Waste-To-Energy Research and Technology Council

WTERT 2005 Fall Meeting at Columbia University

Location: Davis Auditorium, Schapiro Center for Engineering and Physical Science Research,
Fu Foundation School of Engineering and Applied Science
530 West 120th St. (between Broadway and Amsterdam Avenue), New York City
If you arrive at Columbia by subway (Line 1 uptown), ask guard at Columbia 116th St. Gate for directions to Schapiro Hall

Agenda

Thursday, October 20, 2005

8.30 AM **Breakfast in lobby of Davis Auditorium**

9:00 AM **Welcome and introduction: Prof. Nickolas J. Themelis** (WTERT Chair, Earth & Environmental Engineering, Columbia)

9:15 AM **International Session 1** (Chair: Mr. Bill Goldate, Covanta Energy)

- **Mr. Dirk Eeraerts** (Business Development Manager US Office of Keppel Seghers Belgium NV): "Engineering and operating feedback on the Keppel Seghers Water-Cooled Grate and Prism"

  This presentation will start with a brief overview of the technological portfolio of Keppel Seghers which includes WTE grate combustion systems, wastewater treatment, sludge drying & pelletisation, fluidized bed applications and gas cleaning components. The main part of the presentation will be the description of two important developments for the grate combustion of medium-to-high calorific waste fuels: the water-cooled grate and the air-injection prism. The engineering and operational feedback from their application to WTE projects that have been commissioned recently or are under construction will be discussed, in particular the Modena (Italy, 78MWth, water-cooled grate & prism) and the Amsdorf (Germany, 28MWth, water-cooled grate) facilities. Also, long-term operational data from the Moerdijk (the Netherlands) plant will be presented to illustrate the impact of the prism on the plant performance. The presentation will conclude with a look at the main R&D issues for the thermal treatment of solid waste in the future.

- **Prof. Mikko Hupa** (Abo Academi University, Finland): "Fluidized bed combustion of biomass and waste-derived fuels: Current status and challenges"

Fluidized bed combustion (FBC) technology is becoming increasingly important in the global heat and power industry. New FBC capacity is being installed at the rate of several thousand megawatts (thermal) every year. The technology has advanced in many ways since its introduction in the early 1980s. Both circulating fluidized beds (CFBC) and bubbling fluidized beds (BFBC) have shown to be competitive depending on the application. Pressurized fluidized bed boilers (PFBC) are being demonstrated in several larger scale projects. This paper discusses the present state of the FBC technology for large scale heat or power production. Statistical information of the commercial FBC projects is summarized and various trends in the evolution of the technology are presented. The issue of the fuels being selected in the different projects will be discussed in more detail. Fuel mixtures that include various types of wastes present a special challenge to the FBC technology as will be illustrated with examples of recent research.

- **Prof. Y.M. Chang** (National Taipei University of Technology): "Waste-to-energy from municipal solid wastes incineration in Taiwan"

Waste-to-energy technology is an important component of waste management system in Taiwan and, when combined with recycling, composting, and other waste reduction processes, helps to reduce overall disposal costs. The Taiwan EPA has adopted a strategy favoring incineration as the primary method of treatment and landfilling as a supplement. Taiwan has population of 23 million generating about 20,609 tonnes of MSW generated per day. Approximately 7.5 million tonnes of MSW were collected in 2004, including 1.4 million tonnes of recycled material and 0.3 million tonnes of kitchen waste. Taiwan has 21 large refuse-to-energy (RTE) facilities in operation. In general, the heating value for Taiwan refuse is 2,062±238 kcal/kg (LHV, wet base). It is noted that the variability of the heating values seems broader for most area in Taiwan. The heat recovery efficiency has been estimated in the range of 88–100% (mean 97.9%), the thermal efficiency ranges from 68-72%, and the efficiency of electricity generation is 19.1±4.3 % (based on kWh/kcal-steam). Each tonne of feeding refuse can produce 413±109 kWh of electricity. Thus, the entire RTE plants operating in 2004 generated 2.53 billion kWh, or about 1.2% of annual Taiwan electricity generation. Some recycling initiatives being implemented in Taiwan include producer responsibility, pay-as-you-throw, etc. The MSW management strategies relative to RTE will be described. The generation of energy from RTE units has become an important issue in planning new waste management facilities in energy-deficient Taiwan.

11:00 AM **Coffee Break (15 minutes)**

11:15 AM **International Session 2** (Chair: Mr. Ted Michaels, President, IWSA)

- **Ms. K. V. Rajeshwari** (Fellow, Energy and Resources Institute (TERI), New Delhi): "Management of solid wastes in India – Status and initiatives" (Dr. Nikhil Krishnan, Applied Materials, will present on behalf of Ms. Rajeshwari who is unable to attend)

In India, municipal solid waste (MSW) generation from various sources including households, commercial establishments, horticultural and construction sites is estimated at 87,000 tonnes per day. There are large variations in per capita generation and characteristics of waste from one city to another. However, Indian MSW has a high moisture and organic content with an annual energy generation potential of 1460 MW, which is expected to increase to 4565 MW by 2017. Due to high degradability and resource potential associated with Indian MSW, several efforts have been undertaken by various research institutions, government bodies and non-government organizations to recover energy and other useful resources from wastes.

The presentation will cover various ongoing initiatives and status of implementation of waste treatment technologies at both centralized and decentralized levels. It will focus on different technologies being adopted for resource recovery from waste from different sources, by means of select case studies. Various issues associated with the sustainable management of wastes, such as

collection, segregation, public private partnerships, legislation and financial support by government will also be highlighted.

- **Prof. Takashi Nakamura** (Tohoku University): "Fly ash treatment in Japan and the new oxygen-enriched WTE in Sendai"

  Part 1: Fly ash generated from a municipal waste incinerator contains a certain amount of heavy metals and a very small amount of dioxins. As such, it is designated as a specially controlled waste in Japan, and it is obligatory to make it harmless before disposal. The effective use of residual contents is also important as one of the means to deal with the shortage of landfill disposal sites. Five processes are officially registered in Japan for fly ash treatment. The most popular method is chelate treatment in which heavy metals in fly ash are stabilized by chelate agents that keep them from leaching out in controlled landfills. Fixations by cement and melting/vitrification are two other methods. However fixation by cement still requires landfill space while vitrification requires high energy and produces secondary fly ash and slag. A better process, therefore, is desirable. The author has recently developed a new treatment process in which the fly ash is sintered in a rotary kiln. Heavy metals such as Pb and Cd are volatilized by chlorination while minerals such as SiO_2, Al_2O_3 and CaO are sintered to produce a material that is suitable in construction. The secondary ash containing the heavy metals is treated hydrometallurgically and the residue is processed further in non-ferrous smelters. The process results to nearly "Zero Emission" treatment for fly ash.

  Part 2: A new oxygen-enriched waste-to-energy plant was started on test operation this spring in Sendai. It has a high combustion efficiency of municipal solid wastes and good performance of the flue gas control system. It is now operating satisfactorily after overcoming small initial problems. The operating performance of this facility will be discussed.

- **Dr. Juergen Vehlow** (Forschungszentrum Karlsruhe GmbH): "Waste management in the E.U.: The landfill ban and the issue of biogenic waste"

  Waste management in the EU is in almost all aspects controlled by EU directives that have been or will be adopted by national law. The different times of entry to the union and different economic situation are reasons why a uniform waste management policy has yet not been established in the 25 nations; however, it is expected that the fundamental principles will be in force everywhere within few years. In the near future, the direct disposal of reactive waste to landfills will be banned in the entire EU; such a ban has been already enacted in a number of states. The consequences are increased efforts in material recycling and eventually composting. The high landfill standards require incineration of the residual waste (after material recycling), as the final inertisation process, prior to disposal. Furthermore, energy recovery from waste incineration is mandatory. Of major interest in this respect is the fraction of biogenic matter in the waste and its potential for energy supply. This aspect is part of the topics dealt with in the EU Bioenergy Network of Excellence. The potential of the biogenic energy inventory in waste will be discussed.

12:45 PM **Lunch (to be served at Schapiro Hall.**

Please note: You can enjoy your boxed lunch in the front part of Carleton Lounge of the Engineering Building, located at the right of Shapiro Hall where Meeting is held. Carleton Lounge will be open for your use all day Thursday, October 21

2:00 PM **International Session 3** (Chair: Mr. Frank Ferraro, Wheelabrator Technologies)

- **Dr. Antonio Bonomo** (Director, Energy Division, ASM Brescia spa, Italy): "Integrated waste and energy management in Brescia - The CEWEP association of WTE plants in Europe".

  Dr. Bonomo is member of the management of Brescia ASM that provides integrated power, heating, water and waste management services in Brescia County and of the E.U. Confederation of European Waste-to-Energy Plants, an organization founded in 2002 that represents over 200 Waste-to-Energy Plants from across Europe. He will discuss the results of the third WTE line installed in Brescia recently for the co-generation of electricity and district heating from the combustion. He will also describe how CEWEP considers WTE to be a tool for sustainability, the strategies and activities of this organization.

- **Mr. Nicolo Dubini** (President, Pirelli Ambiente, Milan)**: "**The Pirelli Ambiente technology for transforming MSW to a high-grade fuel for co-firing power plants and cement kilns".

  Pirelli Ambiente has developed a technology for using MSW mixed with other solid wastes to produce a fuel of controlled calorific value fuel that is suitable for co-firing coal-fired power plants and cement kilns. This fuel has been used extensively in Italy. This technology uses existing facilities to recover energy from MSW and thus has the lowest capital and operating cost of all renewable energy technologies apart from hydroelectric power. The Pirelli Ambiente experience with this process and its advantages will be described.

- **Prof. Stefano Consonni*** (Energy Engineering, Politecnico di Milano): "An update on waste management and WTE facilities in Italy"

  * study with Prof. Mario Grosso (DIIAR – Environmental Section), Politecnico di Milano

  Gross Municipal Solid Waste (MSW) production in Italy is about 520 kg per capita per year, much higher than the target set by the 5th EU Environmental Action Program (300 kg) but close to the average of western Europe. The past ten years have witnessed a strong drive toward selective collection for subsequent material recovery, which has now reached a national average of over 20%; it ranges from 30% in the North to less than 8% in the South. Despite efforts to reduce landfilling, it is still used for over 50% of the material to be disposed of. Waste-To-Energy plants process about 10% of unsorted waste, again with a marked difference between the North, where WTE plants handle almost 20% of the unsorted waste, and the South, where there are very few WTE plants. In recent years, an increasing fraction of waste has been diverted to the production of Refused Derived Fuel, which however is not necessarily used in combustion plants and frequently ends up in temporary storage sites and/or landfills.
  The WTE plants built in the past decade are very advanced in comparison to older facilities. In addition to much more sophisticated flue gas treatment, which has allowed a drastic reduction of pollutant emissions, the strong incentives introduced in the early 90s to promote energy recovery from MSW have led to plants with high net electric efficiency (27-28% for the largest plants) and high reliability (over 8,000 equivalent hours of operation per year). Many of them operate in cogeneration mode, feeding a district heating system. This presentation gives an overview of the characteristics and the performances of the most advanced plants in Italy, emphasizing the merits and the drawbacks of the various design options, as well as the emerging trends for future WTE realizations.

3:15 PM **Coffee Break (15 minutes)**

3:30 PM **Ongoing research on waste-to-energy processes (**Session Chair: Ms. Maria Zannes, WTERT/IWSA)

- **Dr. Ralf Koralewska** (Martin GmbH): "Industrial scale validation of CFD simulation in conjunction with a fuel-bed model"

  Numeric modeling and simulation by means of Computational Fluid Dynamics (CFD) to describe the thermal and flow processes in waste combustion are state-of-the art tools and used widely. A basic pre-condition for CFD simulation of the gas phase of a boiler is the provision of exact initial values by means of a suitable fuel-bed model. Of primary interest in simulation are the practical implementation and therefore the validity of the model calculations. In this project covering overall validation on an industrial-scale waste-to-energy plant with a MARTIN® reverse-acting grate, the development of a fuel-bed model yielded improvements in the basic boundary conditions for CFD simulation. Comprehensive measurements of temperatures, flue-gas concentrations and velocities were performed and compared with simulated values. Using the model approaches selected it was established that the model for CO burnout and for a number of other simplified partial models, such as heat dissipation in the convective area of the heat exchangers, did not permit accurate analysis or forecasting at these areas. However, there was a good fit with regard to temperature and flue-gas concentration values for CO_2 and O_2. There were some mismatches in the velocity components due, above all, to the turbulence prevailing in the first pass of waste-to-energy plants. Nevertheless, it was possible to identify expected tendencies. The presentation reviews recent investigations of MARTIN GmbH.

- **Prof. Marco Castaldi** (Columbia University): "WTE Research at the Combustion and Catalysis Laboratory (CCL) of Columbia University"

  This effort is focused on understanding various aspects of existing WTE technologies as well as on developing novel approaches. Ongoing research uses thermogravimetric analysis tolls to examine the phenomena occurring during the gasification or combustion of various components of MSW, under conditions that simulate current operating systems as well as novel designs that target maximizing thermal efficiency and material recovery while reducing potential environmental impacts. The waste components tested include waste tires, municipal solid waste (MSW), medical wastes, combined MSW and sewage sludge, hazardous wastes as well as co-feeding fossil fuel with waste components.

- **Prof. Mario Grosso* (**Politecnico di Milano): "Research assessment of alternative strategies for energy recovery from municipal solid wastes".

  *study with Profs. Stefano Consonni and Mario Grosso of Politecnico fi Milano, Mario Grosso and Michele Giugliano

  The paper assesses different strategies for energy recovery from Municipal Solid Waste by dedicated plants and existing industrial facilities, with specific reference to the Italian framework. The former include state-of-the-art Waste-To-Energy (WTE) plants, fed with unsorted waste, pre-treated waste or Refuse Derived Fuel (RDF) and generating electricity and heat through a steam cycle; the latter includes the co-combustion of RDF in coal fired power plants and cement kilns. Scope of the study is the comparison between different possible waste management strategies, based on energetic, environmental and economic evaluations. The analysis proceeds from the unsorted waste downstream of Material Recovery, assumed at 35% by weight. Mass, energy and environmental balances are carried out with a Life Cycle Assessment approach. In order to assess the relevance of scale, both large (about 1.200.000 inhabitants) and small (about 200.000 inhabitants) waste management systems, representative of the Italian situation, are evaluated. Performance estimates of the WTE plant and of the co-combustion unit are carried out by means of a dedicated design and simulation tool developed at Politecnico di Milano. Results have been validated with actual data registered at state-of-the-art plants currently operating in Italy. The energy consumption of the RDF production plant and for the handling of all materials (waste, RDF, solid residues, etc.) are also included in the energy balance.

Overall environmental balances take into account all fluxes of pollutants released in the environment by each process, including both direct (those released from waste treatment plants and from materials transport) and indirect emissions (those related to the production of reactants and to plant construction). Positive emissions are then compared with avoided emissions, i.e. those released from fossil fuel-fired power plants generating the same electricity of dedicated WTE plants or those released from the fossil fuel displaced by RDF co-combustion. The results are discussed in terms of specific energy production, emission inventories and principal impact indicators. For dedicated plants, energy recovery (electric and thermal) plays a basic role in the environmental balance; if this is combined with the very stringent air emission limits currently enforced on WTE plants, a positive net result is obtained, i.e. most of the emissions from the WTE plant are lower than those from the power plants producing the same amount of energy. The co-combustion of RDF in industrial plants exhibits interesting reductions of greenhouse gases emissions. For large scale waste management systems with highly concentrated waste production, a dedicated waste-to-energy plant treating unsorted waste and cogenerating heat and power appears the best option. RDF production and its co-combustion in industrial plants might be preferable for small scale waste management systems where suitable industrial plants are available.

- **Prof. Nickolas J. Themelis** (Columbia University): "Some thoughts on "Thermal Treatment Technologies and the Europlasma process for fly ash vitrification"

  Some of the reasons for the current dominance of mass-burn combustion over other "Thermal Treatment " processes will be discussed, as well as the emergence of China as a WTE nation and the recent growth of gasification and pyrolysis in Japan. In other industries, engineers know that one must start with a specific feedstock in order to get to a certain product, e.g. you need copper concentrates or copper scrap to produce copper. Yet the same feedstock, MSW, is claimed to work by developers of processes that produce entirely different products. For example, the feedstock of an anaerobic digestion process should be source-separated food and plant wastes, as is the case in AD plants in Europe; the same is true if the proposed process produces ethanol, although in this case a high content of sugar would be preferable. On the other hand, the best feedstock for a gasification or pyrolysis process would be non-recyclable plastic wastes, nearly 80% of which are presently landfilled. A remaining problem in MSW combustion is the hazardous nature of fly ash. This presentation will conclude with a description of the Europlasma process for fly ash vitrification (film to be shown: courtesy of Mr. Ulysse Michon of Europlasma).

5:30 PM Poster Session (Foyer in front of Davis Auditorium) *Graduate students will be present to discuss the work presented in the posters*

- **Mike Hyland: Use of WTE Ash in Remediation of Bark Camp Mine**
- **Tracy Jackson – Greenhouse gas reforming over Pt catalyst**
- **Eilhan Kwon – Waste tire decomposition kinetics and mechanism development**
- **Scott Kaufman – Fisher-Tropsch of biogas over novel reactor substrates**
- **Shang Hsiu Lee: Research on abatement of corrosion in WTE combustion chambers**
- **Masato Nakamura: Transport and Reaction Phenomena on WTE Grates**
- **Adam Penque: Removal of Chlorine form WTE Fly Ash**
- **Werner Sunk: Improving Recovery and Quality of Metals Recovered from WTE Ash**
- **Priscilla Ulloa: Life Cycle Analysis of WTE and Landfilling for NYC**

6:45 PM WTERT Dinner (Presidents Room of Faculty House, Morningside Campus, Columbia University)

The sponsorship of the WTERT 2005 Dinner by the Solid Waste Processing Division of the American Society of Mechanical Engineers is gratefully acknowledged

Performance during dinner by Bonsai String Quartet

Presentations by Mr.Amit Chattopadhyay (Manager of Thermal Systems, Malcolm Pirnie**) of the 2005 SWPD/ASME Scholarship Awards**

Presentation of IWSA Service Award to Dr. Frank Roethel, SUNY at Stony Brook

Presentation by Prof. N.J. Themelis (WTERT Chair) and Mr. Ted Michaels (President IWSA) of the WTERT Distinguished Service Awards to:

- **Maria Zannes for service to IWSA and WTERT**
- **Wheelabrator Saugus WTE for thirty years of service to Saugus, Mass.**

Friday, October 21, 2005

The Friday, October 21 session is open to the public

8.30 AM Breakfast in lobby of Davis Auditorium

9:00 AM Waste Management in NYC (Session Chair: Prof. N.J. Themelis)

- **Prof. Paul Brandt-Rauf** (Chair, Environmental Health Sciences, Columbia University): "Comparison of health risks of landfill disposal and WTE processing of NYC MSW"

  A year long study by MS candidate Pearl Moy compared the inhalation health risks of landfill disposal and WTE combustion in a NYC setting, using principles of risk assessment and on the basis of a critical review of the literature on these two methods. Both of these technologies have been improved in the last twenty years, landfills by means of the EPA Subtitle D rules and WTE facilities through the implementation of EPA MACT standards. In addition to modern landfill and WTE emissions, the study considered the impacts from waste-transfer stations, for landfill disposal, and truck transport of both MSW and WTE ash to landfills. The overall individual non-cancer and cancer risks for landfill disposal and WTE combustion were 1.17E+01, 4.14E-05, 3.49E-01, and 1.38E-06, respectively. Impacts from truck transportation were found to be an important contributor to increased health risk. These results suggest that WTE combustion may pose less health impacts than landfill disposal and provide an initial estimation of the relative inhalation health risks from landfill disposal and WTE combustion. Further investigation is needed to validate or modify the findings of this study.

- **Dr. Nikhil Krishnan** (Applied Materials and Earth Institute, Columbia University): "Life Cycle Assessment of waste management options for NYC"

  The U.S. generates about 370 million short tons of Municipal Solid Waste (MSW) each year. While a sizeable fraction of this material is recycled or composted (27% in 2002), most of the remaining MSW is disposed of in landfills. A small fraction is combusted in Waste to Energy

(WTE) facilities to produce electricity and scrap metal. Effective management of MSW is becoming increasingly challenging, especially in densely populated regions, such as New York City, where there is little or no landfill capacity, tipping fees have doubled and tripled in recent years and there is a growing appreciation of the environmental implications of managing MSW. In this paper we assess the overall, quantified life-cycle environmental impacts of two viable options for managing non-recyclable MSW in NYC: landfilling and WTE. With landfills, burdens are associated with transfer stations to handle putrescible wastes, transport of waste to distant landfill sites, and finally landfill gas emissions and potential aqueous run-off. Environmental impacts of concern associated with disposal in WTEs include air emissions of metals, dioxins and greenhouse gases. In analyzing life cycle impacts, we considered a wide range of current and future scenarios associated with differences in the quantity and composition of New York City MSW, transportation factors, performance of landfills and WTE plants, and electricity emission credits.

- **Mr. Jack Lauber** (NYS DEC, retired): "Evolution of New York State incinerators to modern waste-to-energy facilities"

  Waste to energy from MSW in NY state has changed over the years from the crude incinerators of the past that were major air polluters to the modern EPA MACT-regulated, state-of-the-art facilities that have negligible emissions. On the basis of his forty years experience on the regulation of combustion systems in NYS, Mr. Lauber will describe the evolution of "best available control technology" (BACT) for WTEs combusting MSW, highlighting the development of the fabric filter dry scrubbing technology in NY State that is now part of the EPA MACT rules, and compare the present U.S. gas cleaning technologies with the "best available technology" (BAT) requirements in Europe.

10:30 AM **Coffee Break (15 minutes)**

10:45 AM **Waste Management in NYC** (continued)

- **Mr. Ramon Cruz** (Policy Analyst, Environmental Defense): "Trash and the City: A study of MSW transport and consequences in NYC"

  New York City depends on trucks to take out the trash. In fact, diesel trucks carry Manhattan's garbage 7.8 million miles every year. That's the equivalent of driving more than 312 times around the earth. These trucks worsen traffic congestion, add to noise and increase air pollution. Many of these impacts hit hardest in economically disadvantaged communities, but every New Yorker suffers from the overall impact on the city's quality of life. A study carried out by EDF showed that in order to achieve these gains, the city needs to reopen its waterfront for marine transfer stations and recycling centers. The city is assembling ideas for how to move toward a rail- and barge-based transfer system for residential and commercial waste. Manhattan's solid waste can be handled in large part by a clean, safe system of waterfront recycling and transfer stations, reducing the need for trucks that foul the air and clog up neighborhood streets. The latest science makes clear that diesel contributes to asthma attacks, heart disease, cancer and other illnesses. Fortunately, cleaner fuels and retrofit technologies make it possible to significantly reduce pollution from heavy-duty diesel trucks. In addition, New York's waterfront is undergoing a renaissance, has reinstated residential recycling, and is creating new markets for recycled materials. Finally, waste transfer station technology has improved so as to incorporate aspects of green design in addition to eliminating queuing and odor, making them compatible with other waterfront uses.

- **Ms. Adrian Hill** (MPA, Environmental Science and Policy, Columbia U.): "Case studies of innovative waste disposal facilities"

  With no landfills or waste-to-energy plants located within the five boroughs, current disposal methods for New York City's garbage present economic, environmental, political, and social

difficulties. Because local landfilling and incineration are acknowledged as politically challenging, New York is investigating alternative technologies, particularly gasification anaerobic digestion (AD), and waste-to-ethanol hydrolysis. A number of plants utilizing these methods have been constructed and are operating throughout the world. This study examines in detail 5 cases of alternative waste management in cities around the world and offers lessons applicable to New York City. A group of graduate students in Columbia's MPA program in Environmental Science and Policy conducted this study for the New York City Economic Development Corporation. The goal of the analysis was to benchmark the development of these facilities and identify pertinent successes and failures for New York City. The results of the study will be presented.

- **Panel Discussion**: "Challenges and opportunities for waste management in developed and developing megacities"

12:30 PM End of Meeting

The sponsorship of meals and coffee breaks during the technical sessions of this Meeting by the Integrated Waste Services Association is gratefully acknowledged

Directions to the WTERT Fall Meeting

Take Subway 1 or 9 to 116th Street, Buses M4, M11 or M104 from locations in Manhattan or Bus M60 from La Guardia Airport. Follow map of Columbia Campus (Northern Part) on the last page.

Street parking can be found in the neighborhood (RARE!) and the following parking garages are located in the Columbia neighborhood:

- Hospital Parking 114th St. between Broadway & Amsterdam Avenue (212) 523-1051
- Riverside Church 120th St. between Riverside Drive & Claremont Avenue (212) 870-6736
- GGMC 122th St. between Broadway & Amsterdam Avenue (212) 865-1754
- Morningside Garage Broadway at 124th Street (212) 864-9877
- Park Yorkshire 108th St. between Columbus & Amsterdam Avenue (212) 865-2314
- E & B 108th St. between Columbus & Amsterdam Avenue (212) 865-8315
- Westside Parking 108th St. between Broadway & Amsterdam Avenue (212) 222-8800

Map of Columbia Morningside campus: