib extension, only has a lifting capacity of 64.5 tons at a radius of 400 feet from the center of the crane. Therefore, this crane -- the largest crane identified in the United States -- would not be capable of lifting and placing fume hoods throughout the SCA.

Other Considerations

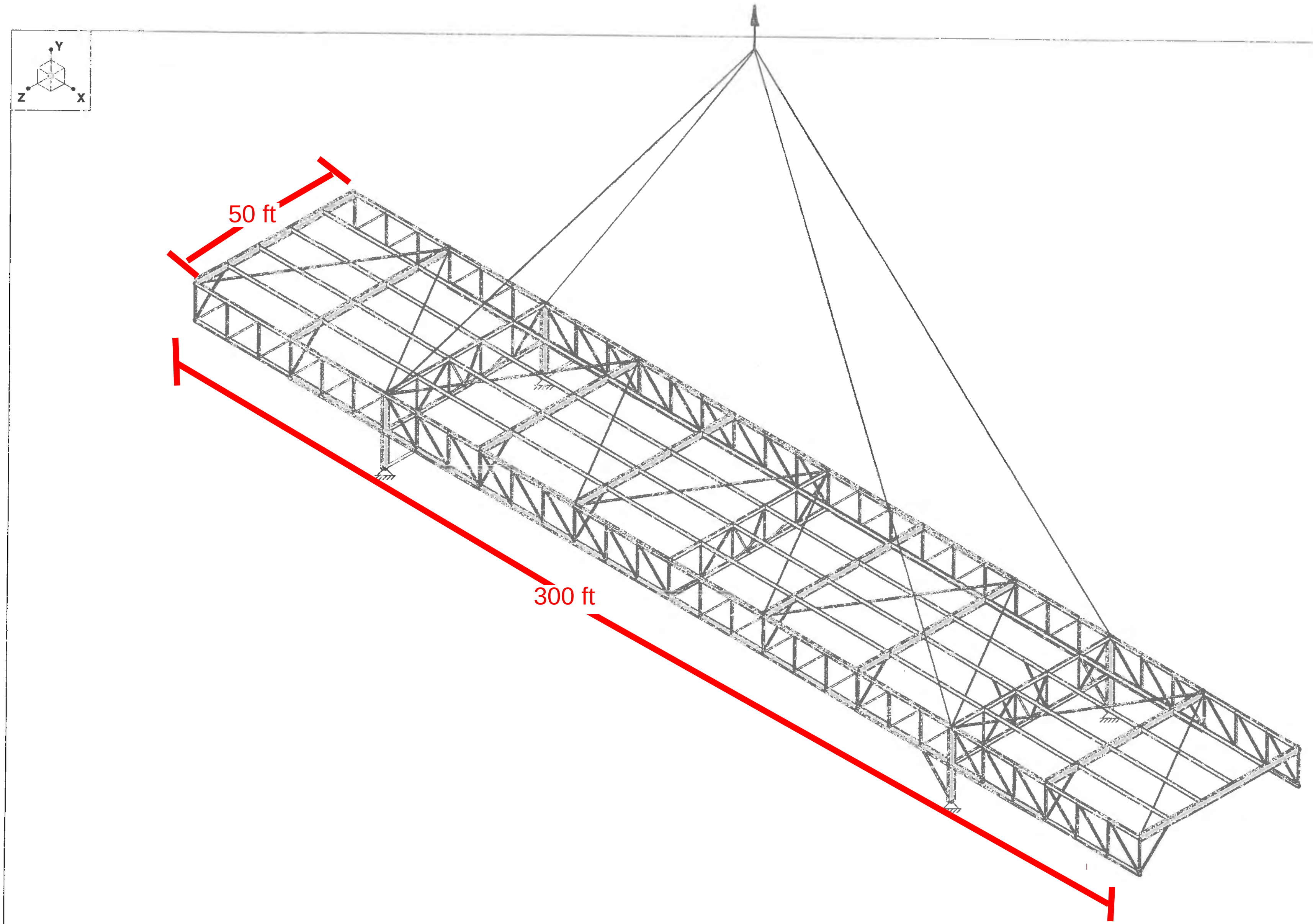
Several additional issues associated with use of a hood were identified, as described below.

- There are several challenges associated with ensuring that the hood is at the right height to capture odors from the geotubes. During initial filling, the bag is flat and then eventually inflates to a height of approximately 8 feet. It would be very challenging to adjust the height of the hood as the geotube is being filled to optimize capture throughout the operation. In addition, the sides and/or support legs would need to be adjustable because sometimes they would rest on adjacent geotubes that are at the same height as the top of the geotube being filled, and other times would rest on geotubes that are at the same height as the bottom of the geotube. The hood conceptual design did not address this challenge. However, these challenges would make it very difficult to capture all emissions using a hood; thus, use of hoods would offer minimal if any incremental benefit over the upgraded geotube cover system that will be implemented.
- The 120-ton weight of the hood would be supported by adjacent geotubes, which would have very low load-bearing capacity. Therefore, the load would need to be widely distributed to ensure that the supporting geotubes would not be damaged. The hood conceptual design did not address this challenge.
- The extreme weight of the crane and the hood would be supported on a relatively small area; therefore, significant improvement of the bearing capacity of the underlying substrate would likely be required. The hood conceptual design did not address this challenge.
- Moving the structure in any wind would present significant problems, including significant worker health and safety concerns. Due to the large sail area, even a light breeze would result in large side loads on the structure that would have to be counteracted by ropes or other anchoring methods. The filled geotubes do not provide sufficient strength to be anchored to. They also do not have the strength to support heavy equipment capable of anchoring the structure aganist wind loads during movement of the hood.
- Significant air handling capacity would need to be incorporated into the hood design. Standard hood design typically dictates 100 cubic feet per minute per square foot (cfm/sf) for the area of the hood. For a 50 ft x 300 ft hood, this results in an air flow of 1.5 million cfm for each of the six hoods. By comparison, the air handling system that powers the HVAC system on the Beverly Briley building in Nashville, Tennessee, is currently the largest air-handling unit in the world with a capacity of 345,000 cfm.
- The enclosure supports would not allow adjacent geotubes to be filled at the same time, which is contrary to current operational plans. This would increase the potential for the

geotubes to roll and decrease the effectiveness of SCA water management efforts as a result of dispersed geotube filling operations.

- Significant worker health and safety risks would be presented during movement and use of the hoods. Workers need to be working on top of the geotubes under the hoods to ensure proper operation.
- Use of the hoods would have significant schedule implications. Typically, multiple days of planning and execution are required for a lift as large as moving a hood of these dimensions. Completing one lift each day would be an aggressive schedule. However, as discussed above, four or more geotubes can be completed in the same day under current operations. One fume hood lift and placement a day would mean that only one geotube, rather than the current four, could be completed each day, thereby increasing the schedule by a minimum factor of four.

ATTACHMENTS



Results for LC 1, ASCE 1

Honeywell	Fume hood 50 x 300	SK - 2
R Budde		Jan 18, 2013 at 8:11 AM
446984-16020	50 ft x 300 ft Fume Hood	Fume hood 50 x 300.r3d

TEREX®

CC9800 | Crawler Crane 1600 t Lifting Capacity

CC9800

CRAWLER CRANE

TEREX®

HIGHLIGHTS

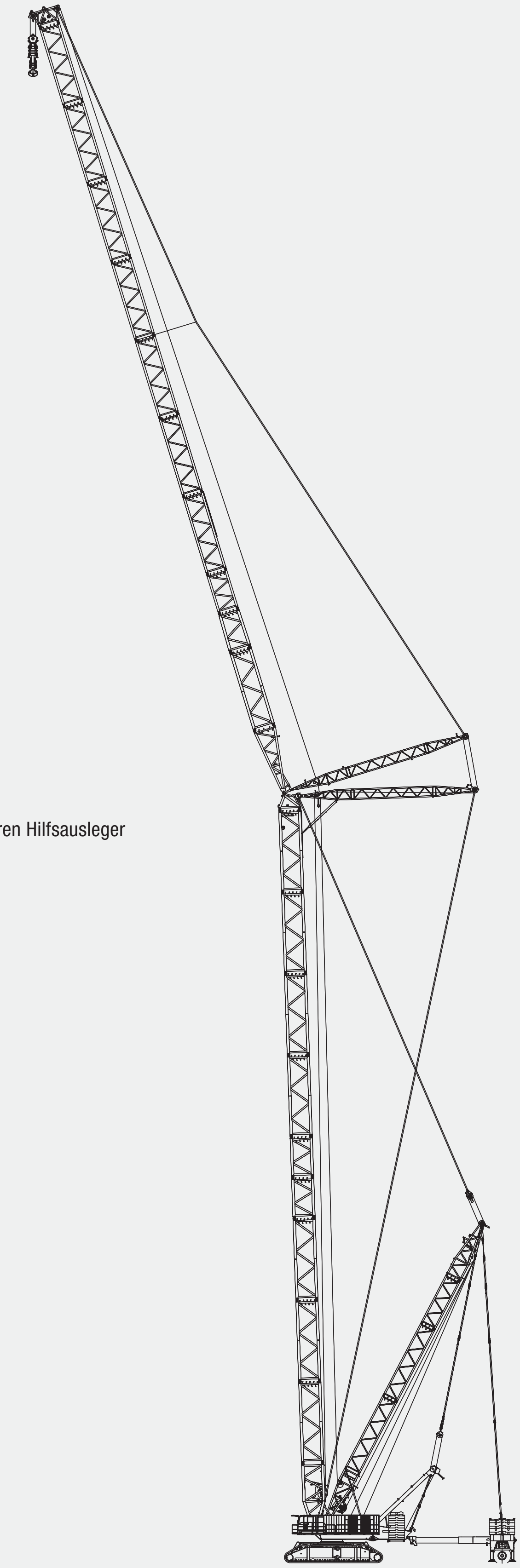
CC9800

HIGHLIGHTS

- Max. capacity 1600 t
- Max. load moment 26930 mt
- Superlift radii 19-30 m
- Excellent capacities at the luffing fly jib
- Redundant drivelines
- 400 V power supply

- Max. Tragfähigkeit 1600 t
- Max. Lastmoment 26930 mt
- Superliftradien 19-30 m
- Ausgezeichnete Tragfähigkeiten am wippbaren Hilfsausleger
- Redundante Antriebseinheiten
- 400 V Stromaggregat

- Capacité maximale de 1600 t
- Moment de charge maximum 26930 mt
- Radius superlift 19-30 m
- Excellentes capacités avec la volée variable
- Double unité d'entraînement
- Groupe électrogène de 400 V



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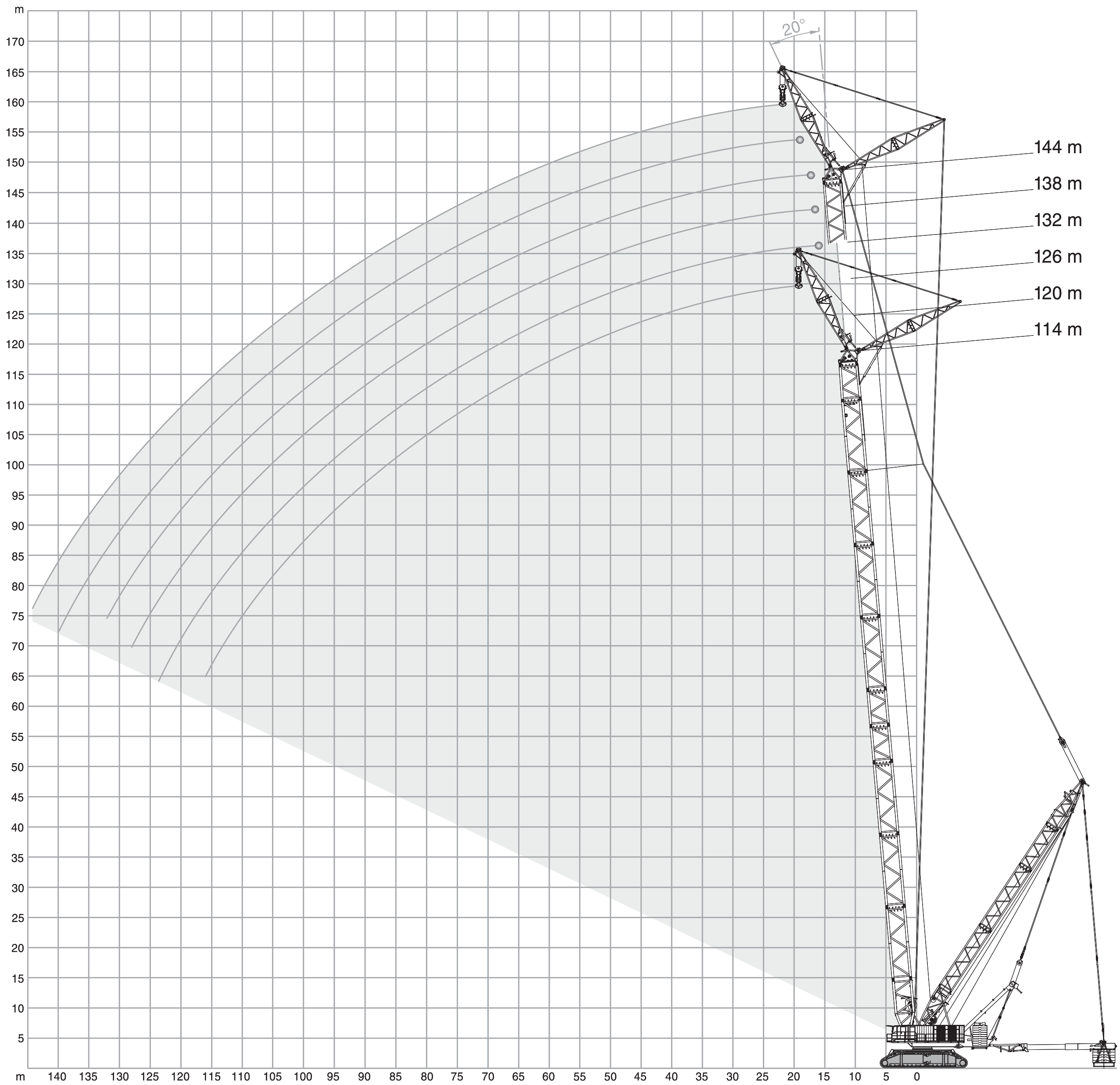

SSL / LSL + LF

235 t + 0 t ZB | 19-30 m | 18 m | 20° | 10,50 m | 360° | ISO

m	114 m 0 t	114 m 0 t - 640 t	120 m 0 t	120 m 0 t - 640 t	126 m 0 t	126 m 0 t - 640 t	132 m 0 t	132 m 0 t - 640 t	138 m 0 t	138 m 0 t - 640 t	144 m 0 t	144 m 0 t - 640 t	m
m	t	t	t	t	t	t	t	t	t	t	t	t	m
22	177,0	400,0	170,0	400,0	160,0	400,0	153,0	380,0	-	-	-	-	22
24	157,0	400,0	151,0	400,0	141,0	400,0	134,0	380,0	128,0	360,0	122,0	322,0	24
26	140,0	400,0	134,0	400,0	125,0	400,0	119,0	380,0	112,0	360,0	106,0	322,0	26
28	125,0	400,0	119,0	400,0	111,0	400,0	105,0	380,0	98,5	360,0	93,5	321,0	28
30	112,2	400,0	106,7	400,0	98,7	400,0	93,0	380,0	87,0	360,0	82,0	320,5	30
34	89,2	400,0	84,5	400,0	76,7	400,0	71,2	380,0	66,0	360,0	61,2	319,5	34
38	70,5	400,0	66,2	400,0	58,7	400,0	53,5	376,0	48,6	360,0	44,2	318,0	38
42	55,1	400,0	51,1	400,0	43,7	397,0	38,8	365,0	34,0	356,0	29,9	315,0	42
44	48,2	400,0	44,2	400,0	36,9	394,0	32,1	360,0	27,3	352,0	23,3	313,0	44
46	42,1	400,0	38,2	400,0	31,0	391,0	26,3	354,5	-	348,0	-	311,0	46
48	36,1	400,0	32,3	400,0	25,2	388,0	20,5	349,0	-	344,0	-	309,0	48
50	30,9	387,0	27,2	385,5	-	376,5	-	332,0	-	327,5	-	306,5	50
52	25,7	374,0	22,1	371,0	-	365,0	-	317,0	-	322,0	-	304,0	52
54	-	356,5	-	353,5	-	347,5	-	305,5	-	310,5	-	293,0	54
58	-	323,5	-	320,5	-	314,5	-	282,5	-	288,0	-	275,5	58
62	-	295,0	-	292,0	-	286,0	-	259,5	-	266,0	-	256,5	62
66	-	270,0	-	267,5	-	261,0	-	237,0	-	244,0	-	237,0	66
70	-	248,0	-	245,5	-	239,0	-	214,5	-	221,5	-	217,5	70
74	-	228,5	-	225,5	-	219,5	-	191,5	-	199,0	-	198,0	74
78	-	211,0	-	208,0	-	202,0	-	169,0	-	177,0	-	178,5	78
82	-	195,5	-	192,5	-	186,5	-	149,5	-	155,0	-	159,0	82
86	-	181,0	-	178,0	-	172,0	-	129,0	-	134,5	-	140,5	86
90	-	168,0	-	165,0	-	159,0	-	115,0	-	117,5	-	121,0	90
94	-	156,5	-	153,5	-	147,0	-	109,0	-	105,0	-	107,5	94
98	-	145,5	-	142,5	-	136,0	-	103,5	-	99,2	-	97,5	98
102	-	135,5	-	132,5	-	126,0	-	98,2	-	93,7	-	92,2	102
106	-	126,5	-	123,5	-	117,0	-	92,5	-	88,2	-	86,7	106
110	-	118,0	-	115,0	-	109,0	-	86,7	-	82,7	-	81,2	110
114	-	110,5	-	107,5	-	101,2	-	81,2	-	77,2	-	75,7	114
116	-	107,0	-	104,0	-	97,5	-	78,5	-	74,5	-	73,0	116
118	-	-	-	100,5	-	94,0	-	75,5	-	71,7	-	70,2	118
122	-	-	-	91,7	-	87,2	-	69,7	-	66,2	-	64,5	122
124	-	-	-	86,5	-	84,0	-	67,0	-	63,5	-	61,5	124
126	-	-	-	-	-	79,5	-	64,2	-	60,7	-	58,7	126
128	-	-	-	-	-	75,0	-	61,5	-	58,0	-	56,0	128
130	-	-	-	-	-	-	-	58,5	-	55,2	-	53,2	130
132	-	-	-	-	-	-	-	55,5	-	52,5	-	50,5	132
134	-	-	-	-	-	-	-	-	-	49,8	-	47,9	134
138	-	-	-	-	-	-	-	-	-	44,3	-	42,6	138
140	-	-	-	-	-	-	-	-	-	41,6	-	39,8	140
142	-	-	-	-	-	-	-	-	-	-	-	37,0	142
144	-	-	-	-	-	-	-	-	-	-	-	34,3	144
148	-	-	-	-	-	-	-	-	-	-	-	-	148

3

144M = 472 ft
Capacity 34.3 tons
122M = 400 ft
Capacity 64.5 tons

APPENDIX A.3

IN-LINE GRINDER EVALUATION

APPENDIX A.3
IN-LINE GRINDER EVALUATION

Over-sized dredge material that is screened out of the slurry was identified as a potential odor source during the odor assessment efforts in late 2012. As part of the winter 2012/13 odor evaluation for the Onondaga Lake project, alternatives were considered to address management of this material. The screening process is located on top of the slurry thickeners. During dredging in Remediation Area D (RA-D), this screened material was often comprised of hard Solvay waste.

The overall objective of the evaluation was to determine if the material could be reduced into smaller pieces that would pass through the screens located on top of the gravity thickeners. An on-site test of an inline grinder was conducted using hard Solvay waste. An inline grinder was identified as the only potentially viable approach because an external system would likely result in another odor source. Test results indicated that the achievable processing rate of the inline grinder was insufficient for the anticipated volume of dredge materials. Debris exceeding the capacity of the grinders would likely result in an accumulation of the hard material in the pipeline ahead of the grinder(s) and cause a required shutdown, which would significantly impact the production of the dredge operations. Therefore, as detailed below, incorporation of in-line grinders would not be implementable or effective. Alternative methods will be used to further reduce potential odors associated with managing oversized material.


Grinder test set-up

Similar in-line grinders are often incorporated into the design and operation of municipal wastewater treatment plants to grind up occasional solids that come into the plant through the sewer lines. The primary function of the grinders in these applications is to protect downstream pumps and systems.

To evaluate the potential grinder application, Parsons worked with a distributor for the JWC Environmental Macho Monster®. This industrial grinder is used for large sludge processing systems, as well as many industrial applications including petroleum refineries, pulp and paper mills, chemical plants, and recycling plants. A grinder unit was brought to the SCA site to conduct a test on the hard Solvay waste materials that were encountered in 2012. This test was conducted on February 12, 2013.

An open channel grinder unit with an attached fabricated hopper was tested to assess the performance of the grinder unit. Material used for the grinder test consisted of solidified Solvay waste material that was taken from stockpiles of screened over-sized materials in the debris management area of the Sediment Consolidation Area (SCA) and from drummed solidified Solvay waste material that was collected with a barge-mounted excavator during the 2012 operating season.


Dry material grind test

Both dry and wet materials were tested. While the grinder was able to reduce the material size during dry material testing, it did so at a very slow rate. In general, the hard material would "bounce" on the grinder teeth for several seconds before being gripped by them and broken up. Over several minutes of testing, very little of the material was ground up.

The initial test was followed by grinding with a flow of hydrant water to the hopper to more closely mimic slurry line flow conditions. The addition of water substantially increased the grinding rate, and all material that was placed into the hopper (including several pieces of the SCA drainage gravel) was eventually ground up. However, the rate at which the material was processed was still significantly slower than the required rate during dredge operations. In addition, larger material (greater than 6-inch diameter) would "bounce" on the teeth for several minutes before being processed.


Wet material grind test

In summary, based on observations by Parsons, Sevenson, and *de maximus*, the processing rate was insufficient for anticipated lake dredge operations even if more than one grinder were used and a bypass was installed. Debris exceeding the capacity of the grinders would likely result in an accumulation of the hard material in the pipeline ahead of the grinder(s) and cause a required shutdown, which would significantly impact the production of the dredge operations. Therefore, incorporation of in-line grinders would not be implementable or effective.