New York State Department of Environmental Conservation
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Erin M. Crotty
Commissioner

June 26, 2003

Mr. Alfred J. Labuz
Manager
Remediation & Evaluation Services
Honeywell
5000 Brittonfield Parkway
Suite 700
East Syracuse, NY 13057

RE: BIOMASS PILOT STUDY - WASTE BED #13 - CAMILLUS (T), ONONDAGA COUNTY

Dear Mr. Labuz:

The New York State Department of Environmental Conservation has reviewed the April 2003 work plan for the Biomass Pilot Study proposed in waste bed #13 located in the Town of Camillus, Onondaga County. The Department agrees that Honeywell and SUNY ESF may proceed with this project as set forth herein.

Although it is recognized that the results from this project may be used to propose an alternative cap design for the waste beds, this letter and authorization to proceed with this project is **not** an acceptance of the work plan as a suitable closure plan of the waste beds. An alternative cap design is regulated under Part 360-2.15(d)(5) with a reference to Part 360-2.13(w) and must be formally approved by the Department prior to closure acceptance.

Honeywell shall keep the Department informed on the project status and meet the following conditions:

1. Honeywell shall submit a status report to the Department by June 30th and December 31st each year this project is underway. This status report shall include a summary of what tasks were accomplished in the prior six months, all data (including analytical), information and recordings obtained in the previous six months, a summary of what is to be accomplished in the next six months with an estimated schedule and any changes to the work plan. Please note that any changes to the work plan need prior written approval from this office before implementation. Data shall be summarized allowing for comparison and trend evaluation. Photographs shall be taken monthly from established reference points to reflect current conditions. Reference points shall be established for each side of each plot. All photographs shall be included in the status report. All items in each of

the five tasks in the April 2003 report shall be discussed in the status report and a summary of the implementation, problems, successes and interpretations shall be included.

2. Honeywell shall receive written Department approval prior to applying any amendments to the waste bed including nutrients, weed control agents, fertilizers, pesticides, herbicides, etc.

3. This project is limited to the areas defined as plots #1, #2, #3 in Figure 1 of the April 2003 work plan. Each plot is approximately two acres in size and located completely within the 163-acre waste bed #13.

4. Each plot will be monitored monthly for erosion. Necessary repairs shall be performed within 14 calendar days. Photographs will be taken each month showing soil and, if evident, erosion around each plot. Each photo shall be dated and its location explained. This information will be included in the status reports.

5. In addition to the analytical parameters included in the work plan, Methods 8260 and 8270 shall be performed on one sample collected from each of the plots. A sample shall be collected during the month of July 2003 and after the third harvest. Sampling depth shall be at the two-foot interval. The initial sampling location shall be noted so that the final sampling location within each plot can be closely replicated after the third harvest. A NYSDOH ELAP certified laboratory will be used for these analyses.

6. This project shall not create any nuisance conditions or adversely affect the environment. Public inquiries regarding this project shall be included in the status report.

7. The Department reserves the right to stop all activities related to this work plan based upon any adverse environmental impact that this project may cause. In the event that this project is halted, Honeywell may be required to remove all growth and amendments to plots #1, #2, and #3. Twelve inches of cover shall be immediately applied to each plot and vegetation established.

8. This project shall not interfere or delay final closure of any waste bed. Subsequent agreements or actions for the closure of any waste bed will supersede tasks necessary for this pilot study and the Department may require removal of the project to effectuate any closure of the waste beds.

Please notify me in writing as to when you will begin the project. Should you have any questions, feel free to contact me.

Very truly yours,

Thomas E. Annal, P.E.
Environmental Engineer 2

cc: Mary Jane Peachey
Jeff Schmitt
Dr. Lawrence P. Abrahamson, SUNY ESF

WORK PLAN

Biomass Pilot Study
Solvay Wastebed 13
Camillus, New York

Honeywell

April 2003

O'BRIEN & GERE

State University of New York
COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY

1163/32255

WORK PLAN

Biomass Pilot Study
Solvay Wastebed 13
Camillus, New York

Honeywell

Jeffrey E. Banikowski, CPG
Sr. Managing Scientist

April 2003

O'BRIEN & GERE ENGINEERS, INC.

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1.1. Background

There are a number of Solvay wastebeds located in central New York. These beds received Solvay waste from about 1892 to 1986 when Honeywell (formerly AlliedSignal) closed. In general, the beds are numbered or lettered sequentially according to age, starting with either A or 1. Wastebed 13, where the pilot study will take place is the largest of the Solvay wastebeds, covering an area of about 163 acres. It was used from 1973 to 1985. The waste in this bed is about 55 ft in depth. As shown on Figure 1, Bed 13 is bounded on the north by Nine Mile Creek, on the west by Airport Road and to the south and east by Solvay wastebeds 14 and 12. The area occupied by the bed was formerly used as a municipal airport and as a gravel pit.

Solvay waste was produced as part of the process to produce soda ash. The waste is comprised largely of calcium carbonate (20%), calcium silicate (17%), magnesium hydroxide (10%), calcium chloride (10%), silicon dioxide (7%), calcium sulfate (4%) calcium hydroxide (4%), and sodium chloride (6%) with lesser amounts of other materials (Kulhawy, et. al., 1977). It consists of predominately silt and sand-size particles and was hydraulically placed as slurry of about 90 to 95% water and 5 to 10% solids.

The primary concern associated with the wastebeds pertains to the potential impact that the chlorides within the leachate from the beds have on surface and ground water resources. For example, chlorides within the waste have been shown to increase within Nine Mile Creek near the beds as it flows to Onondaga Lake.

1.2. Regulatory considerations

In June 2000, the Solvay wastebeds were listed as a Class 3 inactive waste site (Site No. 734076). A Class 3 site is one that does not present a significant threat to the environment or public health. Consequently, action at such a site may be deferred.

These areas are considered by NYSDEC to be solid waste impoundments requiring some form of closure, particularly in view of ongoing leachate generation.

Given the above, a large part of the study will be directed to the evaluation of chloride minimization to ground and surface water through evapotranspiration.

1.3. Organization

ESF personnel working under the direction of Dr. Lawrence P. Abrahamson, Sr. Research Associate will conduct the work. Graduate and undergraduate students will assist Dr. Abrahamson as necessary. The project will be supported by Honeywell and OBG personnel.

2. Pilot study tasks and task execution schedule

It is anticipated that the pilot study will require three growing seasons to complete and that the work will consist of seven tasks. The schedule for execution of these tasks is presented as Figure 2. For ease of review, and due to the number of anticipated activities, subtasks are presented in bulleted format. Tasks 2 through 5 are summarized in Table 1.

2.1. Task 1: project planning

To date, planning has consisted of:

- an initial project meeting between Honeywell and ESF personnel.
- an initial meeting among representatives from Honeywell and NYSDEC at which time NYSDEC endorsed the concept of the pilot study
- completion of a project outline
- preparation of a draft project work plan for Honeywell review
- submittal of the work plan to NYSDEC for review and comment

Additional near-term activities related to project planning that have yet to be conducted include preparation of the necessary contracts to fund the work, subcontracting for a driller and laboratory, and finalization of the work plan to incorporate NYSDEC comments. Project planning is considered an on-going task and will be conducted for the duration of the project.

2.2. Task 2: greenhouse screening of potential clones (spring/summer 2003)

Due to the unique soil characteristics of the wastebeds, several varieties of willow and poplar plants will be evaluated in ESF's greenhouse prior to planting in the field to help ensure success of the project. Subtasks included under Task 2 include:

2.2.1. Greenhouse study design and setup (spring 2003)

- Design the greenhouse screening trial to examine how different willow and poplar clones respond to the soil conditions found in wastebed 13. Two different areas from the wastebeds will be tested. The first area had organic amendments incorporated in the past and the second area will be from an area where no organic amendments have been added.

- Select clones from the ESF collection located in Tully, New York that have the growth potential to act as an effective evapotranspiration cap and that will tolerate wastebed soils.

- Make willow and poplar planting stock for a screening study. One-year old stems of willow and poplar will be graded, cut into 25 cm long sections and stored in a freezer until they are planted in the greenhouse trial.

- Collect soil from two different wastebed 13 locations – one that previously received soil amendments and one that did not. The areas being considered are shown on Figures 1 (plots) and 2. About 3 m^3 of soil from each of the two areas will be collected. Soil will come from the upper 50 cm. Soil will be analyzed for chemical (pH, organic matter content, concentrations of N, P, K, Cl, cation exchange capacity, electrical conductivity) and physical (particle size distribution specific to the proposed planting area) attributes. Analysis will be completed at SUNY-ESF in their NYSDOH certified laboratory. Samples will be tracked using a chain of custody form. Methods used for soil analysis are as follows:

    - pH – Electrometric (EPA 9040B)
    - Organic carbon (EPA 0415.1)
    - N – Kjeldahl, Total – Calorimetric/Auto (EPA 0351.1)
    - P – all forms - Calorimetric/Auto (EPA 0365.1)
    - K – AA, flame technique (EPA 0258.1 CL)
    - Chloride - Calorimetric/Auto Ferricyanide A II (EPA 0325.2)
    - CEC – Sodium or ammonium depending on soil pH (EPA 9081 or 9080)
    - Specific conductance at 25 C (EPA 0120.1)
    - Particle size distribution according to Klute, A. (Ed.). 1986. *Methods of Soil Analysis*. American Society of Agronomy/Soil Science Society of America, Madison, WI.

- Obtain about 3 m^3 of topsoil that will be used as a control treatment for the soils obtained from wastebed 13. About 1 m^3 of sand and gravel will be used in the bottom of the greenhouse pots to facilitate drainage.

- Fill greenhouse pots, install drip irrigation system, plant willow and poplar clones.

2.2.2. Monitor greenhouse trial (spring/summer 2003)

- Analyze chloride concentrations in soil water after drip irrigation system is started to determine levels that the plants are exposed to. Soil water will be collected with tension lysimeters from the center of the pots on a biweekly basis.

- Determine the time of budbreak, survival, early growth rates and physiological characteristics of clones (transpiration and CO_2 exchange). Budbreak and survival will be determined on a weekly basis by observing the response of the cuttings in each pot. Once budbreak has occurred, height growth will be measured biweekly. Transpiration and CO_2 exchange will be measured using a Li-Cor 6400 Portable Photosynthesis System. Transpiration and photosynthesis rates are good indicators of the stress that is being experienced by the plants. Differences in these characteristics are often apparent before growth differences can be measured and will provide important information about the response of different clones that will be necessary to make decisions on planting stock for Task 3.

- Record keeping. Throughout the study, records will be kept in notebooks dedicated to the project. A photolog will also be maintained. At a minimum, each entry in the notebooks will describe the event, the date of the event, and the person making the entry. Record keeping will be applicable to each task.

- After about 20 weeks aboveground biomass will be harvested, dried at 65° C to a constant weight and weighed again to determine aboveground biomass. The initial separation of below-ground biomass from the soil will be performed in the greenhouse by sifting the soil through a fine mesh screen. The below ground biomass and attached soil will be stored in a freezer until the below ground biomass can be washed in an ultrasound bath (Bransonic 72). Once it is washed, it will be dried at 65° C to a constant weight and weighed again to determine below ground biomass. Differences in below-ground biomass will help to determine how different clones are responding to the different soil conditions.

2.2.3. Deliverables

Two deliverables will be prepared; an initial summary type deliverable and a more comprehensive, final deliverable. The deliverables will involve the following:

- The development of recommendations identifying the types of clones to use in the 2003 field study based on the early results from the greenhouse study. Within this suite of clones, other characteristics that contribute to maximizing the transpiration (i.e. growth potential, maximum leaf area development) will be used to select clones for the Task 3 field study.

- Preparation of the final report on the greenhouse study results, incorporating recommendations.

2.3. Task 3: growth and function field study (spring 2003 – winter 2005

The objective of this task will be to plant trials of willow and poplar short-rotation woody crops on Solvay Wastebed 13 to evaluate their growth and evapotranspiration rates. Some of the field study (Spring 2003) will be conducted concurrently with the Spring 2003 greenhouse study. Changes in crop types may occur in subsequent field work based on the results of the 2003 greenhouse evaluations. Subtasks include:

2.3.1. Trial design (spring 2003)

- Perform a site visit to select and delineate two plots for site trials. Each plot will be about one hectare (2 acres) in size. A third area will be identified at this time to be used for activities under Task 5. A staging area will be selected at this time.

- Identify types of vegetation currently growing on the selected plots and develop recommendations for site preparation accordingly. The successful establishment of willow and poplar biomass crops requires that competing vegetation be controlled, especially during the first one to two years, and that soil conditions are suitable for rapid root growth and development. Effective site preparation typically includes the use of chemical (pre-emergence and postemergence herbicides) and mechanical weed control and tillage to develop a suitable seedbed for planting.

- Design trial, including selecting clones and planting stock sizes. In order to maximize evapotranspiration on the wastebeds, clones with the highest transpiration rates (lowest water use efficiency) and the greatest aboveground biomass production under these conditions should be used. Previous studies have shown that willow clones have different transpiration and aboveground biomass production rates, and degrees of tolerance to environmental stresses. The second factor to be studied, size of planting stock, has been shown to affect aboveground biomass production of some willow and poplar clones. Longer cuttings generally have greater aboveground biomass production in the first few years of growth. Longer cuttings should more rapidly develop an extensive root system and draw water from a greater soil volume, although this has not been well documented to date.

- Organize and sort planting stock for trial according to clone and size. Willow and poplar in the short-rotation system to be tested on the wastebeds will be planted at a density of about 15,000 plants per hectare.

- Identify soil moisture monitoring system that will function effectively and accurately on the site with its high salinity conditions. At a minimum, systems to be evaluated will include the TRIME, Dynamax, and Campbell Scientific, Senteck's Enviroscan.

2.3.2. Installation of field trials (spring/early summer 2003)

- Mobilize to the field and install a weather station (Hobo Weather Station or equivalent) to record precipitation, relative humidity, wind speed, direction, and incoming solar radiation. Mobilize site preparation equipment including tractor (Case 4230), 45 cm subsoiler, plough, discs, Howard HR40 Rotavator (or equivalent), herbicide sprayer and New Holland tractor.

- Implement site preparation.

- Layout field trial and mark plots.

- Plant trials and apply pre-emergence herbicide. Pre-emergence herbicides (oxyfluorfen and/or simazine) will be applied according to label recommendations for the type of soil at the site by a licensed applicator.

- Soil samples will be collected in 20 cm increments to a depth of 1.4 m. A minimum of five replicates will be collected for each plot using AMS bucket augers. Each composite replicate will be collected from three points in the plot. Soil samples will be analyzed for chemical (pH, organic matter content, concentrations of N, P, K, Cl, cation exchange capacity, electrical conductivity) and physical (particle size distribution, hydraulic conductivity, water holding capacity, porosity) attributes. This analysis, along with foliar nutrient analysis and other data from the plots, will help to identify the traits that are restricting the growth of the willows. Selecting organic amendments and/or developing appropriate management protocols can then address factors limiting growth. High aboveground biomass production is one of the key variables for maximizing evapotranspiration of willows and poplars on the site. Methods used for soil analysis are as follows:

    - pH – Electrometric (EPA 9040B)
    - Organic carbon (EPA 0415.1)
    - N – Kjeldahl, Total – Calorimetric/Auto (EPA 0351.1)
    - P – all forms - Calorimetric/Auto (EPA 0365.1)
    - K – AA, flame technique (EPA 0258.1 CL)
    - Chloride - Calorimetric/Auto Ferricyanide A II (EPA 0325.2)
    - CEC – Sodium or ammonium depending on soil pH (EPA 9081 or 9080)
    - Specific conductance at 25 C (EPA 0120.1)
    - Particle size distribution, water holding capacity and porosity according to Klute, A. (Ed.). 1986. *Methods of Soil Analysis*. American Society of Agronomy/Soil Science Society of America, Madison, WI.
    - Hydraulic conductivity (EPA 9100)

- Install soil moisture monitoring system. Soil moisture will be monitored at 25 cm increments to a depth of 1.5 m on each of the two plots and at a third background location (where willow or poplar have not been planted) selected in consultation with NYSDEC.

- Install tension lysimeters at 50 cm, 100 cm and 150cm depths to monitor soil water conditions in each of the two plots and at a third background location (where willow or poplar have not been planted) selected in consultation with NYSDEC.

- Install piezometers in order to monitor groundwater levels in each of the two plots and at a third background location (where willow or poplar have not been planted) selected in consultation with NYSDEC.

2.3.3. Maintenance and monitoring (spring – winter 2003)

- Monitor weed competition visually and control when necessary using mechanical and hand weeding. Controlling weed competition during the first spring may require more attention than is typical because site preparation did not occur for this trial until just prior to planting. In order to control weed competition in the most efficient manner, site preparation should begin in the fall prior to planting.

- Evaluate tree growth and development (height growth, survival, leaf area development) every three to four weeks and record the measurements in the project notebook. Leaf area will be measured with a Dynamax AM200 Leaf Area Meter or equivalent.

- Measure soil water Cl concentrations every two to three weeks using tension lysimeters.

- Collect and analyze foliar samples to assess nutrient status (concentrations of N, P, K, Cl) of the willow and poplar clones. Fully expanded, mature leaves will be sampled from the top third of the crown during the first two weeks of August. Leaf samples will be dried at 65°C to a constant weight, ground in a Wiley mill to pass through a 2 mm screen, and stored in glass bottles for analysis. Analysis of foliar nutrients will follow Kalra, Y.P. 1998. *Handbook of Reference Methods for Plant Analysis*. CRC Press, NY. 300pp.

- Measure survival and end of season height and above ground and below ground biomass. Each plant will be cut off between two to four centimeters height after leaf fall. The aboveground biomass of each measurement plot will be weighed after harvest, dried at 65° C to a constant weight and weighed again to determine moisture concentration. Representative plants will be selected from the two areas to determine below ground biomass and distribution of roots. Coarse root (> 2 mm diameter) biomass will assessed by excavating the soil in an area 114 cm by 61 cm around the stool to a depth of 1 m in 20 cm increments. Fine roots (<2 mm diameter) will be assessed by collecting undisturbed soil cores (20 cm long x 7.4 cm in diameter), equally spaced along the diagonal, from each 20 cm layer. Core and layer samples will be stored in freezers at –20°C and –4°C, respectively, until they can be processed. Core samples will be thawed and washed in a 0.5 mm sieve and all roots less than 2 mm in diameter will be removed. The coarse root samples from each layer will be thawed and allowed to dry for 18 – 24 hours. Roots will be removed from the soil as it is passed through a 2 mm sieve. The samples will be dried at 105°C to a constant weight.

- Snowfall will be measured on the site during the winter using a heated tipping bucket and/or snowboards to determine the amount of water input.

2.3.4. 2003 deliverable – end of season report and meeting

The report will describe the growth and survival of different clones and the effects of different sizes of planting stock. Based on the greenhouse and field trials, the report will also contain recommendations on which clones to use in additional field trials with different organic amendments (refer to Task 5).

2.3.5. 2004 maintenance and monitoring (second growing season)

- Second growing season (Spring-Fall 2004). During the second season, the trials will also be used to calibrate one or more water budget models for the study plots (refer to Task 4).

- Mobilize equipment to the site.

- Measure time of budbreak by visiting the site on a weekly basis and recording the proportion of plants that have broken bud.

- Monitor weed competition visually and control when necessary using mechanical and hand weeding.

- Apply necessary fertilizer based on soil and foliar chemistry. The goal of the fertilizer treatments will be to alleviate nutrient limitations that are restricting the growth of the willow and popular. the rate of aboveground biomass production is a key variable determining evapotranspiration.

- Measure and record growth and development (height growth, survival, leaf area development) of the willows and poplars every three to four weeks. Height will be measured on the inner 20 plants in each treatment. Leaf area will be measured using a Li-Cor LAI-2000 Plant Canopy Analyzer.

- Collect soil water samples and measure soil water Cl concentrations every two to three weeks using tension lysimeters installed in 2003.

- Collect and analyze foliar samples to assess nutrient status (concentrations of N, P, K, Cl) of the willow and poplar clones. Fully expanded, mature leaves will be sampled from the top third of the crown during the first two weeks of August. Analysis of foliar nutrients will follow Kalra, Y.P. 1998. *Handbook of Reference Methods for Plant Analysis*. CRC Press, NY. 300pp.

- Determine survival, end of season height, and aboveground and below ground biomass. At the end of the growing season, the diameter of all stems on each of the center 30 plants will be measured at a height of 30 cm above the soil. Aboveground biomass will be estimated for each measurement plot using allometric equations developed previously at SUNY-ESF. Below ground biomass will be measured using the same methods outlined at the end of the first growing season.

- Snowfall will be measured on the site during the winter using a heated tipping bucket and/or snowboards to determine the amount of water input.

2.3.6. 2004 deliverable – end of season report

This deliverable will summarize the results of the second year growing season such as the growth and survival of different clones and the effect of different sizes of planting stock.

2.3.7. 2005 maintenance and monitoring

Third Growing Season (Spring-Fall 2005). During the third growing season these trials will be used to further calibrate water budget models for the site (refer to Task 4). Evapotransipration rates should increase as the plants grow older and have a more developed root system and canopy. Measuring these changes will be important to modeling the long-term effects of willow and poplar on the overall water balance of the wastebeds. Subtasks include:

- Mobilize equipment to the site.

- Measure time of budbreak by visiting the site on a weekly basis and recording the proportion of plants that have broken bud.

- Measure and record growth and development (height growth, survival, leaf area development) of the willows and poplars every three to four weeks. The inner 20 plants in each treatment will be measured. Leaf area will be measured using a Li-Cor LAI-2000 Plant Canopy Analyzer.

- Collect soil water samples and measure soil water Cl concentrations every two to three weeks using lysimeters installed in 2003.

- Collect and analyze foliar samples to assess nutrient status (concentrations of N, P, K, Cl) of the willow and poplar clones. Fully expanded, mature leaves will be sampled from the top third of the crown between August 1 and September 1. Analysis for concentrations of N, P, K, Cl will flow the same protocols listed above. Analysis of foliar nutrients will follow Kalra, Y.P. 1998. *Handbook of Reference Methods for Plant Analysis*. CRC Press, NY. 300pp.

- Determine survival, end of season height, and above ground and below ground biomass. At the end of the growing season, the diameter of stems on each of the center 30 plants will be measured at a height of 30 cm above the soil. Aboveground biomass will be estimated for each measurement plot using allometric equations developed previously at SUNY-ESF. Below ground biomass will be assessed using methods described at the end of year one.

2.3.8. 2005 deliverable

Contained in this report will be a description of the survival, growth and yield data through three growing seasons to predict willow production potential on the wastebeds under these conditions (Winter 2005/06). Estimation of the potential for willow biomass production for the available wastebed acreage will be conducted in conjunction with tasks 5 and 6.

2.4. Task 4: water budget modeling

This task covers each facet of water budget modeling: set up, calibration, and modification of the model throughout the study. The objective of modeling, considered a critical task with respect to determining the success or failure of the study, will be to evaluate the effect of willow and poplar plantations as a hydrologic control to reduce the volume of water percolating through the wastebed, thereby decreasing the amount of leachate transported chlorides to nearby surface water bodies. The model will be used to compare hydrologic performance of baseline (existing) conditions to willow and poplar vegetated cover on soils with and without organic amendments to a conventional low permeability soil/geomembrane covers system. Subtasks associated with the modeling effort include:

2.4.1. Model setup (spring 2003 to spring 2004)

- Select the appropriate model. The following models will be screened and evaluated for the suitability for the project: the Hydrologic Evaluation of Landfill Performance (HELP) model; the Simultaneous Heat and Water (SHAW) model; the Soil Water in Forested Ecosystems (SWIF) model; and the Leaching Estimation and Chemistry Model (LEACHM) model (Spring 2003).

- Review and select well established willow and poplar trials of different ages (ranging from two to seven years old) in central New York (Canastota, Lafayette, Massena, or Tully) to begin assessment of willow crop impact on hydrological cycles. Compile and summarize existing data for precipitation, interception, evapotranspiration, soil moisture, and Leaf Area Index (LAI) in different clones and different age stands (Summer 2003).

- Set up monitoring equipment to collect baseline data during year 1. Equipment will include a meteorological station at each site for climate data; suction lysimeters and soil moisture probes (probes will be selected as part of Task 2 so that the same type of equipment can be used on these sites and on the wastebeds); piezometers to monitor ground water levels; infiltrometers for soil infiltration rates; collect subsurface soils to determine texture, saturated hydraulic conductivity (EPA 9100). Also collect topographic information for determining runoff curve number (Summer 2003).

- Parameterize water model using site-specific data collected in the 2003 growing season. Continue to collect precipitation data, including snow measurements, evaporation, soil moisture and infiltration data. Identify gaps in data acquisition methods or parameters (Winter 2003/2004).

2.4.2. Deliverable

For this deliverable, the development of the hydrologic model for the existing (baseline) conditions and conventional low permeability soil/geomembrane cover system will be finalized. The predictions for the second year vegetative growth using site data and data from other willow and poplar trial locations will also be developed (Spring 2004).

2.4.3. Model calibration

The model will be calibrated from Spring 2004 to Spring 2005 using data obtained from monitoring of the willow and poplar trials on wastebed 13 (Task 2) and from older willow and poplar trials in central NY. Subtasks associated with model calibration consist of:

- The collection and processing of data for LAI, transpiration rates, soil moisture, weather from the second year of growth of willow and poplar stands established under Task 2. The results will be used to parameterize the water budget model for Solvay wastebed 13.
- Assess the data from the established willow and poplar trials in central NY (located in Canastota, Lafayette, Massena, or Tully) and of different ages to supplement assessment of the estimated impact of the willow crop on the hydrologic cycle – interception, evapotranspiration, and soil moisture – through multiple three year growing cycle (Fall 2004).
- Parameterize water budget model using the data collected in the second year of the project. Identify critical gaps in parameters and predict the third year performance (Winter 2005).

2.4.4. Deliverable

This deliverable will consist of calibration runs of the model using field data from years 1 and 2, with predictions for the third year of growth.

2.4.5. Model calibration/validation (summer 2005 to spring 2006)

- Monitor water cycle parameters in original willow and poplar study on wastebed 13 (established under Task 2) in their third year of growth to develop model parameters for the first growing cycle (Summer 2005).
- Monitor water cycle parameters in willow trial with organic amendments established in Task 5 in their second growing cycle to develop model parameters for the first growing cycle (Summer).
- Continue to monitor currently established willow trials of different ages in central NY to assess the impact of willow crops on interception, evapotranspiration, and soil moisture though multiple three year growing cycles (Summer 2005).

2.4.6. Deliverable

This deliverable will consist of the final calibrated and validated model using field data to illustrate the impact of willow and poplar crops with and without organic amendments on the water cycle on wastebed 13 over multiple rotations and years. The model will be used to compare the hydrologic performance of baseline conditions to willow and poplar vegetated cover (third through 30th years) and to conventional low permeability soil/geomembrane covers system (Fall/Winter 2005).

Information presented in this deliverable will predict the success of the use of willows and poplars as a substitute for a NYS Part 360 cap.

2.5. Task 5: assessment of organic amendments

The objective of this task will be to determine the effect of different organic amendments, rates of application and incorporation methods on the soil water holding capacity and on the growth, production and evapotranspiration of the willow biomass crops. Emphasis will be given to those amendments that might inhibit the infiltration of water into the wastebed. Subtasks are as follows:

2.5.1. Design organic amendments study (summer/fall 2003)

- Determine which organic amendments to test on wastebed 13. Research available information or collect samples to determine the physical and chemical characteristics of the material.

- Locate plots on which to conduct the trials to test the effect of different rates and incorporation methods for organic amendments (This will take place concurrently plot identification in Task 3).

- Assess weed cover on the selected area and design a strategy for effective weed control.

- Conduct chemical and/or mechanical weed control on the site. Any chemical weed control activities will be done in accordance with label recommendations and by a licensed applicator.

- Make planting stock for organic amendment trials.

2.5.2. Organic amendment greenhouse study (winter 2003 to spring 2004)

- Design greenhouse trial to assess the impact of different rates and incorporation methods of organic amendments on willow and poplar growth and soil water holding characteristics.

- Collect soils from the wastebeds and organic materials for this greenhouse trial. A maximum of 6 m^3 of soil would be required from the site. The actual amount will depend on the rates of application and number of different organic amendments tested.

- Incorporate organic materials with soils and analyze their chemical (pH, organic matter content, concentrations of N, P, K, Cl, cation exchange capacity, and electrical conductivity) and physical (particle size distribution) attributes using methods in Task 3.

- Fill greenhouse pots, install drip irrigation system, plant clones.

2.5.3. Greenhouse study measurements (winter 2004 to spring 2004)

- Analyze leachate on a weekly basis for concentrations of Cl and after drip irrigation system is started to determine if organic amendments are having an impact on the amount of leachate and/or the Cl concentration in the leachate.

- Determine the time of budbreak, survival, early growth rates and physiological characteristics of clones (transpiration and CO_2 exchange). Budbreak and survival will be determined on a weekly basis by observing the response of the cuttings in each pot. Once budbreak has occurred, height growth will be measured biweekly. Transpiration and CO_2 exchange will be measured using a Li-Cor 6400 Portable Photosynthesis System. Transpiration and photosynthesis rates are good indicators of the stress that is being experienced by the plants. Differences in these treatments are often apparent before growth differences can be measured.

- After about 20 weeks aboveground biomass will be harvested, dried at 65° C to a constant weight and weighed again to determine aboveground biomass. Below ground biomass will be separated from the soil in the greenhouse sifting the soil through a fine mesh screen. The remaining roots and soil stored in a freezer until the roots can be washed in an ultrasound bath (Bransonic 72). Once the roots are washed, they will be dried at 65° C to a constant weight and weighed again to determine below ground biomass. Differences in below ground biomass will help to determine how different clones are responding to the different soil conditions.

2.5.4. Deliverable

This report will present the results of the greenhouse screening trial using the amendments. It will also present recommendations for the rates and incorporation methods for different organic amendments to be used in the field trials.

2.5.5. Organic amendment study on Solvay wastebed 13 (spring 2004)

- Mobilize to wastebed 13 with the organic amendments and the equipment tractor (Case 4230 tractor, 45 cm subsoiler, plough, discs, Howard HR40 Rotavator or equivalent, herbicide sprayer).

- Layout field trial and mark plots.

- Implement incorporation of the amendments and perform final plot preparation activities.

- Plant trials and apply pre emergence herbicide. Preemergence herbicides (oxyfluorfen and/or simazine) will be applied according to label recommendations for the type of soil at the site by a licensed applicator.

- Sample soils from the plot about one month after organic amendments have been applied to the site. Conduct chemical (pH, organic matter content, concentrations of N, P, K, Cl, cation exchange capacity, electrical conductivity) and physical (particle site distribution, hydraulic conductivity, water holding capacity, porosity) to determine the impact of organic amendments on these characteristics.

2.5.6. Maintenance and monitoring (summer to fall 2004)

- Monitor weed competition visually and control when necessary using mechanical and hand weeding.

- Evaluate tree growth and development (height growth, survival, leaf area development) every three to four weeks and record the measurements in the project notebook. Leaf area will be measured with a Dynamax AM200 Leaf Area Meter or equivalent.

- Measure soil water Cl concentrations every two to three weeks using tension lysimeters.

- Collect and analyze foliar samples to assess nutrient status (concentrations of N, P, K, Cl) of the willow and poplar clones. Fully expanded, mature leaves will be sampled from the top third of the crown during the first two weeks of August. Leaf samples will be dried at 65°C to a constant weight, ground in a Wiley mill to pass through a 2 mm screen, and stored in glass bottles for analysis. Analysis of foliar nutrients will follow Kalra, Y.P. 1998. Handbook of Reference Methods for Plant Analysis. CRC Press, NY. 300pp.

- Measure survival and end of season height and above ground and below ground biomass using the same methodology outlined at the end of first year of growth in Task 3.

- Snowfall will be measured on the site during the winter using a heated tipping bucket and/or snowboards to determine the amount of water input.

2.5.7. Deliverable

End of season report (Winter 2005). The report will document the effect of different rates of application and incorporation methods of organic amendment treatments on growth and survival. The effect of the organic amendments on the water budget will be reported as part of Task 4.

2.5.8. Maintenance and monitoring in second year of growth using amendments (spring 2005 to fall 2005)

- Mobilize to the site.
- Monitor weed competition visually and control when necessary using mechanical and hand weeding.
- Evaluate tree growth and development (height growth, survival, leaf area development) every three to four weeks and record the measurements in the project notebook. Leaf area will be measured with a Dynamax AM200 Leaf Area Meter or equivalent.
- Measure soil water Cl concentrations every two to three weeks using tension lysimeters.
- Collect and analyze foliar samples to assess nutrient status (concentrations of N, P, K, Cl) of the willow and poplar clones. Fully expanded, mature leaves will be sampled from the top third of the crown during the first two weeks of August. Leaf samples will be dried at 65°C to a constant weight, ground in a Wiley mill to pass through a 2 mm screen, and stored in glass bottles for analysis. Analysis of foliar nutrients will follow Kalra, Y.P. 1998. Handbook of Reference Methods for Plant Analysis. CRC Press, NY. 300pp.
- Measure survival and end of season height and above ground and below ground biomass using the same methodology outlined at the end of first year of growth in Task 3.

2.5.9. Deliverable – end of season report (winter 2006)

The deliverable will discuss the effect of different organic amendment treatments on the growth and survival of the clones. It will also describe the use yield data through two growing seasons to assess the impact that the different organic amendments treatments will have on the growth and yield of willow and poplar on the wastebed and other effects to water uptake, if any.

2.6. Task 6: large-scale willow production, economics, and market analysis

Large-scale willow production, economics, and market analysis. The objectives of this task will be to evaluate the area available on the wastebeds for willow biomass production, the feasibility of using the willows and poplars as habitat corridors and/or to complement potential recreational uses. Based on these assessments, preliminary designs for these uses will be created. Concurrently, a market analysis will be performed and an estimate of the costs associated with full-scale production will be made. Subtasks associated with this task include:

2.6.1. Covertype analysis

- Evaluate cover types and the amount of area they cover using GIS available survey data.
- Site design based on cover type analysis and input from relevant stakeholders including the NYSDEC. At least two preliminary design options will be developed to describe possible uses of Wastebeds 9 through 15 to produce willows as a green fuel. The designs will accommodate the objectives of this task to the extent practicable
- Economic Assessment and Market Analysis. As part of this task, the market viability of full-scale production will be evaluated. The analysis will address the value of the willows and poplars as an alternate fuel, nearby markets, and production costs associated with the delivery of an end product to these markets. Included with this subtask will be considerations addressing specification requirements for acceptance of the willows and poplars by the identified markets.
- Figure 3 depicts the wastebeds being used for the production of willows and poplars on a conceptual basis.

2.6.2. Deliverable

The deliverable for this task will be comprised of the site designs mentioned above, the market analysis, production specifications, and the projected costs of full-scale willow production.

2.7. Task 7: meetings

It is anticipated that representatives from Honeywell, ESF, and NYSDEC will meet periodically throughout the project to discuss recently completed and upcoming events. Meetings are likely to be held prior to finalization of the work plan, at the end of each growing season, and at least 3 other times possibly corresponding to deliverable dates. The anticipated meeting schedule is shown on Figure 2.

3. Quality assurance/quality control

Data quality objectives for this study are to obtain data of sufficient quality that decisions regarding the viability of using the willows and poplars as an alternate to a 6 NYCRR Part 360 cap can be made. As a result, approximately 10% of the data collected and analyzed in the field will be subject to duplicate measurements. Furthermore, field instruments such as the weather station will be calibrated according to the manufacturer's instructions prior to use and periodically thereafter to verify that the instrumentation continues to operate properly.

Soil, foliage and water samples will be collected, labeled, containerized prior to transportation to the laboratory. Foliage and water samples will be placed in ice-packed coolers for transport to the laboratory. Chain of custody forms will be maintained to track the samples. Approximately 10% of the laboratory samples will be collected in duplicate. Once analyzed the relative percent difference (RPD) between the environmental and laboratory samples will be calculated. For those duplicates failing to achieve less than an RPD of 50%, the sample will be examined in greater detail to determine its usability. If the sample is considered unusable, then one or more additional samples will be collected to replace it at the discretion of the project manager.

In addition to duplicate samples, other control measures will include those that are contained in the analytical methodology and possibly reinsate blanks if it appears that cross contamination could occur during sampling.

4. Health and safety

4.1. In-field considerations

No significant health and safety concerns from hazardous materials are likely to arise during the study. The most hazardous part of the project will be from the risk of physical hazards. Therefore, in keeping with Honeywell's safety protocols, workers will be required to:

- use good housekeeping practices while on-site.
- required to wear suitable clothing (hardhats, boots, gloves, etc).
- maintain site controls to the extent necessary .
- be familiar with the health and safety requirements specified herein.
- report accidents and injuries to Honeywell no later than 24 hours after they occur.

For the duration of the growing season, routine safety meetings will held by Honeywell personnel to discuss health and safety matters with on-site workers.

In the event of an emergency, at least one of the following individuals should be contacted no later than 24 hours after the emergency occurs.

Al Labuz (Honeywell Site Leader)	315-437-6100
Jeffrey Banikowski (O'Brien & Gere)	315-437-6100 (work) 492-9149 (home) 559-0743 (cell)

Other emergency phone numbers as well as addresses include:

Western Area Volunteer Emergency Service (WAVES) Bennett Rd. Camillus, NY	315-487-1212
Community General Hospital 4900 Broad Rd. Syracuse, NY	315-492-5011
University Hospital 420 Adams St. Syracuse, NY	315-464-5611

Hospital routes are shown on Figures 4 and 5. Figure 4 illustrates the route to Community General Hospital and Figure 5 to Upstate Medical Center. Both hospitals are equally accessible to the site.

4.2. Laboratory considerations

Both ESF and a New York State DOH Laboratory will be conduct laboratory analysis during the project. ESF's laboratory health and safety plan is presented as Exhibit 1. Each laboratory will be responsible for the enforcement of their respective plans.

Laboratory instrumentation will be calibrated in accordance with the manufacturer's instructions and maintained in good working order.

References

Blasland, Bouck & Lee Engineers and Geoscientists, 1989. *Hydrogeologic Assessment of the Allied Wastebeds in the Syracuse Area.* Volume 1 of 2.

Kalra, Y.P., 1998. *Handbook of Reference Methods for Plant Analysis.* CRC Press, NY. 300 pp.

Klute, A. (Ed.). *1986 Methods of Soil Analysis.* American Society of Agronomy/Soil Science of America, Madison, W.I.

Kulhawy, F.H., et. al., 1997. *Geotechnical Behavior of Solvay Process Wastes.* Proceedings of the Conference on Geotechnical Practice for Disposal of Solid Waste Materials, American Society of Chemical Engineers.

Table 1. Greenhouse and Field Study Summary Descriptions, Tasks 2 through 5

Greenhouse Studies		
Subtask Description	Execution Schedule	Data Measurement
Study Design	Spring 2003	none
Select Clones, Develop Planting Stock	Spring 2003	none
Evaluate Solvay Waste	Spring 2003	pH, organic matter content, N, P, K, Cl, cation exchange capacity, electrical conductivity, Na, ammonia, particle size distribution, hydraulic conductivity (Data to be used for water budget modeling task)
Obtain Soil for Initial Greenhouse Trials for Plots One and Two	Spring 2003	none
Monitor Greenhouse Trials Applicable to Plots One and Two	Spring/Summer 2003	survival, growth, CO_2 exchange, transpiration, weight

Growth and Function Field Studies		
Subtask Description	Execution Schedule	Data Measurement
Trial Design	Spring 2003	none
Installation of Field Trials on Plots One and Two	Late Spring 2003	pH, organic matter content, N, P, K, Cl, cation exchange capacity, electrical conductivity, Na, ammonia, particle size distribution
Maintain and Monitor Field Trials - A Total of Three Growing Seasons	Spring 2003 to Winter 2005	Tree growth, survival, leaf area, nutrient status (N, P, K, Cl), root development, meteorological data (combined with water budget modeling)

Water Budget Modeling		
Subtask Description	Execution Schedule	Data Measurement
Select Appropriate Water Budget Model and begin Calibration Using Established Trees located in Tully NY	Spring 2003 to Spring 2004	Meteorological data (I.e. precipitation, temperature, relative humidity, wind speed to be collected in conjunction with growth and field trials) interception, evapotranspiration, soil moisture, leaf area index
Set-up Additional Equipment and Begin Monitoring at Growth and Function and Organic Amendment Plot	Spring 2004 to Fall 2005	Collect and process data for leaf area index, transpiration rates, soil moisture, meteorology, interception, evapotranspiraton so that a complete three year willow growth cycle can be modeled

Water Budget Modeling		
Subtask Description	Execution Schedule	Data Measurement
Maintain Monitoring Equipment for On-going Model Calibration	Spring 2003 to Fall 2005	Meteorological data (I.e. precipitation, temperature, relative humidity, wind speed to be collected in conjunction with growth and field trials) , interception, evapotranspiration, soil moisture, leaf area index, so that a complete three year willow growth cycle can be modeled.
Validate model for willow growth and hydrological conditions on the waste beds	Summer 2005 to Spring 2006	Continue processing data for Leaf Area Index, transpiration rates, soil moisture, weather, interception, evapotranspiraton

Organic Amendments Study		
Subtask Description	Execution Schedule	Data Measurement
Selection of potential organic amendments to use on waste beds. Develop of study design for field trial and initiate site preparation.	Summer/Fall 2003	none
Organic Amendments Greenhouse Study (note: this is a second greenhouse study)	Winter 2003 to Spring 2004	Cl leachate concentrations, bud break, survival, growth rates, CO_2 exchange, biomass production
Plant Willow on Organic Amendments Plot on Wastebed 13	Spring 2004	pH, organic matter content, N, P, K, Cl, cation exchange capacity, electrical conductivity, Na, ammonia, particle size distribution
Maintenance and Monitoring of Organic Amendments Plot	Summer 2004 to Fall 2005	Tree growth, survival, leaf area, nutrient status (N, P, K, Cl), root development, meteorological data

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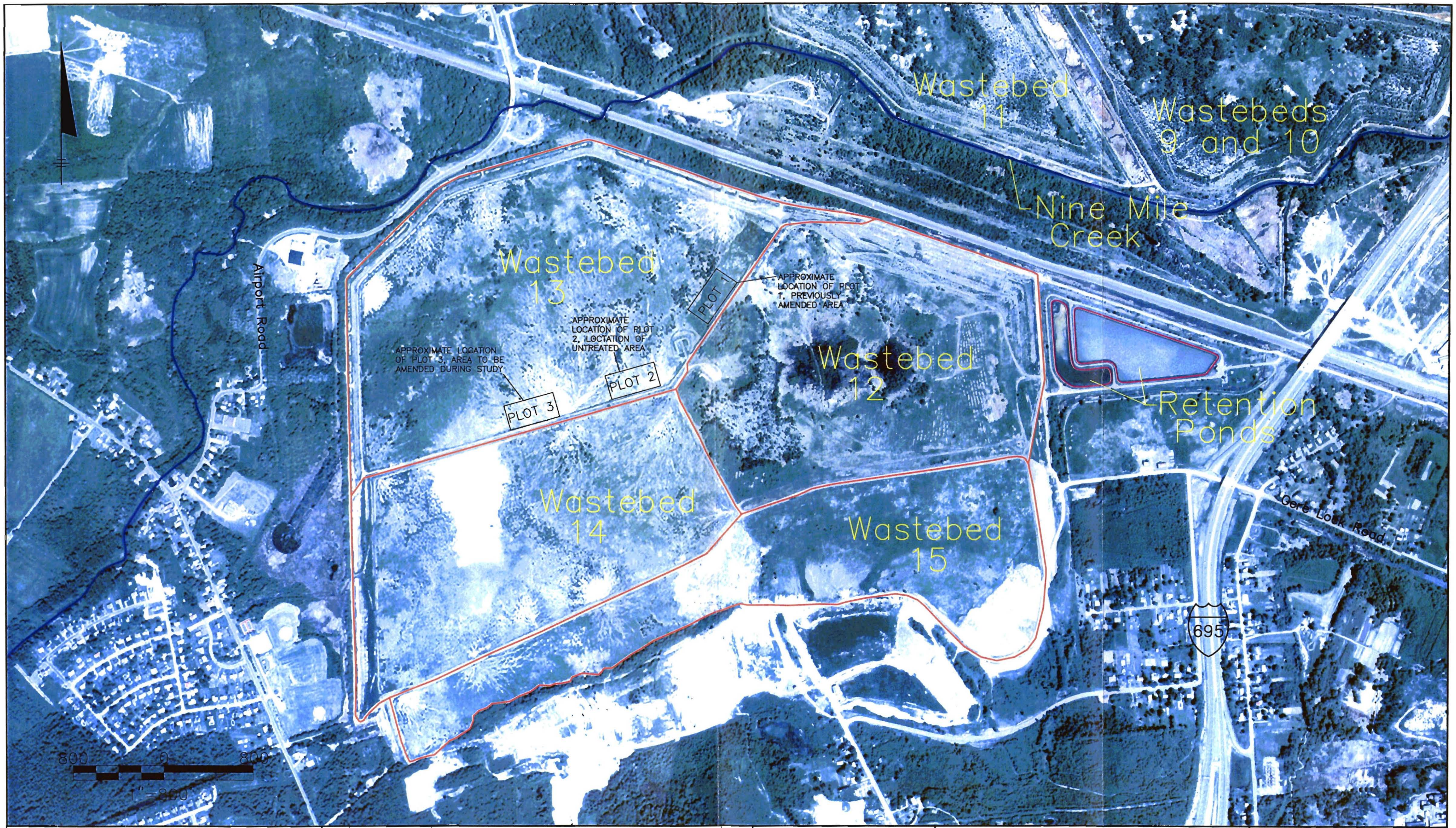
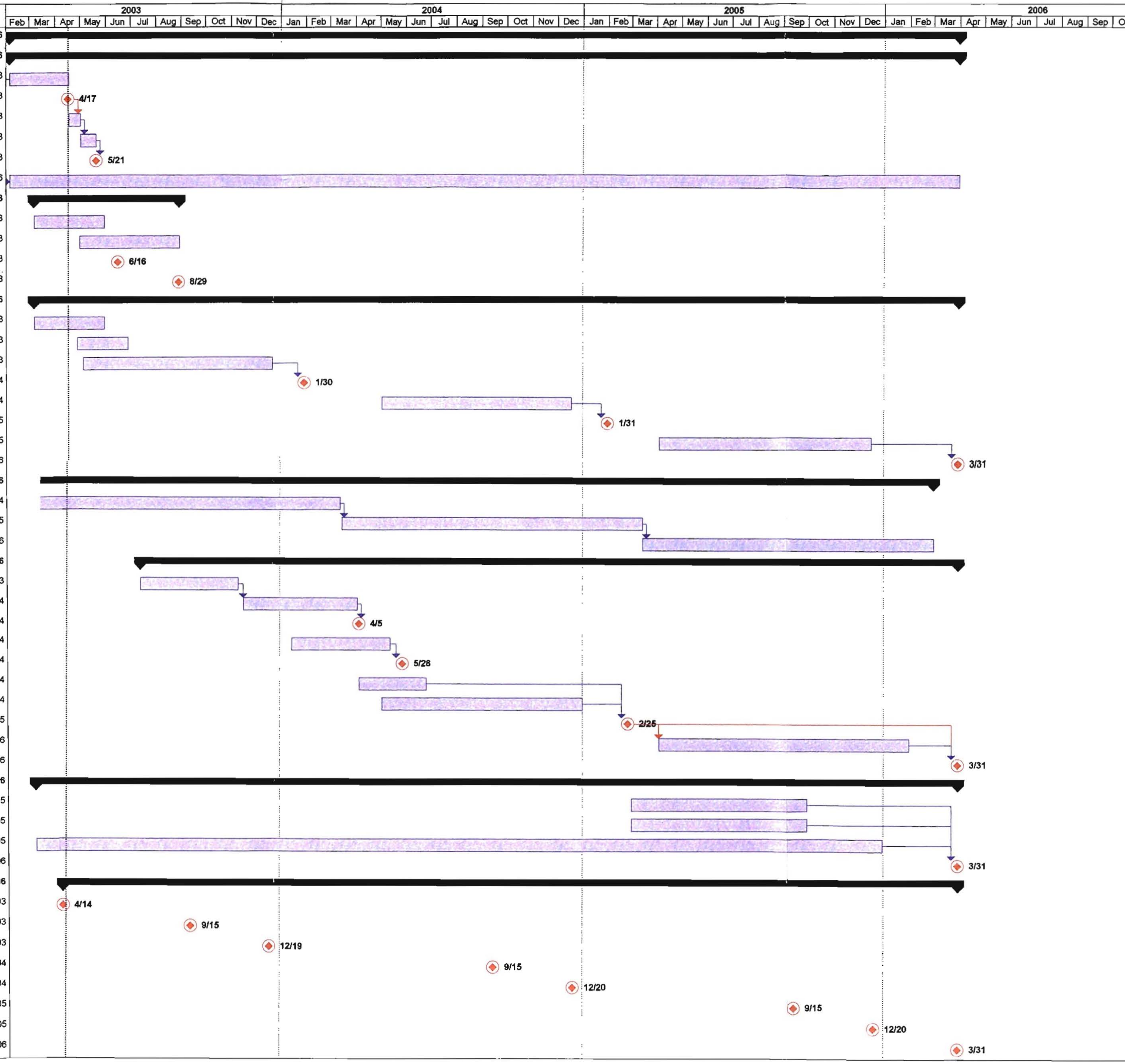


IN CHARGE OF ______				Honeywell	STUDY AREA LOCATION	FILE NO. 32255
DESIGNED BY ______ CHECKED BY ______				O'BRIEN & GERE ENGINEERS INC.	WASTEBED 13	1
DRAWN BY ______	NO.	DATE	REVISION / INIT.		CAMILLUS, NEW YORK SITE PLAN	DATE March 2003

Figure 2
Wastebed 13 Biomass Pilot Study
Proposed Schedule

ID	Task Name	Duration	Start	Finish
1	**Biomass Pilot Study**	**822d**	**2/6/03**	**3/31/06**
2	**Task 1. Project Planning**	**822d**	**2/6/03**	**3/31/06**
3	- Work Plan Preparation	51d	2/6/03	4/17/03
4	- Draft Work Plan	1d	4/17/03	4/17/03
5	- NYSDEC Review	10d	4/18/03	5/1/03
6	- Finalize Work Plan	13d	5/2/03	5/20/03
7	- Final Work Plan	1d	5/21/03	5/21/03
8	- Project Planning	822d	2/6/03	3/31/06
9	**Task 2. Greenhouse Screening of Potential Clones**	**126d**	**3/7/03**	**8/29/03**
10	- Study Design & Set-up	61d	3/7/03	5/30/03
11	- Monitor greenhouse trial	87d	5/1/03	8/29/03
12	- Greenhouse Screening Trial and Selection Interim Update Report	1d	6/16/03	6/16/03
13	- Greenhouse Screening Trial and Selection Final Report	1d	8/29/03	8/29/03
14	**Task 3. Growth & Function Field Study**	**801d**	**3/7/03**	**3/31/06**
15	- Trial Design	61d	3/7/03	5/30/03
16	- Installation of Field Trials	45d	4/28/03	6/27/03
17	- 2003 Maintenance & Monitoring (1st Growing Season)	165d	5/5/03	12/19/03
18	- 2003 First Growing Season Deliverable	1d	1/30/04	1/30/04
19	- 2004 Maintenance & Monitoring (2nd Growing Season)	165d	5/3/04	12/17/04
20	- 2004 Second Growing Season Deliverable	1d	1/31/05	1/31/05
21	- 2005 Maintenance & Monitoring (3rd Growing Season)	185d	4/4/05	12/16/05
22	- 2005 Third Growing Season Deliverable	1d	3/31/06	3/31/06
23	**Task 4. Water Budget Modeling**	**779d**	**3/7/03**	**3/1/06**
24	- Model setup	266d	3/7/03	3/12/04
25	- Model calibration	261d	3/15/04	3/14/05
26	- Model calibration/validation	252d	3/15/05	3/1/06
27	**Task 5. Assessment of Organic Amendments**	**709d**	**7/15/03**	**3/31/06**
28	- Design organic amendments study	85d	7/15/03	11/10/03
29	- Organic amendment greenhouse study	100d	11/17/03	4/2/04
30	- Organic amendment greenhouse study deliverable	1d	4/5/04	4/5/04
31	- Greenhouse study measurements	85d	1/15/04	5/12/04
32	- Greenhouse study deliverable	1d	5/28/04	5/28/04
33	- Organic amendment study on Solvay Waste Bed 13	60d	4/5/04	6/25/04
34	- Maintenance & monitoring	175d	5/3/04	12/31/04
35	- End of season report	1d	2/25/05	2/25/05
36	- 2nd year maintenance & monitoring	217d	4/4/05	1/31/06
37	- End of season report	1d	3/31/06	3/31/06
38	**Task 6 Large-scale Willow Production & Economics**	**801d**	**3/7/03**	**3/31/06**
39	- Site survey	154d	3/1/05	9/30/05
40	- Site design	154d	3/1/05	9/30/05
41	- Economic assessment	736d	3/7/03	12/30/05
42	- Report & potential designs	1d	3/31/06	3/31/06
43	**Task 7 Meetings**	**775d**	**4/14/03**	**3/31/06**
44	- 2003 Final Work Plan Meeting	1d	4/14/03	4/14/03
45	- 2003 meeting with Honeywell	1d	9/15/03	9/15/03
46	- 2003 meeting with NYSDEC	1d	12/19/03	12/19/03
47	- 2004 meeting with Honeywell	1d	9/15/04	9/15/04
48	- 2004 meeting with NYSDEC	1d	12/20/04	12/20/04
49	- 2005 meeting with Honeywell	1d	9/15/05	9/15/05
50	- 2005 meeting with NYSDEC	1d	12/20/05	12/20/05
51	- Project Summary Meeting	1d	3/31/06	3/31/06



Project: I:/div82/projects/jeb_pro/BIOMASSH.MPP
Date: 4/17/03

Task | Progress | Deliverable/Meeting | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

Figure 3

Apollo-Mac-Simulations-Honeywell3-03/afd/EN.gam/Honeywell/3-03/SolvayWastebeds.fh9

Honeywell

Biomass Pilot Study

Solvay Wastebed 13
Camillus, New York

Photo Simulation

Biomass in Various Stages of Growth

Walking and biking trails, access roads

Wetland

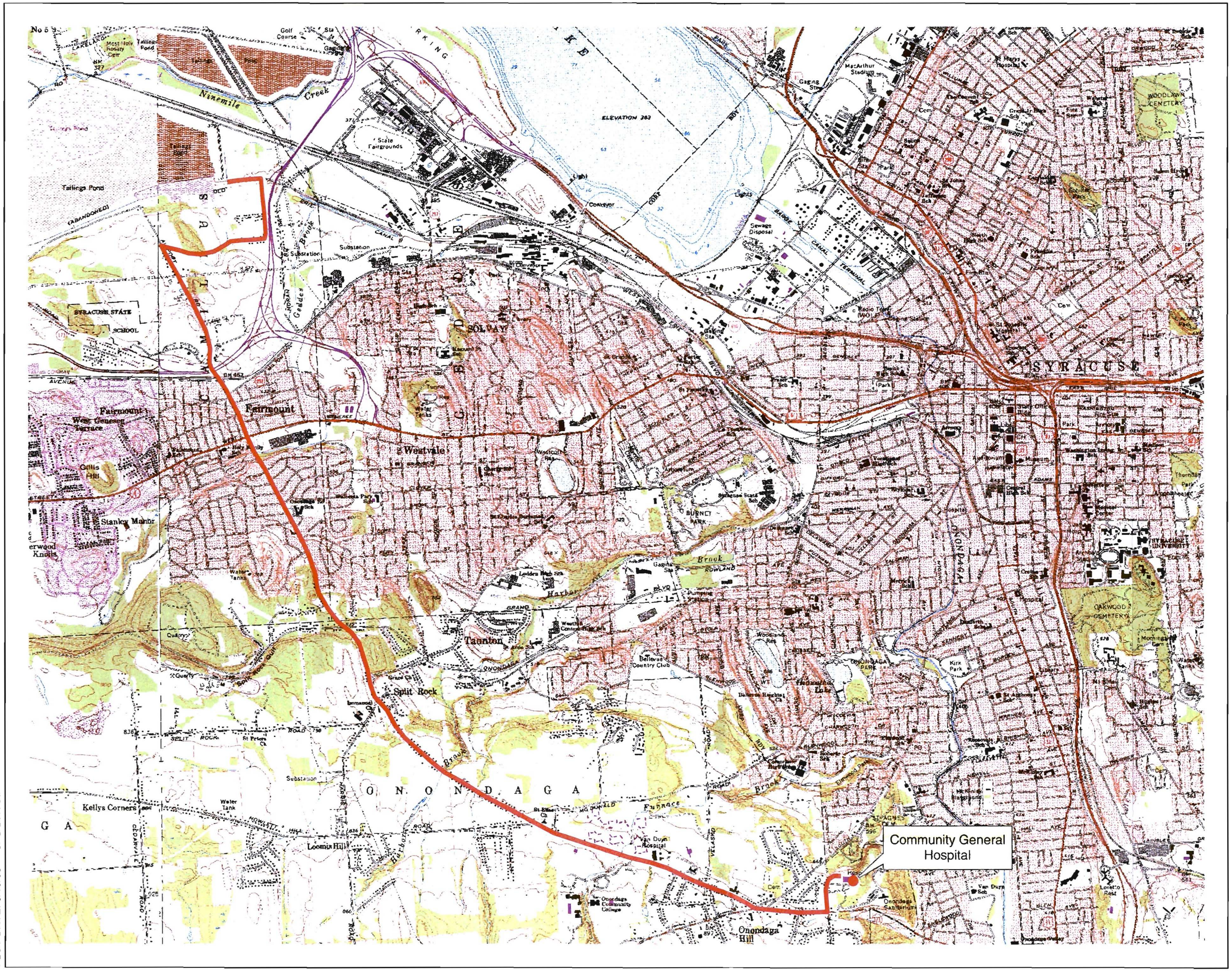
Parking lot

N

O'BRIEN & GERE

State University of New York
COLLEGE OF ENVIRONMENTAL SCIENCE AND FORESTRY

FIGURE 4



Legend

Evacuation Route to Community General Hospital

HONEYWELL
GEDDES/SYRACUSE, NEW YORK

EVACUATION ROUTES

0 1,500 3,000 6,000
Feet

1:36,000

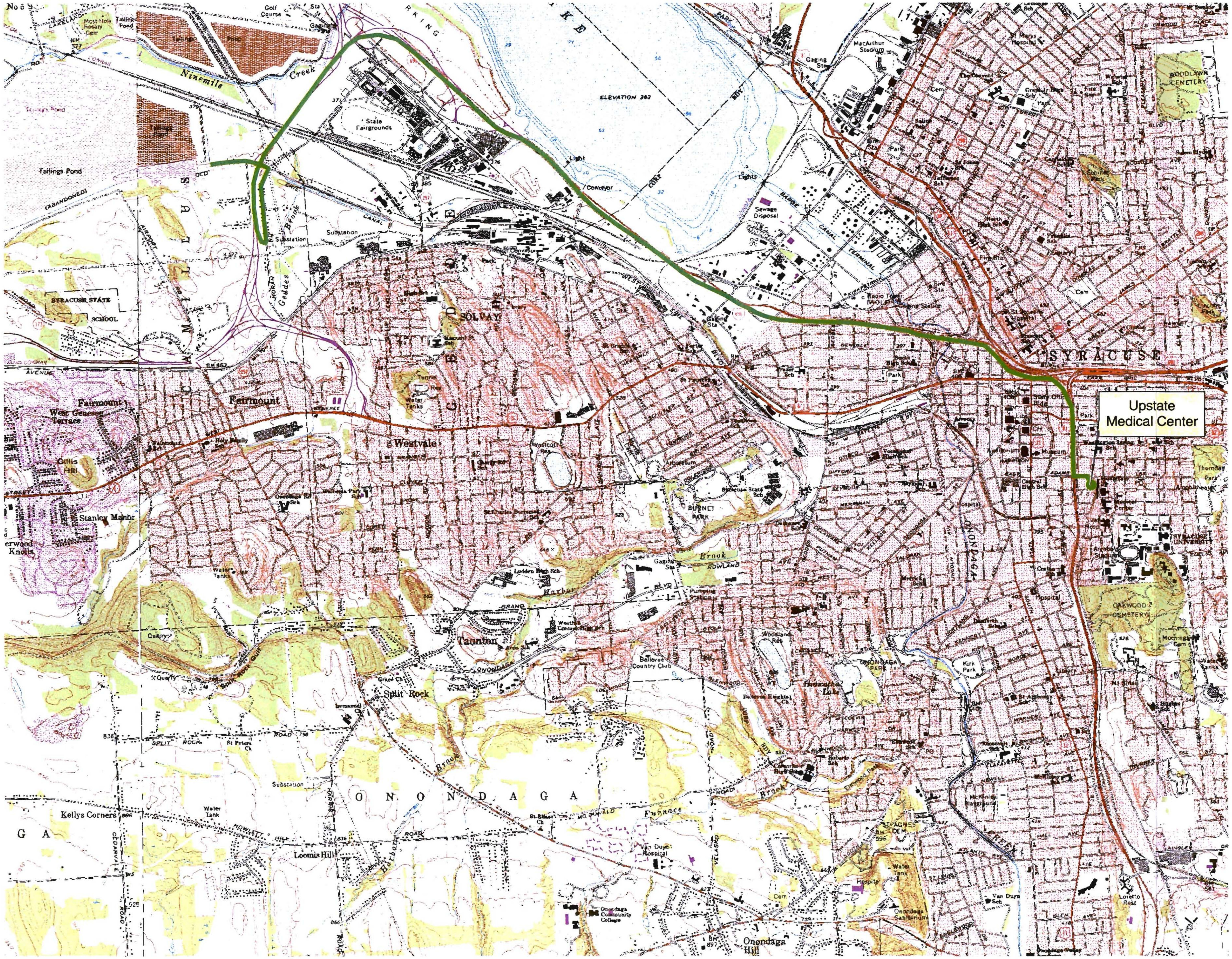
MARCH 2003

O'BRIEN & GERE ENGINEERS, INC

wb_H&S4.MXD

PLOT DATE: 3/19/03 JPS DIV. 82

FIGURE 5



Legend

Evacuation Rt. to Upstate Medical Center

HONEYWELL
GEDDES/SYRACUSE, NEW YORK

EVACUATION ROUTES

0 1,500 3,000 6,000
Feet

1:36,000

MARCH 2003

O'BRIEN & GERE ENGINEERS, INC

PLOT DATE: 3/19/03 JPS DIV. 82 wb_H&S5.MXD

State University of New York
College of Environmental Science and Forestry
1 Forestry Drive
Syracuse, NY 13210
315-470-6500
Webmaster

III. SAFE LABORATORY PRACTICES

A. General Principles

Everyone in a laboratory should observe the following rules:

1. Understand and utilize the safety procedures that apply to the work being performed. Determine the potential hazards (physical, chemical, biological, or radiological), and the appropriate safety precautions to be followed, **before** beginning any task.
2. Be familiar with emergency procedures, the location and use of emergency equipment, and how to obtain help.
3. Be aware of types of protective equipment available. Use the proper type of personal protective equipment for the particular task.
4. Call attention to unsafe conditions or work practices so that appropriate corrections can be implemented.
5. Never consume food or beverages, or smoke in areas where chemicals are being used or stored. Do not apply cosmetics or insert contact lenses while in the laboratory or chemical storage area.
6. Always adhere to appropriate waste disposal procedures.
7. Be certain that all chemicals are correctly and clearly labeled. Post the designated warning signs or labels when specific hazards, such as radiation, flammable materials, biological hazards or other special hazardous conditions exist.
8. Check all burners and gas outlets to ensure that they are off before leaving the laboratory. Do not place gas burners by open windows or in a draft. No gas burner shall be left unattended while in operation.
9. Remain out of the area of a fire, chemical spill, or personal injury unless your assistance is required to help meet the emergency.
10. Use laboratory equipment only for its designated purpose.
11. Carefully position and secure equipment. Take the necessary steps to avoid the accidental jarring of an apparatus or piece of equipment. Use caution in handling hot objects.
12. Check all gas cylinders to ensure that they are securely fastened and that the straps are in good repair.
13. Keep laboratory doors closed to prevent escape of odors into hall.
14. **Think, Act, and Encourage Safety.**

B. Health and Hygiene

The following practices should be observed:

1. Wear appropriate eye protection, such as safety glasses, goggles, and/or a face shield at all times. **Contact lenses should not be worn** in the laboratory.

In the event that a chemical is splashed into the eye, a contact lens may serve to trap and concentrate the chemical, thereby increasing the potential for eye damage. In some cases, the lens may dissolve or in some way become "glued" to the eye.

"Soft" contact lenses can absorb organic solvent vapors and thus potentially damage the eye.

There may be exceptional situations in which contact lenses must be worn for therapeutic reasons. In these situations, employees who MUST wear contact lenses MUST inform their supervisor so that appropriate safety precautions can be devised.

2. Use protective apparel, such as gloves, gowns, lab coats, and other special clothing or footwear as needed. Wearing shorts, tank tops, halters, sandals, or clothing that exposes a large amount of unprotected skin is **strictly prohibited.** It is imperative that the possibility of skin contact with chemicals be minimized.
3. Confine long hair and loose clothing when in the laboratory.
4. Do not use mouth suction to pipette chemicals or start a siphon. A pipette bulb, aspirator or vacuum-assisted pipette must be used.
5. Avoid exposure to gases, vapors, particulates, and aerosols. Use of fume hood whenever such exposure is likely. Appropriate safety equipment must be used when work is not conducted inside a fume hood.
6. Frequently and thoroughly wash hands during the day, immediately before eating and always before leaving the laboratory. When appropriate, a shower should be taken before leaving campus.
7. Avoid the use of solvents for washing the skin. They may remove the natural protective oils from the skin and can cause irritation. Some solvents can facilitate absorption of toxic chemicals or have their own potentially adverse
health effects.
8. Do not attempt to identify chemicals by smell or taste.
9. Minimize your potential for exposure by protecting against inhalation, ingestion, injection and absorption of chemicals.

C. Food, Beverages, and Chemical Contamination

The contamination of food, drink and smoking material is a potential route for exposure to hazardous chemicals. Food and beverages must be stored, handled and consumed in an area entirely free of hazardous chemicals. Smoking is prohibited in all buildings except in the designated room.

1. Well defined areas must be established for storage and consumption of food and beverages. No food will be stored or consumed outside of this area.
2. Consumption of food or beverages, or smoking is not permitted in areas where laboratory operations are conducted or chemicals are handled.
3. Glassware or utensils used for laboratory operations must never be

used to prepare or consume food or beverages. Laboratory refrigerators, ice chests, and cold rooms, are not to be used for food storage.

D. Housekeeping

There is a definite relationship between safety performance and orderliness in the laboratory. Where housekeeping standards are lax, safety performance inevitably deteriorates. The work area must be kept clean, with chemicals and equipment properly labeled and stored.

1. Work areas must be kept clean and free from obstructions. Cleanup will follow the completion of any equipment, laboratory session, or as soon as possible.
2. Spilled chemicals must be cleaned immediately and disposed of properly. Disposal procedures must be followed and all laboratory personnel be informed of them. Chemical accidents and spills are to be attended to promptly. Contact Public Safety (**X6666**) if the spill presents a health risk or is beyond your cleanup capabilities.
3. Unknown chemicals and chemical wastes are to be disposed of promptly using the appropriate procedures. Waste must be deposited in appropriate receptacles.
4. Floors are to be cleaned regularly and kept free of clutter. Keep isles established for emergency egress.
5. Stairwells and hallways may not be used for storage.
6. Access to exits, emergency equipment, valves, controls, alarms, and electrical panels must not be blocked.
7. All glassware shall be properly disposed of in accordance with the appropriate procedure.
8. **Bicycles** and **pets** are **not permitted** in any laboratories.
9. Used sharps such as needles and syringes must be stored in puncture-proof containers while awaiting disposal.

E. Laboratory Equipment Maintenance

Improperly functioning equipment may provide a false sense of safety and create hazardous situations.

1. Equipment must be inspected and tested regularly. Service schedules depend on both the possibility and consequences of failure.
2. Maintenance plans must include a **lock out/tag out** procedure to ensure that a device cannot be restarted while repairs are being conducted. (**See Physical Plant Policy**)

F. Glassware

Accidents involving glassware are a leading cause of laboratory injuries.

1. Careful handling and storage procedures must be used to avoid

damaging glassware.

2. Damaged items are to be discarded or repaired.
3. Adequate hand protection must be used when inserting glass tubing into rubber stoppers or corks, when placing rubber tubing on glass hose connections, or when picking up broken glass.
4. Glass-blowing operations are not to be attempted unless proper annealing facilities are available.
5. Vacuum-jacketed glass apparatuses are to be handled with extreme care to prevent implosions.
6. Only glassware designed for vacuum work is to be used for that purpose.
7. Proper instruction must be provided in the use of glass equipment designed for specialized tasks.
8. Designated **"GLASS ONLY"** waste containers must be used to dispose of glass. (**See Appendix A**)

G. Protective Apparel and Equipment

A variety of specialized clothing and equipment is available for use in the laboratory. The proper use of these items will minimize or eliminate exposure to the hazards associated with most laboratory procedures. All laboratory personnel must be familiar with the location and proper use of protective apparel, safety equipment and emergency procedures.

Each laboratory should include:

1. Protective apparel and equipment recommended for the substances being handled.
2. An accessible drench-type safety shower or means of providing flushing for chemical splashes as immediate first aid treatment.
3. An eyewash fountain or self-contained eyewash station.
4. An accessible fire extinguisher appropriate for the types of fire hazards present. Combustible metals require **Class D fire extinguishers.**
5. A chemical spill kit for small spills.
6. Access to a fire alarm and telephone for emergency use.

H. Cryogenic Hazards

The primary hazard associated with cryogenic materials is the extreme cold and potential for thermal burns. These burns can be severe.

1. Insulated gloves and a face shield are required when preparing and using dry ice or cold baths.
2. Neither liquid nitrogen nor liquid air will be used to cool a flammable mixture in the presence of air.
3. **NEVER** lower your head into a dry ice chest. Carbon dioxide is heavier than air and suffocation may result.

I. Systems Under Pressure

1. Reactions must only be conducted in apparatus that is designed to withstand pressures generated.
2. All pressurized apparatus MUST have an appropriate relief device.
3. Heat must never be added to apparatus which is not designed to withstand heating.
4. If a reaction system cannot be vented directly, an inert gas purge and bubbler system should be used to avoid pressure build up.

J. Warning Signs and Labels

Laboratory areas that have specific hazards must be posted with warning signs.

1. Use standard signs and symbols that have been established for special situations (i.e., radioactivity hazard, biological hazard, fire hazard and laser operations).
2. Post signs that show location of emergency equipment.
3. Waste containers must be labeled to indicate the type of waste that can be safely deposited.
4. **Laboratory Directors** shall ensure that all chemicals under their control are labeled in accordance with the *ESF Hazardous Chemical Labeling Program.* **(See Appendix B)**
5. Each laboratory must post signs identifying the **Unit Safety Coordinator(s) and the Laboratory Director(s).**
6. Chemical code sheets must be posted if cryptic codes are used for laboratory stock solutions. **(See Appendix C)**

K. Unattended Operations

It may be necessary to conduct laboratory procedures over extended periods of time or to run equipment continuously.

1. Such unattended operations must be designed safely.
2. Contingency plans must provide for potential hazards which may result from interruptions of utilities, such as electricity or water.
3. Appropriate signs indicating that a particular laboratory operations is in progress MUST be posted with the name and phone number of the person to contact in an emergency.

L. Working Alone

Avoid working alone in a laboratory. If this is not possible:

1. Arrange with a co-worker to check in with you periodically.
2. On nights, weekends, and holidays contact Campus Public Safety **(Dial-6666)** and arrange for an officer on patrol to check in at your lab periodically.
3. Procedures known to be extremely hazardous may not be undertaken when working alone.
4. The **Laboratory Director(s) and Unit Safety Coordinator(s)** will

determine which procedures have need for special precautions to be taken.

M. Laboratory Security

For the protection of employees, students, equipment, supplies, and the public, laboratories must be locked when unattended.

Security within the laboratory is also important. Locked storage cabinets are advised for sensitive or expensive supplies and equipment. Lockable storage areas or lockers for securing personal property are advised. Needles and syringes must be secured.

Computers, scientific equipment, and research data can be the object of theft, vandalism, or damage from fire or utility failure. Appropriate cabinetry designed to protect these items should be considered. Upon request, Campus Public Safety can assist laboratories with crime prevention surveys and recommendations.

If you observe suspicious persons or activities in your area, contact Campus Public Safety **(Dial-6666)** and an officer will be sent to investigate. Report any thefts or other crimes immediately. Information from these reports is used to adjust patrol activities and may prevent further problems.