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# U.S. DEPARTMENT OF ENERGY

## ENVIRONMENTAL ASSESSMENT

## COMBUSTION ENGINEERING INTEGRATED COAL GASIFICATION COMBINED CYCLE REPOWERING PROJECT

## CLEAN COAL TECHNOLOGY PROGRAM

A PROJECT PROPOSED BY
COMBUSTION ENGINEERING, INC.
AT THE
CITY WATER, LIGHT AND POWER
LAKESIDE GENERATING STATION
SPRINGFIELD, ILLINOIS

MARCH 1992

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| Btu | British thermal unit |
| C-E | Combustion Engineering, Inc. |
| CCT | Clean Coal Technology |
| CFCs | chlorofluorocarbons |
| CFR | *Code of Federal Regulations* |
| CO | carbon monoxide |
| $CO_2$ | carbon dioxide |
| CWL&P | City Water, Light and Power, Springfield, Illinois |
| DOE | (U.S.) Department of Energy |
| EA | environmental assessment |
| EPA | (U.S.) Environmental Protection Agency |
| ESP | electrostatic precipitator |
| °F | degrees Fahrenheit |
| ft | foot |
| $ft^3$ | cubic feet |
| FGD | flue gas desulfurization |
| FWS | (U.S.) Fish and Wildlife Service |
| gal | gallons |
| h | hour |
| HRSG | heat recovery steam generator |
| ICCT | Innovative Clean Coal Technology |
| IDOC | Illinois Department of Conservation |
| IEPA | Illinois Environmental Protection Agency |
| IGCC | integrated coal gasification combined cycle |
| kV | kilovolt |
| kWh | kilowatt-hour |
| L | liter |
| lb | pound |
| mg | milligram |
| Mgd | million gallons per day |
| MW | megawatt |
| MWe | megawatt (electric) |
| MWh | megawatt-hour |
| NAAQS | National Ambient Air Quality Standards |
| NEPA | National Environmental Policy Act |
| No(s). | Number(s) |
| $NO_x$ | nitrogen oxides, oxides of nitrogen |
| $NO_2$ | nitrogen dioxide |
| NPDES | National Pollutant Discharge Elimination System |
| NSPS | New Source Performance Standards |
| $O_3$ | ozone |
| OSHA | Occupational Safety and Health Administration |
| PEIA | Programmatic Environmental Impact Analysis |
| PEIS | Programmatic Environmental Impact Statement |
| $PM_{10}$ | particulate matter less than 10 microns in diameter |
| PON | Program Opportunity Notice |
| ppm | parts per million |
| PSD | prevention of significant deterioration |

| | |
|---|---|
| s | second |
| $SO_2$ | sulfur dioxide |
| TSP | total suspended particulate matter |
| $\mu g/m^3$ | micrograms per cubic meter |
| $\mu S/cm$ | microsiemens per centimeter |
| $yd^3$ | cubic yards |

# 1. INTRODUCTION

On December 22, 1987, Public Law No. 100-202, "An Act Making Appropriations for the Department of the Interior and Related Agencies for the Fiscal Year Ending September 30, 1988, and for Other Purposes," was signed into law. Among other things, the act provided funding to the Department of Energy (DOE) to cost-share the design, construction, and operation of Innovative Clean Coal Technology (ICCT) Projects to demonstrate the feasibility of technologies that reduce emissions of sulfur dioxide ($SO_2$) and oxides of nitrogen ($NO_x$) from coal combustion. Emissions of $SO_2$ and $NO_x$ have been identified as contributors to acidic deposition ("acid rain") both nationally and internationally. The ICCT Program is part of DOE's Clean Coal Technology (CCT) Demonstration Program.

On February 22, 1988, DOE issued Program Opportunity Notice (PON) Number DE-PS01-88FE61530 for Round II of the CCT Program. The purpose of the PON was to solicit proposals to conduct cost-shared ICCT projects to demonstrate technologies that are capable of being commercialized in the 1990s, that are more cost-effective than current technologies, and that are capable of achieving significant reduction of $SO_2$ and/or $NO_x$ emissions from existing coal burning facilities, particularly those that contribute to transboundary and interstate pollution. The Combustion Engineering (C-E) Integrated Coal Gasification Combined Cycle (IGCC) Repowering Project was one of 16 proposals selected by DOE for negotiation of cost-shared federal funding support from among the 55 proposals that were received in response to the PON.

The ICCT Program has developed a three-level strategy for complying with the National Environmental Policy Act (NEPA) that is consistent with the President's Council on Environmental Quality regulations implementing NEPA (40 CFR 1500-1508) and the DOE guidelines for compliance with NEPA (10 CFR 1021). The strategy includes the consideration of programmatic and project-specific environmental impacts during and subsequent to the project selection process. As the first level, DOE published and publicly distributed a Programmatic Environmental Impact Analysis (PEIA) for the ICCT Program (DOE/PEIA-002) in September 1988.* The PEIA assessed the impacts of all technologies proposed to be demonstrated under the ICCT Program. As a second level, prior to project selection, DOE prepared a confidential, project-specific analysis for internal DOE use in the decision-making process. This Environmental Assessment (EA), which represents the third level of NEPA review, provides a site-specific analysis of the expected environmental impacts of the proposed C-E IGCC Repowering Project.

*A Programmatic Environmental Impact Statement (DOE/EIS-0146) was also prepared for the CCT Program and was published in November 1989.

# 2. PURPOSE AND NEED FOR THE PROPOSED ACTION

The DOE entered into a cooperative agreement with C-E under which DOE proposes to provide cost-shared funding to design, construct, and operate an IGCC project to repower an existing steam turbine generator set at the Springfield (Illinois) City Water, Light and Power (CWL&P) Lakeside Generating Station, while capturing 90% of the coal's sulfur and producing elemental sulfur as a salable by-product. The proposed demonstration would help determine the technical and economic feasibility of the proposed IGCC technology on a scale that would allow the utility industry to assess its applicability for repowering other coal-burning power plants.

This EA has been prepared by DOE in compliance with the requirements of NEPA. The sources of information for this EA include the following: C-E's technical proposal for the project submitted to DOE in response to the ICCT PON; discussions with C-E and CWL&P staff; the volume of environmental information for the project and its supplements provided by C-E; and a site visit to the proposed project site.

# 3. PROPOSED ACTION AND ALTERNATIVES

## 3.1 PROPOSED ACTION

The proposed federal action is for DOE to provide cost-shared funding to construct and demonstrate an IGCC system at CWL&P's Lakeside Generating Station. Project sponsors are DOE, C-E, the Illinois Department of Energy and Natural Resources, and CWL&P of Springfield, Illinois, the city's municipally owned utility.

### 3.1.1 Location

The project site is situated in Sangamon County in central Illinois (Figure 1). CWL&P operates the City of Springfield's power plant and water supply complex, located on approximately 75 acres in the southeastern corner of the city, on the northwestern shore of Lake Springfield. The site (Figure 2) is bounded on the west by Interstate 55 and on the north by East Lake Drive, a major local artery. The relatively flat site abuts the lake to the east and south. Lake Springfield is a 6.3-square mile impoundment created in 1935 by the damming of Sugar Creek. The lake provides a reliable water supply for the City of Springfield and serves as a source of cooling water for the power plants. On the northeastern corner of the site, Spaulding Dam forms the outlet of the lake. Just north of East Lake Drive and northeast of Spaulding Dam, CWL&P maintains a 125-acre solid waste settling and storage facility (Figure 3).

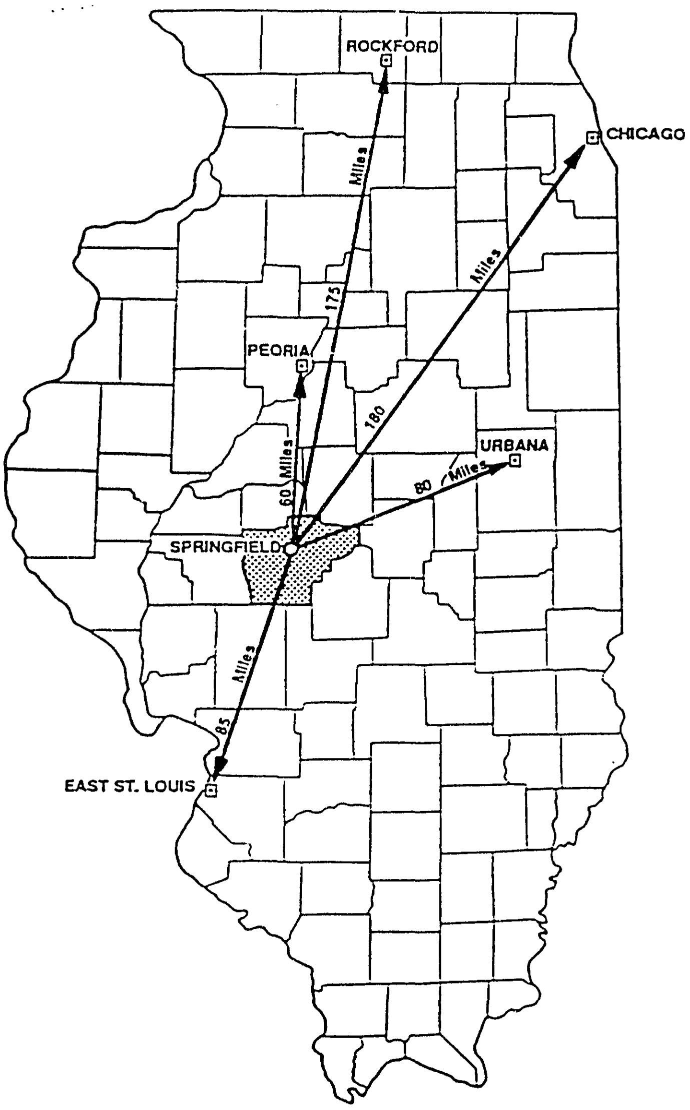


Figure 1. Location of Sangamon County, Illinois.

### 3.1.2 Lakeside Generating Station

The C-E IGCC Repowering Project is a proposed repowering of the existing Lakeside II Generating Station operated by CWL&P.

ORNL-DWG 91M-8109

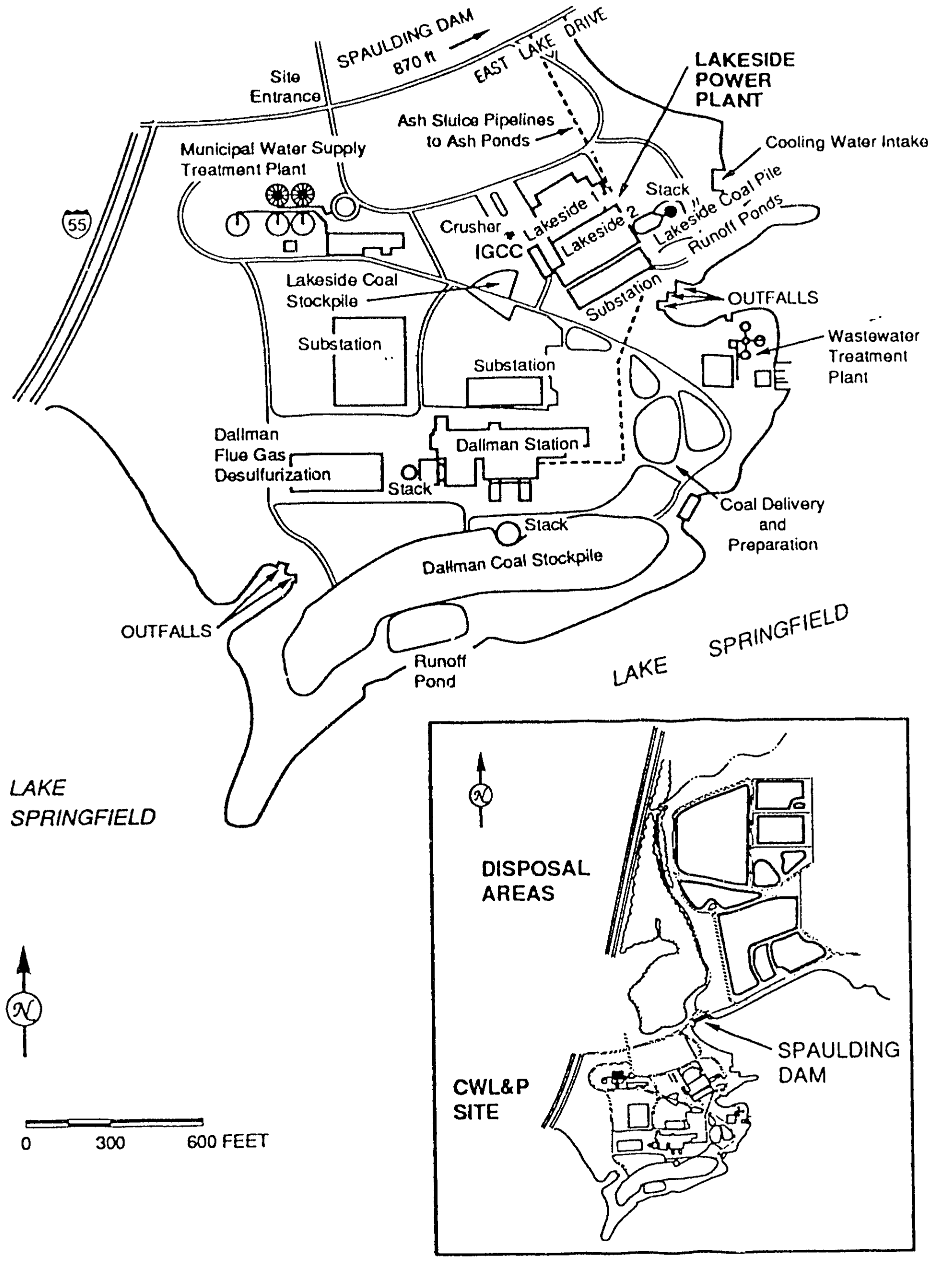


Figure 2. Location of Lakeside Generating Station and the proposed demonstration project.

ORNL-DWG 91M-7110

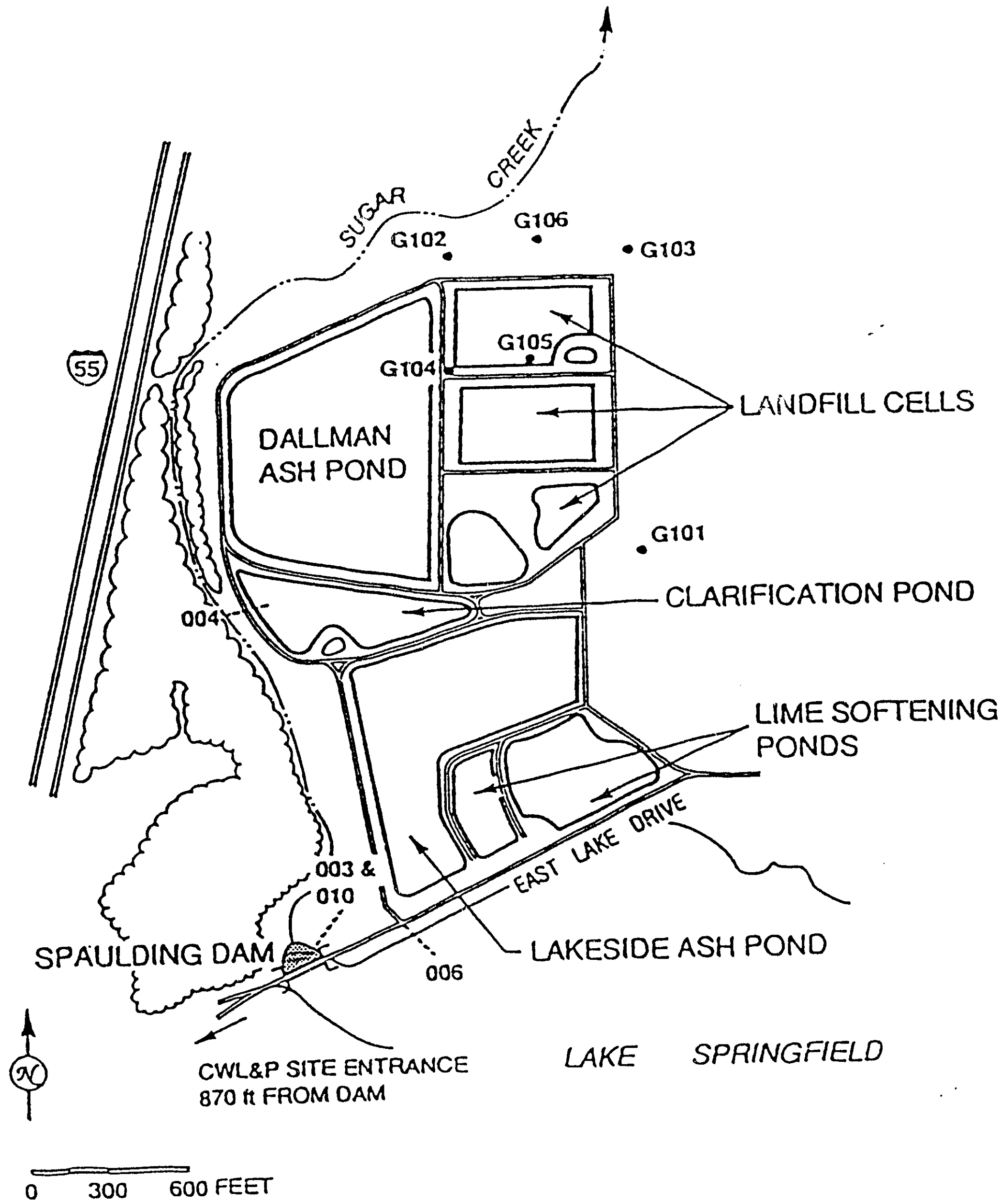


Figure 3. City Water, Light and Power solid waste settling and storage facility.

A gas reburning, sorbent injection project was also selected for demonstration at Lakeside II as part of the CCT Program (using Boiler 7) in 1988. An EA was prepared for this other CCT project in 1989 (DOE/EA-0381). Construction and modification of the gas reburning demonstration will be completed in November 1991. Long-term testing is expected to begin in December 1991 and conclude in September 1993. The following sections characterize the existing site facilities, processes, and operating resource base for the IGCC project.

### 3.1.2.1 Existing facilities

Major existing facilities on the 75-acre CWL&P site consist of Lakeside Generating Station, Dallman Generating Station, Springfield's municipal water supply treatment plant, and an industrial wastewater treatment plant serving the power plants. Details of the CWL&P site are shown on the existing site plan (Figure 2).

**Lakeside Station.** This station is comprised of two power plants, Lakeside I and Lakeside II. Lakeside I, which first operated in 1935, was retired in 1984. During its operational years, Lakeside I was comprised of Boilers 1 through 4, which powered steam turbines 1 through 3. These units (boiler/turbine combination) were originally coal-fired but were converted to oil-fired capacity before decommissioning. They were used to provide peaking capacity until retirement.

Lakeside II is comprised of Boilers 5 through 8 and steam turbines 4 through 7. The newest boiler in Lakeside II began operation in 1965. Boilers 5 and 6 and their associated steam turbines 4 and 5 have been out of service for several years. Turbines 4 and 5 each have a nameplate capacity rating of 20 MW and are available for repowering. Turbines 6 and 7 are rated at 33 MW each, giving the Lakeside II station a current generating capacity of 66 MW. In 1987, Lakeside II recorded an average capacity factor of 16.3%: 26.2% for Turbine 6 and 6.4% for Turbine 7. At their rated firing capacities, Boilers 7 and 8 can each consume crushed (pulverized) coal at a rate of 18.2 tons/h. Lakeside II is currently used only for peaking service.

Several facilities are common to both Lakeside I and Lakeside II. A single, 300-ft stack serves the entire station. The currently operating units of Lakeside II employ an electrostatic precipitator (ESP) for particulate matter control and discharge flue gases through this stack. Two coal stockpile areas serve the station; but only one, covering a maximum area of about 0.75 acre, is currently in use. From the active stockpile, coal is conveyed to a live bin that feeds coal to a crusher. This crushing facility processes the coal feedstock to the required maximum size before introduction to the boilers.

**Dallman Station.** The Dallman Generating Station is the third power generating facility on the CWL&P site and is the newest and largest of the three. It contains three coal-fired units (Units 31, 32, and 33), with a total generating capacity of 352 MW. Units 31 and 32 are each rated at 80 MW, and each can consume coal at a rate of 45 tons/h. These two units each have a 450-ft stack. Unit 33, the newest in the station, was placed in service in 1978. It has a rated capacity of 192 MW and can consume coal at a rate of 112.3 tons/h. Unit 33 is served by its own 500-ft stack. Dallman Station had a 1987 average capacity factor of 43.5%: 47.3% for Unit 33, 40% for Unit 32, and 31.8% for Unit 31. Units 31 and 32 each have an ESP for control of air emissions. Unit 33 has both a flue gas desulfurization (FGD) system and an ESP for air emission control and is also equipped with a continuous $SO_2$ monitor. All stacks are equipped with opacity monitors.

**Other Facilities.** The CWL&P site contains an on-site industrial wastewater treatment plant to serve the power plants. This plant treats blowdown wastewater from Dallman Station and other miscellaneous wastewaters from both plants. The plant consists of a grit chamber and settling basin, monitoring and chemical treatment facilities, and three small clarifiers. Following removal of suspended solids, flocculation, and clarification, wastewater from the plant is discharged to Lake Springfield. The treatment plant has a capacity of about 7 million gallons per day (Mgd).

CWL&P's nearby 125-acre solid waste settling and storage facility (Figure 3) consists of two large ash-settling lagoons, a clarification pond, two lime softening ponds, and three dry landfill cells constructed for disposal of FGD sludge from the Dallman Boiler 33. The 40-acre Dallman ash pond is the larger of the two ash-settling lagoons, with a capacity of 930,000 $yd^3$. The Lakeside ash pond is at a higher elevation than the Dallman pond and currently receives ash from the two operating Lakeside boilers. Both ash lagoons discharge the supernatant to the 9-acre clarification pond, which in turn discharges to Sugar Creek. The three landfill cells cover about 33 acres; the southern cell is the only one currently in use. The remaining two empty cells have a capacity of 570,000 $yd^3$ each. A small holding pond in the southeastern corner of the northern cell collects runoff from the three cells. Collected stormwater either evaporates in the holding pond or is pumped to the Dallman ash pond. The lime softening ponds are currently used only to store lime waste from the water purification plant.

The CWL&P site also contains the municipal water purification plant, substations and transmission facilities, offices, maintenance facilities, aboveground and underground fuel oil storage tanks, parking areas, and rail lines.

#### 3.1.2.2 Fuel consumption, effluents, and wastes

The Lakeside and Dallman stations burn coal to generate electricity. As indicated in Table 1, the existing stations consume about 850,000 tons of coal per year. The Illinois No. 5 coal, which is and would continue to be burned, is a medium-sulfur, bituminous coal with the following average characteristics: 2.8% sulfur, 9% ash, 18% moisture, and a heating value of 10,400 Btu/lb. Air emissions from combustion include $SO_2$, $NO_x$, particulate matter, sulfuric acid mist, and carbon dioxide ($CO_2$). Natural gas lines are present on the CWL&P site, but the only current use of natural gas is for building heat, not for power generation.

Air emissions for Dallman Unit 33 are regulated by the U.S. Environmental Protection Agency (EPA) New Source Performance Standards (NSPS) for electric generating plants. This unit, which began operation in 1978, qualifies for the special category of NSPS for plants built between 1971 and 1978. Therefore, the NSPS limits for this plant are 1.2 lbs of $SO_2$, 0.7 lb of $NO_x$, and 0.1 lb of particulate matter per million Btu of heat input. The other, older units are regulated by the Illinois Environmental Protection Agency (IEPA) under the State Implementation Plan, which limits Lakeside II Units 7 and 8 and Dallman Units 31 and 32 to 6.0 lb of $SO_2$ and 0.1 lb of particulate matter per million Btu of heat input. $NO_x$ emissions for these older units are not regulated. Table 1 presents the actual annual emissions for the existing plants.

As indicated in Table 1, the industrial wastewater treatment plant currently treats and discharges 3 Mgd ($1,200 \times 10^6$ gal/year) of blowdown wastewater from Dallman Station and miscellaneous wastewaters from both plants. The facility monitors and reports flow, temperatures, pH, and concentrations of iron and copper, oil and grease, total residual chlorine, and total suspended solids. Table 2 characterizes the water quality at each of the 12 wastewater outfalls for the CWL&P facilities, including the wastewater treatment plant (discharge point 005). Discharges at the outfalls are permitted under a National Pollutant Discharge Elimination System (NPDES) permit that is administered by the IEPA. CWL&P is authorized by IEPA to discharge effluents to Sugar Creek and Lake Springfield under conditions specified by NPDES Permit No. IL0024767.

**Table 1. Comparison of operating characteristics for the existing and proposed CWL&P facilities**

| Operating characteristics | Existing plant[a] | Proposed IGCC[b] | Existing plus proposed plant |
|---|---|---|---|
| Capacity, MW | 418 | 73 | 491 |
| Capacity factor, %[c] | 40 | 65 | 44 |
| Power production, MWh/year | 1,464,672 | 415,662 | 1,880,334 |
| Coal consumption, tons/year | 850,000 | 174,380 | 1,024,380 |
| Water consumption | 100,000 | 5,700 | 105,700 |
| Cooling water, $10^6$ gal/year | 99,000 | 5,500 | 104,500 |
| Wastewater, $10^6$ gal/year | 1,200 | 108 | 1,308 |
| Process water, $10^6$ gal/year[d] | 0 | 67 | 67 |
| Air emissions | | | |
| Sulfur dioxide, tons/year | 24,800 | 1,116 | 25,916 |
| Nitrogen oxides, tons/year | 12,800 | 1,088 | 13,888 |
| Particulate matter, tons/year | 414 | 54 | 468 |
| Sulfuric acid mist, tons/year | 265 | 14 | 279 |
| Carbon dioxide, tons/year | 1,850,000 | 370,845 | 2,220,845 |
| Effluents | | | |
| Wastewater discharges, $10^6$ gal/year | 1,200 | 108 | 1,308 |
| Cooling water, $10^6$ gal/year | 99,000 | 5,500 | 104,500 |
| Average temperature rise at outfalls, °F[e] | 5.3 | 0.1 | 5.4 |
| Solid waste | | | |
| Ash, $yd^3$/year | 56,000 | 11,300 | 67,300 |
| Sludge, $yd^3$/year | 60,000 | 0 | 60,000 |
| Spent limestone, $yd^3$ | 0 | 11,900[f] | 11,900[f] |
| Zinc ferrite pellets, tons/year | 0 | 94 | 94 |
| Elemental sulfur by-product, tons/year | 0 | 5,600[g] | 5,600[g] |

[a]The existing plant consists of all facilities at the CWL&P site. Data are based on actual plant history.

[b]Based on the maximum rate (79 MW, gross) and a 65% capacity factor for the IGCC.

[c]Capacity factor is the ratio of the energy output during a period of time to the energy that would have been produced if the equipment had operated at its maximum power during that period.

[d]Process water consumption includes water consumed by the gasification process and water discharged as vapor.

[e]Based on Sargent & Lundy (1990), which derived an average temperature rise for the CWL&P facilities based on individual temperature rises for the Lakeside and Dallman plants given in Beck (1984).

[f]Based on a one-time 2-month test of in-bed desulfurization. During the test, spent limestone is vitrified with the coal ash slag and will be handled like the ash (includes the approximately 2000 $yd^3$ of ash generated during the 2-month period).

[g]Based on 3.2% sulfur. 5,600 tons per year is an upper bound estimate.

Table 2. Limits and values for water quality parameters at NPDES Outfalls at Dallman and Lakeside Power Plants in Springfield, Illinois, May 1990–May 1991. (*Source*: NPDES Discharge Monitoring Reports, May 1990–May 1991).

| Outfall | Flow (Mgd) | Temperature (°F) | pH[a,b] | Total Suspended Solids (mg/L) | Total Residual Chlorine (mg/L) | Total Iron (mg/L) | Total Copper (mg/L) | Oil and Grease (mg/L) |
|---|---|---|---|---|---|---|---|---|
| NPDES Permit Limits | None | [c] | 6–9 | 15[d]<br>30[e] | 0.2 | 2.0[d]<br>4.0[e] | 0.5[d]<br>4.0[e] | 15[d]<br>20[e] |
| 001 | 24.1 | 74.5 | —[f] | — | 0 | — | — | — |
| 001A | 0.15 | — | 7.2–8.8 | 11 | — | — | — | 1.2 |
| 002 | 124.2 | 74.8 | — | — | 0.0–0.11[g] | — | — | — |
| 003 | 0.20 | — | 8.1–9.8 | 3.1 | — | — | — | 0.9 |
| 004 | 3.84 | — | 7.0–9.5 | 11.1 | — | — | — | 1.2 |
| 005 | 3.50 | — | 6.3–10.3 | 6.5 | — | 0.15 | 0.019 | 0.78 |
| 006[h] | 0 | — | — | — | — | — | — | — |
| 007[i] | 0.009 | — | 7.2 | 143 | — | 0.3 | — | 0.4 |
| 008[j] | 0.006 | — | 7.7–8.0 | 18 | — | 0.6 | — | 0.14 |
| 009 | 121.4 | 78.8 | — | — | 0–0.11[k] | — | — | — |
| 010 | 0.14 | — | — | — | — | — | — | — |
| 011[h] | 0 | — | — | — | — | — | — | — |

[a]pH range limit for outfalls 001A and 003 are 6–10.
[b]Values for pH are the range of all values from May 1990 and May 1991.
[c]The thermal discharge to Lake Springfield from the Lakeside plant shall not exceed 99°F more than 5% of the hours in the 12-month period ending with any month and the discharge from the Dallman plant shall not exceed 99°F more than 8% of the hours in the 12-month period ending with any month and at no time shall any discharge exceed 109°F.
[d]30-day average.
[e]Maximum value.
[f]"—" indicates parameter is not monitored.
[g]Values are the range of the average values measured during chlorine treatment. The maximum limit value of 0.2 mg/L was not exceeded at any outfall.
[h]There was no discharge from this outfall from May 1990 and May 1991.
[i]Flow occurred at this outfall during June 1990 only.
[j]Flow occurred at this outfall during June 1990 and January 1991 only.
[k]Chlorine was added in only 6 of 13 months.

Ash and FGD sludge generated by the Lakeside and Dallman stations are deposited in CWL&P's solid waste settling and storage facility. As indicated in Table 1, the two stations currently generate ash at the annual rate of 56,000 $yd^3$, and Unit 33 generates FGD sludge at the annual rate of 60,000 $yd^3$. The three landfill cells were constructed for storage of Dallman Unit 33's FGD sludge. Under current operating conditions, CWL&P estimates the useful life of the landfill cells to extend until 2008. The remaining life of the 40-acre Dallman ash pond is less certain because varying quantities of ash are reclaimed from the pond by a private operator. Therefore, CWL&P conservatively estimates the remaining ash pond life without reclamation to extend to at least 1996. Alternatives for ash disposal are discussed in Section 4.1.4.

### 3.1.3 Proposed Integrated Coal Gasification Combined Cycle System

#### 3.1.3.1 Project facilities

IGCC facilities would be installed within and adjacent to Lakeside II. New equipment includes the coal preparation equipment, coal handling and feed equipment, gasifier, heat exchangers, cyclones and baghouses, sulfur removal system, gas turbine, a 246-ft stack, and heat recovery steam generator (HRSG). Existing plant equipment to be integrated with the new equipment includes the Lakeside II Turbine 4, condenser, feedwater heating train, condenser cooling water lines, and ash sluice lines. In conjunction with renovating the Lakeside II building for the proposed IGCC project, asbestos removal from the building would be required (see Section 3.2). The IGCC project would also use an existing Lakeside storage area for coal storage.

#### 3.1.3.2 Process description

The proposed C-E coal gasification process is known as an air-blown, entrained-flow gasification process, in which pulverized coal is used to produce a clean, low-Btu fuel gas. As discussed below, four major subsystems make up the proposed IGCC demonstration plant: coal processing, gasification and gas cooling, hot gas cleanup, and power generation. Figure 4 is a simplified process flow schematic for the plant.

The coal processing is done by conventional, commercially available technologies, in which conveyor belts and crushing mills are employed to pulverize the coal. The pulverized coal is then fed to the pressurized gasifier.

The C-E gasifier consists of a reductor (top) and combustor (bottom) section. Coal is fed into both sections. During coal gasification, part of the coal and char (a solid product) are fed into the combustor section with an upward-flowing stream of compressed air and burned to generate heat and hot gases. The hot gases generated in the combustor then enter the reductor section of the gasifier. With additional feed coal and the heat generated in the combustor section, the remainder of the carbon from the char plus the fresh coal is converted to gases by the gasification reaction. These gases are commonly known as fuel gas. Fuel gas is composed of hydrogen, carbon monoxide, methane, carbon dioxide, and other carbon- and sulfur-containing compounds. Because of the high temperatures generated in the combustor section (in excess of 2000°F), ash in the coal is converted into a liquid that is allowed to flow out the bottom of the gasifier into a water-filled quench tank, where it is cooled to form a non-leachable glassy substance (slag).

The fuel gas generated by the reductor section and any unreacted char exit the top of the gasifier and are sent to cooling systems where the fuel gas is cooled to approximately

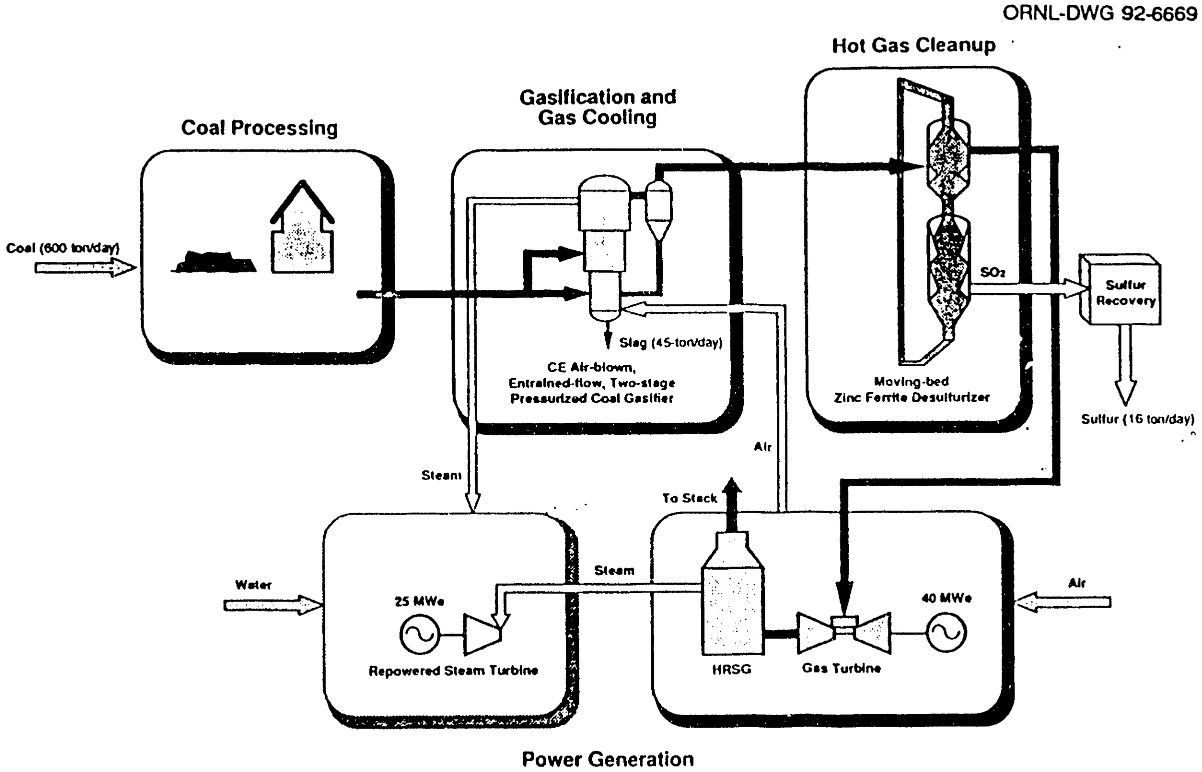


Figure 4. Combustion Engineering IGCC repowering project schematic.

1000°F by various heat exchange surfaces and water spray to match the hot gas cleanup system. Following cooling, the fuel gas is cleaned to remove sulfur-containing compounds and any fine particulate matter. The coal char gas stream is sent to the high-efficiency cyclone, where fine particles and char that are suspended in the gas are separated from each other. The solid char is returned to the combustor section of the gasifier for further conversion. The gas stream, which now does not contain any solid particles, goes to the hot gas cleanup system, where sulfur-containing compounds are removed from the fuel gas.

A newly developed process for removing sulfur from the hot gas is also proposed to be tested. It consists of a moving bed of zinc ferrite sorbent that absorbs the sulfur-containing compounds. For system reliability, a conventional low-temperature sulfur-removal system may be installed as a backup to provide a commercially proven technology for sulfur removal. The low-temperature sulfur-removal system uses an amine-type solution to absorb sulfur compounds in the fuel gas. A limestone sorbent injection system for optional demonstration of in-bed desulfurization would also be installed and tested for 2 months.

The resulting clean fuel gas is well suited to be burned in a gas turbine to produce electricity. The exhaust gases from the turbine are then sent to the HRSG, where they produce steam for use in a steam turbine to generate additional electricity. The combination of gas turbine and steam turbine to produce electricity is commonly known as a combined cycle. Because a gasifier is used to provide energy to gas and steam turbines, the entire process is known as integrated gasification combined cycle.

### 3.1.3.3 By-products

By-product sulfur is recovered from the gas cleanup system by use of a Claus process where sulfur compounds are converted to elemental sulfur at the rate of 16 tons/day. This process would be applied to both the hot gas and conventional low-temperature cleanup options. Sale of the by-product elemental sulfur for use in manufacturing is proposed, but contracts have not yet been signed. Until it is sold, elemental sulfur would be stored onsite at a location (to be identified) above the 100-year floodplain. The high-temperature zinc ferrite process also generates fine particles at a rate of 33 lb/h. Because of its high zinc content, this reclaimable material is expected to be recycled to the sorbent producer.

### 3.1.3.4 Performance characteristics

The anticipated IGCC operation is bracketed by two cases defined as "Nominal" and "Maximum Rate." Under both cases, the plant is designed such that the gas turbine would be fully utilized by being fully loaded with gasifier fuel gas. Table 3 presents a comparison of the two cases.

**Table 3. Comparison of IGCC plant design cases[a]**

| | Nominal | Maximum rate[b] |
|---|---|---|
| Coal feed (tons/day) | 600 | 735 |
| Gas turbine power (MW) | 40 | 40 |
| Steam turbine power (MW) | 25 | 39 |
| In-plant use (MW) | 5 | 6 |
| Net power (MW) | 60 | 73 |
| Net plant heat rate (Btu/kWh) | 8,690 | 8,800 |

[a]Existing steam turbine nameplate capacity is 20 MW. Refurbished turbine would be capable of producing more than 20 MW.

[b]The maximum rate was used to estimate the effluent rates reported in Table 1 and as the basis for assessing impacts reported in Section 4.

The nominal case IGCC plant is expected to perform at an optimum condition producing its highest-Btu fuel gas which coincides with minimum steam production. This nominal case yields the maximum plant efficiency, thus requiring minimum coal feed to fuel power generation.

The maximum rate case provides for a conservative operating condition requiring greater mass flow of lower-Btu fuel gas to fully load the gas turbine. Under this condition, excess steam is produced by the synthetic-gas cooler. This results in lower plant efficiency and a higher required coal feed rate. The Table 1 IGCC emissions are based on this maximum rate case at 65% capacity factor. This serves as the basis for all analyses except modeled concentrations from air emissions (Section 4.1.1), which are based on the maximum rate case at 100% capacity factor. To accommodate variations within or beyond the expected operating limits, capability is provided to supplementally fire the HRSG with excess fuel gas or natural gas and to supplementally fire the gas turbine with natural gas. These added capabilities economically provide operating flexibility for the IGCC plant.

The air emissions in Table 1 are compared in Table 4 based upon the pounds of pollutants emitted per megawatt-hour (MWh) of electricity produced. Table 4 shows that the emissions per unit of electricity generated would be less for the proposed plant than for the existing plant. This improvement is possible because the IGCC plant would be more efficient than the existing plant in energy conversion and more effective in the capture of potential pollutants. As shown in Table 1, however, total air emissions from the proposed plant will be greater than those from the existing plant overall because of the proposed action.

Table 4. Rate comparison of air emissions
[Units are pounds of emissions per MWh]

| Pollutant | Existing plant[a] | Proposed IGCC | Existing plus proposed plant |
|---|---|---|---|
| Sulfur dioxide | 34 | 5 | 28 |
| Nitrogen oxides | 17 | 5 | 15 |
| Particulate matter | 0.6 | 0.3 | 0.5 |
| Carbon dioxide | 2530 | 1780 | 2360 |

[a]The existing plant consists of all facilities at the CWL&P site. Data are based on actual plant history.

### 3.1.3.5 Construction activities

The 2-year construction effort is tentatively slated to begin in early 1993. The IGCC Repowering Project is planned to operate for about 20 years. The proposed action covers the first 5 years, i.e., the DOE-assisted operation for demonstration purposes. The remaining 15 years would be commercial operation continued independently of DOE. IGCC system startup is planned for mid-1995.

### 3.1.3.6 Resource requirements

**Fuel.** At a 65% capacity factor, the IGCC would use about 174,000 tons of Illinois No. 5 coal per year in addition to the 850,000 tons per year for the current Dallman and Lakeside plants (Table 1). The IGCC would primarily use the same Illinois No. 5 coal used at the existing plants, delivered by truck from an underground mine located 20 miles away, although four or five other coal types also would be tested during the demonstration period. These coal tests, typically 2 weeks in length, would be conducted to obtain process performance data when operating with coal types that represent the varied U.S. coal reserves. Examples of candidate coals are Pittsburgh No. 8 (eastern bituminous), Texas Lignite (southwestern lignites), and Wyoming coal (western sub-bituminous). DOE will review the test plans to ensure that no state or federal regulation is violated by the tests. An extension of the existing on-site natural gas pipeline to the new gas turbine would provide a backup fuel for the turbine. Natural gas would also be used occasionally for supplemental steam generator firing during peaking periods; use of natural gas during peaking periods has been estimated to be about 50,000 $ft^3/h$ supplied through existing lines.

**Process Materials.** Process chemicals and consumables include the gas cleanup sorbents, replacement catalyst for the Claus unit, and chlorine-based water treatment chemicals. About 94 tons per year of zinc ferrite pellets would be used for the hot gas sulfur-removal process, while less than 0.5 tons per year of *N*-methyl diethanolamine, the regenerable liquid sorbent for the conventional desulfurization system, would be used. Approximately 12,000 $yd^3$ of limestone would be required during a 2-month demonstration of the limestone injection system. Favorable demonstration of this system could lead to 15 years of continued use of limestone for the IGCC following the 5-year demonstration period. Limestone would be obtained from the same commercial source that currently supplies Dallman Station; zinc ferrite pellets and catalyst would be obtained from established suppliers (the specific source depends on technology requirements and cost); and water treatment chemicals would continue to be obtained from current CWL&P suppliers.

**Water.** IGCC operations would increase water usage at the CWL&P site. As indicated in Table 1, the IGCC would use an additional 5,500 million gal of cooling water per year, produce about 108 million gal of wastewater per year, and the IGCC system would evaporate and consume about 67 million gal of water per year in chemical reactions. The CWL&P site currently uses about 99,000 million gal of cooling water per year and discharges about 1,200 million gal of wastewater per year.

**Energy.** The IGCC would require 5 to 7 MW of auxiliary power under maximum load, which would be drawn from the power generated by plant operation.

**Land.** The IGCC would occupy about 0.6 acre on the CWL&P site next to the Lakeside building for equipment and for coal storage. The existing adjacent 40-acre ash ponds would be used for disposal of the project's slag waste. By-product elemental sulfur would be stored on-site until it is shipped or purchased. No previously undisturbed area would be affected.

**Labor.** The construction labor requirement for the IGCC has been roughly estimated to be 650,000 manhours (160 full-time workers for 2 years). About 80% of labor needs would be met from the regionally available labor pool. The remaining 20% would be met by contractor specialists assigned to the IGCC project. Current operations would not be curtailed during construction. Operations would require a permanent staff increase of 41 persons—an 18% increase for CWL&P power plant operations.

**Construction materials.** Steel, concrete, and equipment for the facility would be procured locally or regionally when possible. Custom process equipment would be largely fabricated in C-E's Chattanooga, Tennessee, fabrication facilities or by C-E subsidiaries. It is expected that General Electric Co., in South Carolina, would supply the gas turbine. For project construction, C-E estimates that approximately 25% of required materials would be procured locally. For routine operation, over 80% of project materials would be procured locally, including local coal.

## 3.2 RELATED ACTIONS

Independent of the proposed project, CWL&P has developed and initiated a plan to remove asbestos from its Lakeside building and to upgrade transmission lines to prepare for future expansion. This plan includes a 2-year program for removing asbestos insulation associated with the antiquated equipment, which must be completed before major modifications within the Lakeside building can be initiated. Additionally, Lakeside station expansion will require that a 3.5-mile segment of off-site transmission line be upgraded from 69 to 138 kV. The line upgrade will occur within the existing corridor along the route from the CWL&P site north to the Eastdale substation. These actions would be required to meet CWL&P's needs either under the proposed project or the no action alternative.

## 3.3 ALTERNATIVES TO THE PROPOSED ACTION

The alternatives discussed in the following sections were considered through all three elements of the NEPA strategy presented in Section 1. The no action alternative was considered in the CCT Programmatic Environmental Impact Analysis (DOE/PEIA-002 September 1988) as well as in the preparation of this EA. Alternative sites and technologies available to the CCT Program were considered during the project selection process. The project-specific preselection environmental review prepared by DOE for the IGCC Repowering Project also considered alternative sites and technologies available to the offeror. Brief summaries of the alternatives are provided here.

### 3.3.1 No Action

Under the no action alternative, DOE would not provide cost-shared funding for the IGCC Repowering Project. The host utility may elect to complete the project without DOE participation, cancel the project, or seek other means to meet power generation needs. Project cancellation would not contribute to the CCT Program objective to demonstrate the economic feasibility and environmental acceptability of improved technologies developed to use coal as an energy resource.

### 3.3.2 Delayed Action

Delaying the installation and operation of the proposed project would delay the availability of demonstration data on IGCC technology applicable to potential large-scale or commercial use. Such a delay would retard the commercial application of the technology by other utilities, would not be consistent with the schedule of demonstrations defined by the CCT Program, and would not contribute to the accomplishment of the objectives of the program as defined by Congress.

### 3.3.3 Alternative Sites

In its selection of proposals for funding by the CCT Program, DOE considered the technical and environmental merit of the proposals and did not define area limits for the location of the proposed demonstrations. Therefore, DOE received proposals for projects located across the United States. The C-E proposal to demonstrate the IGCC Repowering

Project with CWL&P acting as the host utility was selected. In its selection process, DOE prepared a preselection environmental review based on project-specific environmental data and analyses that proposers supplied as part of each proposal. This review, developed for internal DOE use only, included a discussion of the advantages and disadvantages of the proposed and alternative sites reasonably available to each offeror. No other alternative sites are currently being considered. Because DOE has considered these alternative sites in its preselection review, they will not be addressed again in this EA.

### 3.3.4 Alternative Technologies

Other commercially available technologies could be used at the CWL&P facilities, but these technologies would not provide the information to be gained by demonstration of the proposed IGCC Repowering Project. The proposed process was selected because of its potential application in reducing $SO_2$ and $NO_x$ emissions of commercial-scale power stations. The preselection environmental review developed by DOE for internal use during the selection process included a discussion of the advantages and disadvantages of the proposed and alternative technologies reasonably available to each offeror. Alternative technologies were considered by DOE and selected for demonstration at other locations. Site-specific analyses of alternative technologies are provided in NEPA documents prepared by DOE for other CCT projects. Programmatic analyses of alternative technologies are provided in the PEIA prepared by DOE for the ICCT Program and also in the PEIS published by DOE in November 1989 (see Section 1).

# 4. ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION AND THE NO ACTION ALTERNATIVE

## 4.1 THE PROPOSED ACTION

### 4.1.1 Air Quality

As indicated in Table 1, the proposed project would result in increases in air emissions of $CO_2$ (20%, from 1,850,000 to 2,220,845 tons per year), $SO_2$ (4.5%, from 24,800 to 25,916 tons per year), $NO_x$ (8.5%, from 12,800 to 13,888 tons per year), sulfuric acid mist (5.3%, from 265 to 279 tons per year), and particulate matter (13%, from 414 to 468 tons per year). However, the air quality analysis conservatively assumed permitted emission rates at 100% capacity factor for the existing plant, and the maximum rate (79 MW, gross) at 100% capacity factor for the IGCC. Table 5 displays the air emissions used in the analysis.

**Table 5. Air emissions used in the analysis for the existing and proposed CWL&P facilities**

| Air emissions | Existing plant[a] | Proposed IGCC[b] | Proposed plant[c] |
|---|---|---|---|
| Sulfur dioxide, tons/year | 69,300 | 1,717 | 71,017 |
| Nitrogen oxides, tons/year | 34,900 | 1,674 | 36,574 |
| Particulate matter, tons/year | 1,123 | 83 | 1,206 |

[a]The existing plant consists of all facilities at the CWL&P site. Air emissions are based on permitted emission rates at 100% capacity factor.

[b]Based on the maximum rate (79 MW, gross) at 100% capacity factor for the IGCC.

[c]The proposed plant consists of the IGCC plus the existing plant.

Current National Ambient Air Quality Standards (NAAQS) that govern criteria pollutants include standards for particulate matter less than 10 microns in diameter ($PM_{10}$), $SO_2$, nitrogen dioxide ($NO_2$), carbon monoxide (CO), ozone ($O_3$), and lead. Illinois has adopted the NAAQS and, in addition, retains earlier (before July 31, 1987) NAAQS standards for total suspended particulate matter (TSP) as standards for the State. For this analysis, all $NO_x$ emissions are conservatively assumed to be in the form of $NO_2$ for comparison with the $NO_2$ standard. The Lakeside II power plant is located in Capital Township, a part of Sangamon County within Air Quality Control Region 75 (West Central Illinois Intrastate). Sangamon County, including Capital Township, is in attainment for all criteria pollutants.

Because of the small size of the disturbed area, the presence of pavement over much of the surrounding area, and the implementation of dust-suppression measures (e.g., sprinkling during dry periods), the levels of particulate matter resulting from construction activity are expected to be insignificant. Increased vehicle exhaust emissions during construction would be negligibly small compared to existing levels.

Potential operational impacts of air emissions were modeled and evaluated for three criteria pollutants ($SO_2$, $NO_2$, and $PM_{10}$) and TSP by comparing maximum ground-level concentrations from specific sources predicted by the EPA-recommended Industrial Source Complex Short-term model (EPA, 1987) with NAAQS and with allowable Prevention of Significant Deterioration (PSD) increments (Tables 5 and 6, respectively). The PSD increments limit the degradation of ambient air quality, and the NAAQS set an absolute limit for pollutant concentrations in the ambient air to protect human health and the environment. Thus, the comparisons were used as yardsticks to measure the IGCC's potential to affect human health and the environment. All sources within 30 miles with the potential to contribute appreciably to concentrations near the CWL&P site were included.

For comparisons with NAAQS, modeled concentrations included sources at the CWL&P site, the Capitol power plant in Springfield, and the Kincaid Generating Station in Kincaid, Illinois. The modeled concentrations were added to measured background concentrations from distant sites that are not appreciably affected by nearby pollution sources to obtain total existing and proposed concentrations near the CWL&P site. Table 6 indicates that both existing and proposed concentrations are less than NAAQS, with the exception of TSP. Existing and proposed concentrations of TSP and $PM_{10}$ are elevated, especially near the site boundaries, due to active coal piles (where coal is delivered and withdrawn). Because coal pile emissions are primarily large particles (greater than 10 microns) that are quickly deposited back to the ground from the ground level sources, TSP concentrations are expected to decline rapidly with distance; indeed, 3 miles from the site the highest 24-h TSP concentration measured in 1988 was 138 $\mu g/m^3$ (IEPA, 1989), below the TSP standard of 150 $\mu g/m^3$.

The proposed project would be the only source within 30 miles for which PSD requirements are applicable. Table 7 displays the maximum additional concentrations of air pollutants due to the addition of the IGCC. Table 7 indicates that the proposed plant would result in minor increases in concentrations of $SO_2$, $NO_2$, $PM_{10}$, and TSP. The modeled pollutant concentrations due to the proposed source are less than 25% of the allowable PSD increments in all cases, except for the 24-h-average concentrations of $SO_2$ (44% of the PSD increment). The nearest Class I PSD area is the Mingo Wilderness area in the southeastern corner of Missouri, about 185 miles south-southwest of Springfield, Illinois. Effects on ambient air quality there would be negligible because of the large distance between that area and the proposed project and because the wilderness area is generally upwind of the proposed project.

The effects of CO and lead emissions on ambient air concentrations are expected to be negligible compared to the concentrations allowed under the NAAQS (10,000 $\mu g/m^3$ for an 8-h period and 40,000 $\mu g/m^3$ for a 1-h period, for CO; 1.5 $\mu g/m^3$ for a calendar quarter, for lead). Only trace amounts of lead (about 30 ppm) are found in Illinois coal (Dvorak, 1977). CO is generated by oxidation of the carbon in the coal. Because of atmospheric dilution on the order of at least 1:10,000, ambient ground-level concentrations would be much less than NAAQS. The remaining criteria pollutant, $O_3$, is formed by complex photochemical reactions involving hydrocarbons and $NO_x$. Contributions of the proposed action to $O_3$ concentrations cannot be quantified. Increases in noncriteria pollutants are expected to be minor or negligible. Increases in fugitive road dust and exhaust emissions from five additional truck trips per hour during operations would be minor.

Emissions of $SO_2$ and $NO_x$ can lead to acidic deposition (precipitation and dry deposition). $NO_x$ emissions can also lead to increases in $O_3$ concentrations in the lower atmosphere. Because these processes occur at the regional scale, it is appropriate to compare

Table 6. Comparison of maximum existing and proposed concentrations of air pollutants with NAAQS[a]

| Pollutant | Averaging time | Background (monitored data) | Existing sources (modeled)[b] | Proposed plant (modeled)[c] | Existing conc. (incl. background) | Proposed conc. (incl. background) | NAAQS |
|---|---|---|---|---|---|---|---|
| $SO_2$ | 3-hour | 265 | 878 | 905 | 1143 | 1170 | 1300[d] |
| | 24-hour | 92 | 165 | 173 | 257 | 265 | 365[d] |
| | annual | 13 | 13 | 14 | 26 | 27 | 80 |
| $NO_2$ | annual | 26 | 6 | 7 | 32 | 33 | 100 |
| $PM_{10}$ | 24-hour | 72 | 73[e] | 74[e] | 145 | 146 | 150[d] |
| | annual | 23 | 8[f] | 8[f] | 31 | 31 | 50 |
| TSP | 24-hour | 122 | 243[g] | 245[g] | 365 | 367 | 150[d,h] |
| | annual | 41 | 27[i] | 27[i] | 68 | 68 | 60[h] |

[a]Units are $\mu g/m^3$. Based on permitted emission rates at 100% capacity factor for the existing plant, and the maximum rate (79 MW, gross) at 100% capacity factor for the IGCC.

[b]Existing sources consist of all facilities at the CWL&P site, the Capitol power plant in Springfield, Illinois, and the Kincaid generating station in Kincaid, Illinois.

[c]The proposed plant consists of the IGCC plus existing sources.

[d]Not to be exceeded more than once per year.

[e]Most of the modeled $PM_{10}$ is from active coal piles (69 $\mu g/m^3$).

[f]Almost all of the modeled $PM_{10}$ is from active coal piles (8 $\mu g/m^3$).

[g]Most of the modeled TSP is from active coal piles (230 $\mu g/m^3$).

[h]In 1987, TSP standards were replaced by $PM_{10}$ standards in the NAAQS, but Illinois retains TSP standards.

[i]Almost all of the modeled TSP is from active coal piles (27 $\mu g/m^3$).

**Table 7. Comparison of maximum additional concentrations of air pollutants due to the IGCC with allowable PSD increments[a]**

| Pollutant | Averaging time | IGCC | Allowable PSD increments |
|---|---|---|---|
| $SO_2$ | 3-hour | 94 | 512 |
| | 24-hour | 40 | 91 |
| | annual | 3 | 20 |
| $NO_2$ | annual | 3 | 25 |
| $PM_{10}$ | 24-hour | 2 | 30 |
| | annual | 0.1 | 17 |
| TSP | 24-hour | 2 | 37 |
| | annual | 0.1 | 19 |

[a]Units are $\mu g/m^3$. Based on the maximum rate (79 MW, gross) at 100% capacity factor.

the effects of the proposed project with $SO_2$ and $NO_x$ emissions at the same scale. The proposed project would increase $SO_2$ emissions in Illinois by 0.14% and increase $NO_x$ emissions by 0.17% (EPA, 1988).

Chlorofluorocarbons (CFCs) and $CO_2$ are of concern on the global scale. CFCs destroy stratospheric $O_3$ that protects people from the sun's ultraviolet radiation. Carbon dioxide and CFCs are contributors to the "greenhouse effect." No CFCs would be used or produced by the proposed facility. The only CFC emissions associated with the facility are those that result from incidental leaks from building and vehicle air conditioning systems. The proposed project is expected to add about 370,000 tons of $CO_2$ per year to the atmosphere. The IGCC's rate of $CO_2$ generation per megawatt-hour is about 70% that of the existing CWL&P facilities (which use conventional pulverized coal combustion) (Table 4). A conventional pulverized coal plant with scrubbers to meet current $SO_2$ emission limits would produce about 8% more $CO_2$ per megawatt-hour than the proposed IGCC system.

Four existing air permits have been issued to CWL&P by IEPA. These include operating permits for Lakeside II, Dallman Unit 31, Dallman Unit 32, and Dallman Unit 33, which is designated a new source under the NSPS and includes an FGD system. The required air emissions permit for the proposed project is a PSD review by IEPA, as a major source modification, pursuant to the Clean Air Act.

### 4.1.2 Surface Waters

Historical sources of pollution to Lake Springfield include agricultural runoff, sedimentation, acidic coal-mine wastes, and discharges from sewage treatment facilities. Water quality data for the 4,224-acre lake show the presence of nutrient enriched conditions throughout the lake. Strong thermal stratification is usually evident in the deeper, lower end of Lake Springfield near Spaulding Dam only during the warmest period of the year (July), while upstream of Lindsay Bridge (located about 12,300 ft upstream of Spaulding Dam), strong stratification is usually not evident (Beck, 1984). Dissolved oxygen concentrations show much stronger evidence of stratification during the summer. Near the dam, oxygen concentrations at the surface may drop below 5 mg/L, and the bottom may become anoxic (C-E Environmental, 1989).

Cooling water discharges from the Lakeside and Dallman power plants elevate surface temperatures on Lake Springfield. Between July 1979 and September 1983, the temperature of cooling water for the Lakeside plant increased an average of 8.6°F between inlet and outlet (Beck, 1984); the range of mean monthly temperature increases was 0-20.2°F. During the same time period, the temperature of cooling water for the Dallman plant increased an average of 14.9°F; the range of mean monthly temperature increases was 6.8-23.4°F. Plant capacity factors during this time period for Lakeside and Dallman ranged from about 8 to 52% and 27 to 55%, respectively. More recently, the average increase at the outfalls for the existing CWL&P facilities with a 40% capacity factor has been estimated at 5.3°F (Sargent & Lundy, 1990). In July 1976, the thermal plumes from the Lakeside and Dallman plants were estimated to be about 24 acres and 43 acres, respectively, at which time the respective plants were operating at about 50% and 70% of their total capacity (Betz Environmental Engineering, 1977). During this same time, temperature increases of 3.6-9.9°F were observed at Spaulding Dam. These data demonstrate that, although the mixing zones for these two facilities were rather small (less than 3% and 6% of Lake Springfield north of Lindsay Bridge for Lakeside and Dallman, respectively), the extent of their influence on surface temperatures can be considerable (approximate distances from the Lakeside and Dallman cooling water outfalls to Spaulding Dam are 1,700 ft and 5,000 ft, respectively). More recent data on the thermal mixing zone are not available, but Sargent & Lundy (1990) recently estimated that the depth of the heated layer at the existing facility is about 4 ft.

Below the Spaulding Dam spillway, Dallman and Lakeside power stations discharge effluents into Sugar Creek from two NPDES-permitted outfalls. The first of these (outfall 003/010) is the storm sewer outfall and the discharge point for the Dallman intake screen backwash, located just below the dam. The other outfall (004) is the ash pond outfall, about 1000 ft downstream of the dam. Stream flow below the dam usually remains above 4.6 ft$^3$/s, but during periods of low flow, the only source of water immediately downstream of the dam is from CWL&P discharges. Table 2 characterizes the water quality at each of the 12 wastewater outfalls for the CWL&P facilities. For Sugar Creek, in the vicinity of the outfalls and ash ponds, the water quality during high flow periods is expected to be similar to that of Lake Springfield, but the water quality during low flow periods will essentially be that of the outfalls combined with the subsurface flows from the waste disposal areas. Further downstream, other tributaries empty into the creek, and approximately 2 miles downstream from the dam, the creek receives treated discharges from the Springfield Sanitary District wastewater treatment plant. Table 8 characterizes the water quality of Sugar Creek at a station 2.9 miles downstream of Lake Springfield. Because of the lack of water quality data for Sugar Creek in the vicinity of the CWL&P facilities, the limited nature of the water quality data for the monitored outfalls, and the influence of other factors (e.g., wastewater

**Table 8. Selected water quality parameters for Sugar Creek at a USGS hydrologic station located 2.9 miles downstream of Lake Springfield for water year 1989 (November 1988 through September 1989). Unless otherwise noted, units are in mg/L. (*Source*: USGS 1990).**

| Parameter | Mean | Range | Standard[a] |
|---|---|---|---|
| pH | 8.0 | 7.4 - 8.4 | 6.5 - 9.0 |
| Flow rate (cfs) | 60.0 | 4.6 - 159.0 | None |
| Dissolved oxygen | 8.9 | 4.0 - 15.0 | 6.0[b] |
| Alkalinity[c,d] | - | 116 - 152 | None |
| Hardness[d] | 385.0 | 274 - 448 | None |
| Conductivity[e] | 927.0 | 640 - 1447 | None |
| Ammonia nitrogen | 0.15 | <0.1 - 0.23 | 1.5/15 |
| Nitrate + nitrite | 0.64 | <0.1 - 2.1 | None |
| Chemical oxygen demand | 16.0 | 11 - 21 | None |
| Total organic carbon | 6.9 | 5.9 - 8.3 | None |
| Total suspended solids | 24.0 | 6 - 46 | None |
| Volatile suspended solids | 6.0 | 1 - 24 | None |
| Phosphorus, total | 0.09 | 0.05 - 0.13 | 0.05 |
| Copper, total | <0.005 | <0.005 - 0.006 | 0.02 |
| Iron, total | 1.06 | 0.42 - 1.97 | 1.0 |
| Oil and grease | 1.0 | <1 - 1 | 20.0[f] |

[a]Illinois Environmental Protection Agency general use standards (C-E Environmental 1989).
[b]Not less than 6.0 mg/L during at least 16 h of any 24-h period, nor less than 5.0 mg/L at any time.
[c]Values are for one-time measurements of methyl orange alkalinity taken at one site just below the outfall of Spaulding Dam and at one site just below the outfall of the ash pond discharge. Source: Betz Environmental Engineering 1975.
[d]mg/L, as $CaCO_3$.
[e]$\mu$S/cm.
[f]Daily maximum CWL&P NPDES discharge standard for all applicable outfalls at the Lakeside/Dallman Station site. The 30-day average specified on the permit is 15 mg/L (C-E Environmental 1989).

treatment facility, tributaries) to the stream's water quality upstream of this USGS monitoring station, it is not possible to ascertain the influence of CWL&P operations on the water quality of Sugar Creek.

During construction of the proposed IGCC project, no surface water impacts are expected. Any runoff from the construction site would enter the existing storm drainage system and would be treated prior to discharge from existing NPDES-permitted outfalls.

Several wastewater streams would be generated during IGCC operation. During all modes of operation, the IGCC would discharge steam-cycle cooling water and steam drum blowdown. About 5,500 million gal/year of steam-cycle cooling water would be used (Table 1); the steam drum blowdown would amount to about 6 million gal/year. Ash and slag sluice water would also be added to the current sluice water during all modes of IGCC operation. This additional sluice water would be at its highest level, about 13,000 gal/h (70 million gal/year), during the 2-month demonstration of the in-bed limestone-sorbent injection desulfurization system. The back-up conventional low-temperature desulfurization system would produce about 27 million gal/year of gas cleanup condensate water that would be sent to the wastewater treatment plant and about 1 million gal/year of non-contact cooling water blowdown that may be discharged with little or no treatment. The high temperature desulfurization system is expected to involve smaller wastewater discharges than either of the other desulfurization systems. Up to 67 million gal of water per year would be consumed in the gasifier or evaporated by the IGCC system (Table 1) and therefore would not be returned directly to either Lake Springfield or Sugar Creek.

Intermittent stormwater runoff from areas of new or upgraded facilities associated with the project would be directed—as is done currently—to the Lakeside coal pile runoff pond, where runoff is monitored before discharge to the lake via the existing NPDES outfall No. 008. As shown in Table 2, outfall No. 008 is a minor contributor to wastewater discharges to Lake Springfield. The volume of stormwater runoff would not be measurably affected by the project because only a small area (about 0.12 acre) would be covered by a new building as a result of project activities and runoff patterns would not be appreciably changed.

Effluents resulting from operation of the IGCC would be discharged from existing NPDES-permitted outfalls or the Springfield Sanitary District wastewater treatment facility. The concentrations of pollutants at the outfalls (Table 2) are expected to remain about the same. However, small changes in the water quality of Sugar Creek and Lake Springfield would be expected because the volume of treated wastewaters discharged would increase by about 10%. These water quality changes would be restricted to small areas because the increases in wastewater discharges to Lake Springfield and Sugar Creek are relatively small: cooling water discharge to Lake Springfield would increase by about 5.5% from 99,000 to 104,500 million gal/year, and wastewater discharges to Sugar Creek would increase about 9% from 1,200 to 1,308 million gal/year (Table 1).

As shown in Table 1, the increased discharge is expected to result in an average temperature rise at the outfall of about 0.1°F (Sargent & Lundy, 1990). This increase is small compared with the 5.3°F average increase at the outfalls for the existing CWL&P facilities (Table 1). Correspondingly, the areal extent of the Lakeside thermal plume is expected to increase by a small amount. The proposed project is expected to increase the depth of the heated layer by less than 0.5 ft from its existing depth of 4 ft (Sargent & Lundy, 1990). Because water temperature influences the concentration of oxygen in water, the small increase in temperature may cause a negligible reduction in the dissolved oxygen concentration in the thermal mixing zone.

CWL&P is currently authorized by IEPA to discharge effluents to Sugar Creek and Lake Springfield under conditions specified by NPDES Permit No. IL0024767. Increased discharges from the IGCC would employ existing outfall pipes or the municipal sanitary sewer. The nature and quality of the effluent would be the same as prior to the proposed action. However, because the volume of the treated wastewater discharge would increase by 108 million gallons/year (from the present 1200 million gallons/year to 1308 million gallons/year, i.e., nine percent), a modification to the existing NPDES permit probably would be required. The proposed project would comply with the amended NPDES permit limits.

### 4.1.3 Groundwater

Groundwater resources in Sangamon County are found in both overburden and bedrock aquifers. Several low-yield water wells in both overburden and bedrock aquifers lie within 2 miles of CWL&P's solid waste disposal sites. Most of these wells are domestic farm wells that produce from thin (<15 ft thick) and discontinuous sand and gravel lenses in Pleistocene glacial till (overburden aquifers) or Pennsylvanian age sandstone, fractured shale and limestone (bedrock aquifers). None of these wells is capable of producing groundwater at rates sufficient to develop a municipal water supply source. The nearest high yield groundwater source capable of sustaining a municipal water supply is 4 miles away.

Groundwater in the overburden surrounding CWL&P's solid waste disposal sites has been characterized and monitored. Overburden strata and near surface bedrock strata have generally low hydraulic conductivities. The overburden consists mainly of clayey to sandy silt. The former channel of Sugar Creek which underlies the waste sites is richer in fine sand. Sugar Creek was diverted to the west prior to construction of the Dallman fly ash pond in 1976. In general, water soluble materials placed in the unlined waste sites can be expected to migrate through the earthen fill around the sites until they reach Sugar Creek.

Groundwater quality in the vicinity of the CWL&P solid waste disposal sites is generally good. However, one well, located between Sugar Creek and the north side of the waste disposal sites, detected high levels of sulfates. It is not clear whether this well identified an area of groundwater contamination or was a poorly installed monitoring well. If contamination occurred, the most likely source was the nearly-filled solid waste disposal site to the south. The elevated sulfate levels have recently disappeared, perhaps as a result of dewatering other empty solid waste disposal sites to the south. The possibility that the high sulfate levels were caused by a poorly installed monitoring well is supported by data from a replacement monitoring well indicating normal sulfate levels. The sulfates may have been introduced to the original well via a faulty well seal that allowed surface water with high sulfate levels to enter the well. The original well has been sealed and capped.

The proposed project should not exacerbate existing groundwater contamination (if any actually exists). The only storage or disposal of by-products or wastes from the project are the disposal of slag in the Dallman fly ash pond and possible temporary storage of elemental sulfur. Neither is expected to negatively impact groundwater.

There may be up to a 50% increase in the rate of disposal in the fly ash pond. However, because the IGCC system waste is a vitrified slag that is less leachable than conventional fly ash, no appreciable increase in leachates in the groundwater beneath the unlined ash pond is expected. The vitrified slag is less leachable than fly ash because it is fused into larger particles and has less surface area exposed for leaching. A supplemental permit would address adding a maximum of 11,300 $yd^3$/year of vitrified slag to the Dallman fly ash pond for 5 years. The IEPA (Land Division) is the responsible permitting agency. Initial discussions with the IEPA have not indicated any problems. Because the water level of the ponds is above the water level of the creek, most of the groundwater from the solid waste disposal sites ends up in nearby Sugar Creek as base flow rather than migrating to off-site groundwater resources. Consequently, off-site groundwater impacts to low-yield water wells within 2 miles are expected to be negligible. Because the nearest high yield groundwater source capable of sustaining a municipal water supply is 4 miles away, it would not be affected by the proposed project. The current effects of groundwater from the waste disposal sites on Sugar Creek are unknown, but the proposed IGCC system would not appreciably increase or decrease any effects that might exist because the vitrified slag it produces is less leachable than the finely divided fly ash previously produced at Lakeside II.

### 4.1.4 Land Use and Solid Waste Disposal

The CWL&P site is located immediately southeast of Springfield, in Sangamon County, Illinois, a land area developed for agricultural and commercial purposes. Existing land use around the CWL&P site would not be affected by the IGCC because all construction and operations would occur on the CWL&P site itself.

Solid wastes generated by the IGCC would consist of zinc ferrite sorbent fines, unsalable elemental sulfur, and two types of gasifier slag (with and without in-bed sorbent). Because of the high zinc content, the fines are expected to be recycled to the sorbent producer. Elemental sulfur would be produced as a salable by-product (Section 3.1.3.2). If contracts are not secured to sell these potential waste materials as by-products, the zinc ferrite fines and sulfur would be disposed of in appropriate, licensed off-site disposal facilities.

The project would generate 3 $yd^3/h$ of a hard, dense, glassy material (termed vitrified slag) that would be slurried to the Dallman fly ash pond and mixed with fly ash from the Dallman Units 31 and 32. As indicated in Table 1, the IGCC is expected to generate about 11,000 $yd^3$ of slag (ash) per year. By comparison, the Lakeside and Dallman units produce about 56,000 $yd^3$/year. Assuming none of the fly ash is sold for use in construction or other industries, the Dallman fly ash pond would reach its capacity in 5 years at the current rate of filling (by the end of 1996). By adding vitrified slag from the IGCC to the waste stream, the operating life of Dallman fly ash pond would be reduced by 32%, assuming none of this waste were sold.

CWL&P anticipates extending the life of the fly ash pond by aggressive marketing of fly ash for construction and other uses. Some of CWL&P's fly ash output is currently being reclaimed by a private contractor. CWL&P plans to develop an aggressive marketing strategy to reclaim more of the slag as a beneficial product. A recent report presents encouraging information, noting slag reuse for road construction material and aggregate as particularly promising (Praxis Engineers, 1987). Should reclamation and sale of the slag prove unacceptable or insufficient to alleviate the capacity problem of the Dallman ash pond, ultimate disposal of dewatered slag in an off-site licensed commercial disposal facility is an alternative. The Christian County Landfill, about 25 miles east of the CWL&P site, is licensed to accept numerous types of waste materials including that resulting from power generation. This landfill has sufficient capacity to accept the slag resulting from the IGCC project. Another alternative that CWL&P is exploring is transporting the slag to worked coal mines, particularly surface mines, for burial. The IEPA Land Division is the responsible permitting agency for disposal of solid wastes.

Lakeside's boilers and piping are insulated by asbestos insulation. The asbestos waste produced from removing asbestos insulation during construction of the IGCC would be disposed of either in the off-site landfill currently used by CWL&P for asbestos disposal or in an approved landfill selected by the contractor that removes the insulation. Asbestos removal would be required regardless of the proposed project and would proceed in compliance with all applicable regulations. The exact amount of asbestos that needs to be removed is not yet known. Other construction wastes are nonhazardous and would be disposed of in an off-site landfill.

#### 4.1.5 Floodplains and Wetlands

No new facilities would be built in floodplains. However, part of the existing waste ponds, which would receive slag from the project, are located within the 100-year flood zone of Sugar Creek. The waste ponds are bermed 8 to 10 ft above the calculated 100-year flood elevation. These waste ponds have been classified as artificial wetlands by the Illinois Department of Conservation (IDOC, 1988) for the U.S. Fish and Wildlife Service (FWS). With the exception of algae, these waste ponds do not support aquatic life.

A floodplains/wetlands notice for the proposed project was published in the *Federal Register* (Vol. 55, No. 152, p. 32126. August 7, 1990). No comments were received.

#### 4.1.6 Ecology

##### 4.1.6.1 Terrestrial ecology

The CWL&P site is located in an area of mixed industrial, agricultural, and residential development. Terrestrial habitats in the vicinity of the plant include vestigial riparian woodlands, croplands, artificial grasslands and savannahs (suburban lawns, pasture, and parks), and weedy herbaceous and shrubby vegetation in disturbed areas. Construction of the proposed facility would result in no direct destruction of terrestrial communities. The IGCC would be built on the existing site; wastes would be stored or disposed of in an existing waste facility; the upgraded electrical transmission lines would be strung in an existing corridor that need not be expanded; and the coal would be delivered by truck from the same underground mine, located 20 miles away, that currently supplies coal to the CWL&P facilities.

As indicated in Table 6, the addition of the IGCC would result in small increases in concentrations of $SO_2$, $NO_2$, $PM_{10}$, and TSP. Therefore, the proposed project would not cause appreciable damage to local plants from air pollution. Changes to regional and global terrestrial ecosystems caused by acid deposition and greenhouse gases are expected to be negligible.

##### 4.1.6.2 Aquatic ecology

Aquatic habitat would not be altered and surface water impacts are not anticipated during the construction phase of the IGCC; therefore, no impacts to aquatic biota are expected during construction. The potential for aquatic impacts during operation is discussed below.

Results from several studies of the aquatic biota of Lake Springfield indicate that the overriding factors influencing composition and structure of the biotic communities are sedimentation and eutrophication (Hinsman and Skelly, 1987). Sedimentation has contributed to the loss of habitat in Lake Springfield, particularly in the headwater reaches, while eutrophication is probably the most important factor contributing to the reductions in dissolved oxygen concentrations, most notably near the dam.

No recent studies have been conducted on the aquatic biota of Lake Springfield; most studies were performed between 1971 and 1983 when Lakeside was operating at a capacity near to or greater than the projected capacity of the IGCC (C-E Environmental, 1989;

Hinsman and Skelly, 1987). Thus, impacts to the aquatic biota are expected to be less than those associated with past operations.

Thermal effluents from Dallman generally cause seasonal reductions in the density and diversity of biota only near the heated effluents (WAPORA, 1983). Fish tend to avoid the thermal effluents during the summer by leaving the discharge cove or staying in the cove but remaining at depths below the heated waters. There appear to be only minor effects on the plankton (WAPORA, 1983). In the cooler months, fish tend to congregate in the thermal discharge area while plankton densities decline, possibly due to increased grazing from the greater numbers of fish. Because the heated effluents remain on the upper layer of the lake, the benthic invertebrate community appears to be, at most, minimally affected by thermal discharges.

Increases in temperature from operation of the demonstration project should have little direct effect on the aquatic biota of Lake Springfield. During the summer months, available habitat within the heated mixing zone may be reduced by a combination of increased temperatures, the existence of low oxygen concentrations, and the possibility of further reductions in dissolved oxygen concentrations due to increased temperature. No current estimates of the size of the mixing zone are available. Betz Environmental Engineering (1977) estimated that the Lakeside mixing zone had an area of 24 acres in 1976 when the plant had a generating capacity twice as large as Lakeside would have if the IGCC system were built. Consequently, the mixing zone of the proposed Lakeside plant with the IGCC system will be less than 0.25% of the 1,000 acres north of Lindsay Bridge.

No recent studies of impingement and entrainment at the CWL&P facilities have been conducted. However, in a 1978-79 study by CWL&P, high rates of impingement and entrainment were not observed at the Lakeside water intake structure. Because quantities of water similar to those used during the late 1970s would be used in the demonstration project, increases in impingement and entrainment above the 1978–79 levels are not expected.

Studies of the biota in Sugar Creek below Spaulding Dam have been limited to qualitative surveys of benthic macroinvertebrates and fishes, which provide no indication of the "health" of these communities in Sugar Creek.

#### 4.1.6.3 Threatened and endangered species

No Federally listed threatened or endangered species are known to occur in the vicinity of the Lakeside Generating Station, but it lies within the range of the Indiana bat (*Myotis sodalis*) and the bald eagle (*Haliaeetus leucocephalus*). No effects on species listed as endangered or threatened are expected to result from the proposed project. By a letter dated December 12, 1989, the FWS concurred with this conclusion.

### 4.1.7 Health and Safety

The proposed project would require normal construction activities. However, these activities sometimes lead to injuries or fatalities. Installation of the coal gasifier, gas turbine, and associated equipment would be covered by Occupational Safety and Health Administration (OSHA) standards (29 CFR 1910). Operation of the repowered facility would be pursuant to Illinois safety standards [Illinois has adopted OSHA regulations (29 CFR 1926)].

Lakeside's boilers and piping are insulated by asbestos insulation. Removing asbestos insulation presents hazards to workers, but special clothing would be worn and procedures followed to reduce potential hazards.

The proposed project would use a 3.5-mile section of existing transmission line that will be upgraded from 69 to 138 kV. Much scientific and public attention has been focused on potential health effects of electromagnetic fields such as those generated by electrical transmission lines. Evidence of nonthermal health effects of these electromagnetic fields continues to be inconclusive. Because the upgrade will occur within the existing corridor and is required regardless of the proposed project to satisfy CWL&P needs, it is unlikely that any transmission-line-related adverse impacts would occur as a result of the proposed project.

### 4.1.8 Social, Economic, Historic, and Archaeological Resources

With a population of 183,400 and 6% unemployment, Sangamon County's work force is dominated by government, retail trades and other services. The addition of 160 workers for construction and 40 workers for operation would be drawn primarily from local populations, and would have a negligible effect on the work force.

East Lake/Adlai Stevenson Drive connects CWL&P to the principal conduit, Interstate 55. These vehicle transportation routes are the principal conduits for commuting personnel, supplies, fuel, equipment, and solid waste transport. Transportation increases from materials, worker commuting and fuel transport would not strain existing capacities.

Water used for sanitation and boiler feedwater comes from CWL&P. Water used for non-sludge treatment such as blowdown and noncontact cooling comes from Lake Springfield adjacent to the CWL&P site. No increase in water use is expected during construction. During operation, increases in water demand for sanitation and employees would be negligible, and increases for boiler use and non-sludge treatment would not strain existing capacities.

Lake Springfield is used extensively for recreation. Recreational resources are located primarily around Lake Springfield, and have co-existed with the CWL&P site since the development of both the site and the lake in the 1930s. Present recreational and visual aesthetic configuration would be unaffected by IGCC system construction and operation. Ambient noise is generated by plant operations and highway traffic. The principal source of off-site noise is highway traffic. Increases of ambient noise levels during construction would be short term and minor. No appreciable changes in off-site noise levels would be expected due to IGCC operation.

The CWL&P site and landfill have been disturbed and developed for years and contain no historical places or archaeological sites. Consultation with the Illinois State Historic Preservation Officer (letter of November 30, 1989) confirmed that no significant historic, architectural, or archeological resources are located within the proposed project area.

### 4.1.9 Cumulative Impacts

No cumulative impacts are expected beyond those already discussed. In examining air quality impacts, all sources with the potential to contribute appreciably to concentrations near the CWL&P site were included in the analyses. For surface waters, the discussion noted historical sources of pollution to Lake Springfield, including agricultural runoff, sedimentation, acidic coal-mine wastes, and discharges from sewage treatment facilities. Cumulative impacts to local groundwater from other sources are not expected. Similarly, cumulative impacts to land, ecological, and socioeconomic resources are not anticipated. The gas reburning, sorbent injection CCT demonstration project also proposed for the CWL&P site (DOE/EA-0381) is expected to be completed by September 1993, which is prior to completion of the IGCC Repowering Project. Significant cumulative impacts are not expected to occur.

### 4.1.10 Summary of Impacts

Addition of the IGCC at the CWL&P site is expected to result in minor increases in concentrations of air pollutants. The proposed project should not exacerbate existing groundwater contamination (if any actually exists) because the only storage or disposal of by-products or wastes from the project would be the disposal of slag in the Dallman fly ash pond and possible temporary storage of elemental sulfur on site at a location above the 100-year floodplain. The volume of treated wastewaters discharged would increase, but changes in water quality would be restricted to a small area because the increase in wastewater discharge to Lake Springfield and Sugar Creek (not including the sanitary sewer discharge) is estimated to be about 10% or less. The increased discharge would result in some increase in ambient temperatures in Lake Springfield near Spaulding Dam, but thermal discharges are not expected to have deleterious effects on the aquatic ecosystem of the lake. Increases in impingement and entrainment of fish are not expected. The proposed project should not cause damage to local plants from air pollution. Construction and operational workers would be drawn primarily from local populations, and the effect on the area's work force would be negligible.

## 4.2 NO ACTION ALTERNATIVE

Under the no action alternative, DOE would not fund the proposed project. The proposed project could proceed without DOE funding or it could be canceled. If the proposed project is canceled, the impacts described herein would not occur.

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- Mr. Theodore W. Hild
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- Mr. Richard C. Nelson
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- Mr. David Kolaz
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The principal source for this EA is *Integrated Coal Gasification Combined-Cycle Demonstration Project, Lakeside Generating Station, Springfield, Illinois, Environmental Information Volume*, prepared by C-E Environmental, Inc. Portland, Maine, in December 1989. Supplemental information packages for air quality were prepared in March and October 1990, for groundwater in October 1990, and for surface water in July 1991. Full bibliographic citations for documents cited in the text are listed below:


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