DRAFT ENVIRONMENTAL IMPACT STATEMENT

MINNESOTA POWER & LIGHT COMPANY'S PROPOSED UNIT 4 CLAY BOSWELL STEAM ELECTRIC STATION

JULY, 1977

PREPARED BY

MINNESOTA POLLUTION CONTROL AGENCY

VOLUME III

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THIS DOCUMENT IS CONTAINED IN THREE VOLUMES.

VOLUME I

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CHAPTER V

PROBABLE ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION AND ALTERNATIVES

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Chapter V examines the probable adverse and beneficial impacts of MP&L's proposed Unit 4 at the Clay Boswell Steam Electric Station and of reasonable alternatives to MP&L's proposed action. The same environmental components used in Chapter IV for the description of the environmental setting provide the framework in Chapter V for determining the probable environmental impacts.

Probable impacts are presented for all environmental components except Geography. No regional, local, or site specific geographic impacts are expected due to construction and operation of MP&L's proposed Unit 4 or any reasonable alternative.

ENERGY

Energy Impacts of Proposed Action

Installation of the 500 MW proposed Unit 4 at the Clay Boswell Station will increase the total electric generating capability of the Minnesota Power and Light Company (MP&L) system to 1,760 MW. Thus, the Clay Boswell Steam Electric Station will provide 57% of the total MP&L generating capability with Unit 4 providing 29% of the total.

The revised demand illustrated in Figure IV-4 identifies a demand of 1,499 MW in the year 1980. With a total generating capability of 1,760 MW, the reserve margin (generating capability in excess of the projected demand) will be 17%. This margin is provided to cover scheduled and unscheduled outages of MP&L generating units. If Unit 4 is not operating during the year 1980, the projected shortages will be 239 MW. This electric power shortage would have to be made up by purchases of power through MP&L's agreements with other regional sources.

The construction of the proposed Unit 4 will use energy in the form of construction materials and supplies. Energy also will be used to operate construction equipment and transport personnel. No estimates have been made of this energy consumed during construction.

MP&L's proposed Unit 4 will consume an estimated average of 1,867,239 tons (1,693,931 mt) annually of sub-bituminous coal from the Big Sky Mine, near Colstrip, Montana. This coal will have an estimated heating value of 8,610 Btu per lb (4,783 kg-cal per kg). Total coal consumption during the expected life of Unit 4 is 65,353,365 tons (59,287,566 mt). Based on a unit train diesel fuel consumption of 0.0017 gal per ton mile (0.0044 liter per mt km), coal transportation will consume 2.38 million gal (9.01 million liter) annually of diesel fuel.

MP&L's proposed Unit 4, with a gross generating capacity of 554 MW, will require approximately 50 MW for auxiliary electrical requirements. The auxiliary electrical energy requirement is based on MP&L's preliminary motor list (1) and a 15% design margin for all electrical equipment at the generating facility, including all pollution control equipment. The pollution control equipment is estimated to require 7.1 MW including a 15% design margin. Thus, pollution control equipment will use 14% of the required auxiliary electrical energy or 1.3% of the gross generating capacity.

The transportation of new operating personnel from their residences to the Clay Boswell Station will consume gasoline during the entire life of the Station. The 170 new employees are estimated to travel approximately 20 miles per day to and from work at the Clay Boswell Station. Based on one person per vehicle and average gasoline consumption of 16 miles per gal (6.8 km per liter), gasoline consumption will be 55,250 gal (209,138 liters) annually or 1.9 million gal (7.2 million liters) during the 35 year expected life of Unit 4.

Energy Impacts of Alternatives

Waste Wood As Supplemental Fuel

Waste wood will replace 55,000 tons (49,895 mt) annually of sub-bituminous coal transported to the Clay Boswell Station from the Big Sky Mine. Based on a unit train diesel fuel consumption of 0.0017 gal per ton mile (0.0044 liter per mt km), utilizing waste wood would reduce train diesel fuel consumption 70,000 gal (264,971 liter) annually. However, 132,260 tons (119,984 mt) annually of waste wood will have to be transported by rail or truck from the local source to the Clay Boswell Station. Based on an average truck haul distance of 29 mi (47 km) for waste wood and a diesel fuel consumption of 0.0104 gal per ton mile (0.0270 liter per mt km), utilizing waste wood would increase truck diesel fuel consumption 39,890 gal (150,996 liter) annually. Thus, utilizing waste wood will decrease diesel fuel consumption by 30,110 gal (113,976 liter) annually.

Processing of waste wood is estimated by MP&L to require 4.2 MW or 0.8% of the total net generating capability of Unit 4 (504 MW). This requirement will be offset slightly by the reduced coal handling requirements during the times waste wood is being burned. The use of waste wood as a supplemental fuel will not change the fuel or heat input requirements of Unit 4. Although the coal saved by using waste wood will be available for other uses, the waste wood will not be available for other uses, such as those now being considered by Blandin Paper Company.

Coal Beneficiation

The use of beneficiated coal for Units 1, 2, 3, and 4 at the Clay Boswell Station will increase raw coal requirements when compared to MP&L's proposed action. This increase is due to losses during coal cleaning and coal consumption for coal drying. The estimated average raw coal required for the coal preparation plant, including drying, is 4,427,000 tons (4,016,107 mt) annually which is 8.8% greater than the 4,071,000 tons (3,693,149 mt) annually required for MP&L's proposed action. Thus, coal beneficiation will result in the mining and consumption of an additional 11 million tons (10.0 million mt) during the estimated life of the Clay Boswell Station. These estimated coal consumption data include coal for Units 1, 2, 3, and 4 as well as coal received at the Clay Boswell Station for transfer to MP&L's Laskin Station.

In addition to coal for drying, the coal preparation plant will require electrical energy for operation of coal cleaning, drying, and handling equipment. Based on processing 4,427,000 tons (4,016,107 mt) annually, the estimated energy consumption is 71 million kw hr annually. No estimate has been made for the additional energy required to increase mine production by 8.8%, but this increase is expected to be much less than the increase required for the preparation plant.

Coal beneficiation will increase average annual coal deliveries to the Clay Boswell Station by approximately 9,000 tons (8,165 mt) when compared to MP&L's proposed action. Thus, energy consumption will be slightly higher for unit train transportation for beneficiated coal than for raw coal as proposed by MP&L. Based on a unit train diesel fuel consumption of 0.0017 gal per ton mile (0.0044 liter per mt km), diesel fuel consumption will increase 11,500 gal (43,531 liter) annually. This represents a 0.2% increase in unit train diesel fuel consumption when compared to MP&L's proposed action.

The increase in coal deliveries also will increase energy requirements for coal handling. The beneficiated coal will have a lower ash and sulfur content than the raw coal, resulting in the production of lesser quantities of ash and SO_2 scrubber sludge. Thus, less energy will be required for solid waste handling when burning beneficiated coal than when burning raw coal as proposed by MP&L. These changes in energy consumption for coal and solid waste handling are not believed to be significant.

The lower ash and sulfur content of the beneficiated coal requires that the SO_2 spray tower absorbers be operated only 80% of the time as compared to 100% of the time for MP&L's proposed action. The reduction in operating time results in a slight increase of about 1 MW in the net generating capacity of the Clay Boswell Station.

Dry Cooling Towers

The use of dry cooling towers instead of MP&L's proposed wet cooling towers will decrease the net generating capability of the proposed Unit 4. This decrease occurs because the dry cooling towers will require 5 to 50 MW additional power to operate cooling tower fans and pumps. Thus, the 504 MW net generating capacity for MP&L's proposed Unit 4 would be reduced to 499 to 454 MW net generating capacity with dry cooling towers. When compared to the proposed wet cooling towers, dry cooling towers would increase the 50 MW required for auxiliary electrical power to 55 to 100 MW. These increases in electrical power requirements are based on dry cooling towers having heat rates 1 to 10% greater than MP&L's proposed wet cooling towers. The amount of energy consumption could be minimized by optimizing the dry cooling towers with special design of the power cycle, specifically the steam generator, turbine, and condenser.

The reduction in net generating capacity because of reduced generating unit efficiency due to dry cooling towers will require additional coal to be mined, transported, and consumed and cause the production of additional solid waste to achieve an equivalent electrical energy output. This increased coal consumption will result in increased consumption of diesel fuel for unit train coal transportation and of electrical energy for coal handling. The increase in solid waste production will result in increased electrical energy consumption for solid waste collection, handling, and disposal.

Wet/Dry Cooling Towers

The use of wet/dry cooling towers with 80% evaporative or wet and 20% dry instead of MP&L's proposed wet cooling towers will decrease slightly the net generating capacity of the proposed Unit 4. This slight decrease occurs because the dry portion of the cooling tower needs increased fan power. The increased fan capability will require 0.5 to 5.0 MW. Thus, the 504 MW net generating capacity for MP&L's proposed Unit 4 possibly could be reduced to 499 MW net generating capacity with wet/dry cooling towers. When compared to the proposed wet cooling towers, wet/dry cooling towers possibly could increase the 50 MW required for auxiliary power to 55 MW. These increases in electrical power requirements are based on wet/dry cooling towers having heat rates 0.1 to 1.0% greater than MP&L's proposed wet cooling towers.

The slight reduction in net generating capacity because of the slight reduction in generating unit efficiency will require additional coal to be mined, transported, and consumed and additional solid waste production for the equivalent electrical energy output. These will cause slight increases in energy consumption for coal transportation and handling and solid waste collection, handling, and disposal.

Disposal of Solid Waste in an Abandoned Mine

The disposal of solid waste in an abandoned mine will increase energy consumption for solid waste handling, processing, transport, and disposal with the major energy increase being for solid waste transport. The rail transport of the solid waste from the Clay Boswell Station to the abandoned mine will increase diesel fuel consumption. Based on a train diesel fuel consumption of 0.0025 gal per ton mile (0.0065 liter per mt km) and an average haul distance of 15 miles (24 km), 8,350 gal (31,607 liter) of diesel fuel will be required annually to transport the 222,416 tons (201,772 mt) of solid waste.

GEOLOGY

Bedrock Geology Impacts of Proposed Action

Construction of proposed Unit 4 and the proposed disposal pond for fly ash, SO_2 scrubber sludge, and bottom ash will entail excavation of the ground surface to only relatively shallow depths. Bedrock in the vicinity of the Clay Boswell Station is overlain by glacial deposits in excess of 250 ft (75 m) thick (2)(3)(4) which will therefore preclude impacts to the bedrock and any associated mineral resources.

Bedrock Geology Impacts of Alternatives

Disposal of Solid Waste in an Abandoned Mine

It is not anticipated that there will be any primary or secondary impacts on bedrock geology or associated mineral resources if exhausted iron ore mines or sections of active mines designated exhausted were to be used as alternative sites for disposal of bottom ash, fly ash, and SO_2 scrubber sludge wastes. However, this will depend on the characteristics of the particular site, and would require reevaluation once the site had been selected.

Other Alternatives

No impacts to the bedrock geology and associated mineral resources are anticipated in relation to the other alternatives to the proposed action.

Glacial Geology Impacts of Proposed Action

No regional impacts on the glacial geology are anticipated from the construction of proposed Unit 4; however, site-specific impacts are anticipated.

With varying degree, construction activities for the proposed Clay Boswell Unit 4 and respective disposal pond for waste fly ash, SO_2 scrubber sludge, and bottom ash will disturb the local natural processes of erosion, deposition, and soil formation of the glacial deposits common to the area. Clearing, excavation, and construction will affect about 17% or 620 acres (250 hectares) of the total site (5). Because the terrain is relatively flat, potential erosion and consequent adverse sedimentation in contiguous areas caused by construction and excavation should not be significant provided acceptable controls are adopted and implemented. There has been, however, erosion and sedimentation from the construction of Unit 4 in the area that has steep slopes along Blackwater Lake. Construction of the proposed disposal pond will entail the most major earth moving, with the greatest potential for local significant impact. It is expected that adverse conditions will prevail during construction of the disposal pond, and during the period before a stable vegetative cover is re-established.

Geotechnical investigations related to dike stability for the proposed Unit 4 ash and SO_2 scrubber sludge disposal pond (6) were done essentially in accordance with accepted engineering practice. These investigations indicated adequate safety factors against slope and foundation failure for the typical dike section which reportedly represents some 95% of the perimeter dike (6). Thus, there should be no stability problems with the typical dike section.

Stability analyses for the maximum height dike section, which will overlie strata of relatively weak clays on the east side of the pond, suggest that this section may have marginal stability during and immediately after construction. The relatively weak foundation clays can be expected to gain strength with time due to consolidation under the weight of the dike. Thus, dike stability will increase with time after construction, as long as there is no foundation failure during or immediately after the construction period.

The present state of the art in applied soil mechanics is such that, prior to construction, the stability of the maximum height dike section during and immediately after construction cannot be reliably determined. This is due to the unknown degree of consolidation or drainage of pore water in the foundation clay during construction. There is no reason to expect, however, that the maximum height dike section cannot be safely constructed.

To insure stability of the maximum height dike section during and immediately after construction, a program of field instrumentation and performance monitoring for the maximum height dike section could be implemented by MP&L (7). Monitoring behavior (e.g., pore water pressures and displacements) of the clay foundation beneath the maximum height dike section should provide advance warning of impending instability, if any, so that dike construction can be temporarily slowed or halted to allow consolidation to increase the strength of the foundation clay. If necessary, stage construction techniques can be employed to raise the height of this dike section in increments over an appropriate period of time.

Plans for covering the filled disposal pond have not been documented to date. It is assumed that, when the disposal ponds are full and the Clay Boswell Station is taken out of service, the ponds will be covered with local soils of the area, then vegetated. Short-term disruption of the natural processes previously mentioned will result during excavation of the cover materials and until a sufficient vegetative cover can be established. If topsoil is not replaced, revegetation will be more difficult to accomplish and erosion, sedimentation, and resultant impacts are likely to be prolonged. After vegetation is established, no impacts are expected to occur. No adverse erosion, sedimentation, and resultant impacts should be experienced during operation of the generating facilities, provided a stable terrain is established once construction is complete.

Construction of proposed Unit 4 is not expected to have any indirect regional or site-specific impacts on the glacial geology features.

Glacial Geology Impacts of Alternatives

Waste Wood as Supplemental Fuel

The use of waste wood as a supplemental fuel will result in a decrease of about 7% in solid waste production. Thus, the area of the proposed new ash and

SO_2 sludge pond can be reduced slightly. However, this decrease in disposal pond area will not alter the impacts on glacial geology when compared to MP&L's proposed new pond.

Coal Beneficiation

The burning of beneficiated coal in Units 1, 2, 3, and 4 at the Clay Boswell Station will significantly decrease solid waste production when compared to burning raw coal as proposed by MP&L. For Units 1, 2, and 3, solid waste production will decrease from 169,301 tons (153,587 mt) to 120,188 tons (109,033 mt) annually for a 29% decrease. For Unit 4, solid waste production will decrease from 228,384 tons (207,186 mt) to 144,608 tons (131,186 mt) annually for a 37% decrease. These decreases in solid waste production will significantly reduce the area and volume required for the proposed new ash and SO_2 sludge pond. The reduced pond area will require less disturbance to soils at the proposed pond site, resulting in decreased impact on the glacial geology. The reduced pond area also will permit the pond to be constructed on the more favorable soils and decrease requirements for borrow material.

Dry and Wet/Dry Cooling Towers

Dry and wet/dry cooling towers both will decrease Unit 4 efficiency. If the Clay Boswell Station is operated at the same gross generating capacity with dry or wet/dry cooling towers as with MP&L's proposed wet cooling towers, the impacts on glacial geology will not be affected by cooling tower type. However, if the Clay Boswell Station is to have the same net generating capacity with dry or wet/dry cooling towers as with MP&L's proposed wet cooling towers, the quantity of coal consumed will be increased with dry and wet/dry cooling towers and there will be a resultant increase in solid waste production. For dry cooling towers, coal consumption will increase 0.5 to 5.0%, with solid waste production increasing 1,223 to 12,232 tpy (1,109 to 11,907 mtpy). This slight increase in solid waste production will require a slightly larger disposal pond, but this increase is not expected to have any significant additional impacts on glacial geology when compared to MP&L's proposed action. For wet/dry cooling towers, coal consumption will increase 0.05 to 0.5%, with solid waste production increasing 122 to 1,223 tpy (111 to 1,109 mtpy). This slight increase in solid waste production will not cause any additional impacts on the glacial geology when compared to the impacts of MP&L's proposed action.

Disposal of Solid Waste in an Abandoned Mine

No regional impacts to glacial geology are anticipated if exhausted iron ore mines or sections of active mines designated "exhaused" were to be used as alternative disposal sites for bottom ash, fly ash, and SO_2 scrubber sludge from MP&L's proposed Unit 4.

The local natural processes of erosion, deposition, and soil formation will be disturbed to a minor extent during site preparation, improvement of existing access roads, or construction of new access roads.

As long as a particular mine is used, erosion and sedimentation will result from continual use of access roads. The road design, amount of maintenance, and erosion and sedimentation control measures taken will affect the degree of the impact.

After the inactive mine is filled, the greatest potential impact to the glacial geology of the site will concern the excavation of recommended cover materials for the completed fill. This impact should be relatively short term depending on the success of appropriate erosion and sedimentation controls used, and the time required to establish adequate vegetative cover.

When the mine is abandoned after being filled, potential adverse erosion and accompanying sedimentation may occur from unattended access roads if corrective measures are not implemented. Lack of attention to this problem could result in a long term impact to the immediate area.

No secondary or indirect impacts to the glacial geology are anticipated as a result of this alternative on either a regional or site-specific scale.

HYDROLOGY

Surface Hydrology Impacts of Proposed Action

The construction of MP&L's proposed Unit 4 at the Clay Boswell Station is not expected to have any regional or site-specific impacts on surface water in the area. Construction of Unit 4 will involve about 0.03 % of the drainage area to the Pokegama Dam, and impacts upon water quantities will be negligible.

The impacts on surface water from the operation of proposed Unit 4 will depend upon the total water consumption at the Station, and regulation of the Mississippi River flow through Pokegama Dam. The water consumption for the Clay Boswell Station is presented in Table V-1. An increase in water consumption will occur when MP&L's proposed Unit 4 becomes operational because of the water losses due to operation of the Unit 4 wet cooling tower. When Unit 4 becomes operational, the combined electric generating units at the Clay Boswell Station will consume about 16.5 cfs (0.47 cu m per sec) of water through evaporation, wind drift, seepage, and similar losses.

TABLE V-1
CONSUMPTIVE WATER USAGE RATES -
UNITS 1, 2, 3, AND 4 - CLAY BOSWELL STEAM ELECTRIC STATION

Parameter	Existing Plant[a]	Proposed Action
Intake flow		
Average		
gpm	113,000	119,250
cfs	251.7	265.7
cu m per sec	7.13	7.52
Discharge flow		
Average		
gpm	109,680	111,855
cfs	244.4	249.2
cu m per sec	6.91	7.06
Consumptive use		
Average		
gpm	3,320	7,395
cfs	7.4	16.5
cu m per sec	0.21	0.47
Consumptive use		
Extreme[b]		
gpm	3,520	8,395
cfs	7.8	18.7
cu m per sec	0.22	0.53

[a] Does not include intake from wells.

[b] Based on extreme meteorological conditions.

Ordinarily, surface water impacts are estimated for periods of critical flow. Indeed, current Minnesota State regulations define the critical low flows as "stream flows which are equal to or exceeded by 90% of the seven consecutive daily average flows of record (the lowest weekly flow with a once in 10-year recurrence interval) for the critical month" (8). The primary assumption in this definition is that the stream flow is a function of meteorological events of a random (stochastic) nature. As such, a critical low flow usually can be estimated by using meteorological records, probability, and statistics. However, in this particular instance, the stream flow is, at least in part, regulated by reservoir releases from Leech and Winnibigoshish Lakes as managed by the U. S. Army Corps of Engineers (COE). As a result, the critical low flow cannot be determined precisely and specific impacts cannot be assessed. It is clear that the location, duration, and severity of impacts will depend on how the COE manages reservoir releases.

While specific impacts cannot be assessed, it is instructive to examine some likely impacts assuming different situations. Examination of the operations manual (9) (10) for the reservoirs indicates that a total outflow from Leech and Winnibigoshish Lakes of 100 cfs (2.83 cu m per sec) may be a reasonable value to use as a critical low flow. Assuming this is the critical flow, 2 different scenarios are considered here to assess the impacts of different modes of managing the reservoirs.

In the first scenario, it is assumed that releases from upstream reservoirs are maintained to provide a minimum flow of 100 cfs (2.83 cu m per sec), without taking into consideration consumptive water losses at the Clay Boswell Station. In other words, the COE will release enough water from these two upstream reservoirs to yield 100 cfs (2.83 cu m per sec) discharge at Pokegema Dam, but will ignore the 16.5 to 18.7 cfs (0.47 to 0.53 cu m per sec) consumptive use of the Station in operation.

Under this scenario, the Clay Boswell Station will consume about 16 to 19% of the river flow and will reduce the amount of water available for downstream users to approximately 81 to 84 cfs (7.79 to 2.38 cu m per sec). This flow reduction could adversely affect the major water users downstream, including municipal and industrial water supplies at Grand Rapids, Minneapolis, St. Paul, St. Cloud, and elsewhere.

Locally, under this scenario, the operation of the Clay Boswell Station will have a minor impact on water elevations in Blackwater Lake. If Blackwater Lake is at its minimum desired stage of 6.0 ft (1.83 m) as specified in the manual of operations (2) (3), the operation of Unit 4 will decrease the Lake elevation approximately 0.23 ft (0.07 m).

Also, with an inflow of 100 cfs (2.83 cu m per sec) and a Clay Boswell Station withdrawal of 252 to 268 cfs (7.13 to 7.52 cu m per sec), a reversal of flow in Blackwater Lake will occur between the intake and discharge of the Station. This recirculation of water could cause a water temperature rise both upstream and downstream from the Station's discharge point. According to the thermal study (11), at a river low flow of 216 cfs (6.12 cu m per sec), a temperature rise of 5°F (2.8°C) will occur immediately downstream and upstream of the discharge point. Obviously, a greater increase in temperature is expected at a river low flow of 100 cfs (2.83 cu m per sec).

A second scenario also is considered. Assume under this scenario that the reservoirs are regulated to maintain 100 cfs (2.83 cu m per sec), taking into account consumptive water losses at the Station. If the outflow from Pokegama Dam is maintained at 100 cfs (2.83 cu m per sec), the effects on downstream water users will be less than for the first scenario. However, it will be necessary to increase the discharges from Leech and Winnibigoshish Lakes. The increase in discharge of 16 to 19 cfs (0.47 to 0.53 cu m per sec) will come from Leech and/or Winnibigoshish Lakes and will be consumed at the Clay Boswell Station. To release the additional flow beyond 100 cfs from Leech and Winnibigoshish Lakes, special authorization will be needed from the Minnesota DNR, and the volume of released water again will depend on the elevation of the lakes at the time of release, and the duration of the release.

Assuming authorization will be obtained to release sufficient flow from Leech and Winnibigoshish Lakes to make up the losses from the Clay Boswell Station, the resulting impacts will occur primarily in and along the lakes. It is estimated that the release of additional water from the lakes will decrease the water level approximately 0.04 ft (0.010 m) in Winnibigoshish Lake and 0.02 ft (0.07 m) in Leech Lake. While the severity of impacts will depend upon the lake elevations at the time of release and the duration of the releases, those decreases in lake water do not represent a significant impact.

Locally, the impacts to Blackwater Lake water temperature will be less than those projected in the first scenario; however, the impacts will be greater than those projected in the thermal study (11) in which the critical river flow was assumed to be 216 cfs (6.12 cu m per sec).

Another example may serve to better clarify the impacts anticipated from operation of the Clay Boswell Station as proposed by MP&L. From May to September, 1976, northern Minnesota experienced drought conditions. During May, the river discharge at Pokegama Dam reached 164 cfs (4.64 cu m per sec), the lowest flow for that water year and, the second lowest value since 1962 when the COE began regulating flow in the river. If MP&L's proposed Unit 4 at the Clay Boswell Station had been operating during the low flow period from May to September and the COE had managed the lakes as described under the first scenario, the lake level would have been about 0.37 ft (0.11 m) lower than it actually was during that low flow period. If Unit 4 had been operating during the May to September period and the COE managed the lakes under the second scenario described above, the level in Blackwater Lake would have remained the same, but the level in Winnibigoshish would have been about 0.04 ft (0.014 m) lower and the level in Leech Lake would have been about 0.03 ft (0.010 m) lower than they actually were during that low flow period.

The above illustrations are only estimates. Actual elevations will vary slightly depending on Station operation, amount of release, and lake elevation at the time of release as well as the rate and duration of release. Within the limits of these estimates, it is apparent that the consumptive use of water resulting from the operation of proposed Unit 4 at the Clay Boswell Station probably will not result in a significant impact on the levels of Blackwater, Winnibigoshish, and Leech Lakes during periods of critical low flow. However, there may be significant thermal impacts locally and significant downstream impacts, depending on how the lake system is managed, as well as other factors.

Once operations have been terminated at the Clay Boswell Station, no adverse impacts to the surface water are expected to occur.

Surface Hydrology Impacts of Alternatives

Waste Wood as Supplemental Fuel

The use of waste wood as a supplemental fuel is not expected to have any impact on surface hydrology. The affected drainage areas are relatively small at the waste wood source and at present waste wood disposal sites. A relatively small area will be required for waste wood storage at the Clay Boswell Station. Thus, the impacts on surface hydrology will be negligible.

Coal Beneficiation

Coal beneficiation is not expected to have any impact on surface hydrology in Minnesota. However, a coal preparation plant located at the Big Sky Mine, near Colstrip, Montana could have adverse impacts in Montana.

The estimated makeup water requirements for the coal preparation plant is 19 gal per ton (83 liter per mt) of raw coal. Based on design capacity, the coal preparation plant will require 436 gpm (1,650 lpm) of makeup water. Based on processing an average of 4.4 million tons (4.0 million mt) annually of raw coal, the coal preparation plant will require 82 million gal (311 million liter) annually. Possible makeup water sources include the Yellowstone River, mine drainage water, sewage effluent from Colstrip's treatment facilities, and discharge water from electric generating facilities at Colstrip. All these sources are in the drainage of the Yellowstone River. Thus, coal beneficiation at the Big Sky Mine will result in appropriations of up to 82 million gal per year (311 million liter per year) from the Yellowstone River. Presently a 30 mile (48 km) long pipeline exists between the Yellowstone River and Colstrip. This pipeline has a capacity of 8,000 gpm (30,282 lpm) and supplies water for electric generating facilities at Colstrip. If water was to be obtained directly from the Yellowstone River, sewage effluent from Colstrip, and/or the electric generating facilities at Colstrip, it will be necessary to construct a pipeline between Colstrip and the Big Sky Mine.

Dry Cooling Towers

If dry cooling towers were to be used as an alternative to the wet cooling towers proposed for Unit 4, water consumption for Unit 4 will be substantially reduced. Cooling tower makeup essentially will be eliminated except for the requirements of the small wet cooling tower required for auxiliary cooling. The water consumption for the proposed Unit 4 wet cooling tower (3,500 gpm annual average (13,249 lpm) will be reduced to an estimated 35 gpm (132 lpm) based on a 1% requirement for auxiliary cooling. In addition, blowdown from the proposed wet cooling tower will be eliminated with the dry cooling tower, except for a small auxiliary tower blowdown estimated to be 10 gpm (37.9 lpm).

With the use of dry cooling towers for Unit 4, the surface hydrology impacts will be essentially the same as for the existing Units 1, 2, and 3. Dry cooling towers essentially eliminate possible adverse impacts of MP&L's wet cooling towers on the Mississippi River.

Wet/Dry Cooling Towers

If wet/dry cooling towers were to be used as an alternative to the wet cooling towers proposed for Unit 4, water consumption for Unit 4 will be reduced. Cooling tower makeup will be reduced relative to the amount of dry cooling employed. Water consumption will be reduced to an estimated 2,800 gpm (10,599 lpm) annual average for a wet/dry tower designed to evaporate approximately 80% of that proposed for the Unit 4 wet cooling tower. In addition, blowdown from the proposed wet cooling tower will be reduced by approximately 20% to 700 gpm (2,650.7 lpm).

Disposal of Solid Waste in an Abandoned Mine

The disposal of the ash and SO_2 scrubber sludge in an abaondoned mine is expected to have negligible surface hydrology impacts. The affected drainage areas at the Clay Boswell Station and any abandoned mine disposal site will be small in relation to the total drainage basin.

Ground Water Hydrology Impacts of Proposed Action

The Clay Boswell Station site is essentially a peninsula in Blackwater Lake and the Mississippi River. Both shallow (perched) and deep (glacial outwash) ground water systems at the Station site are, for all practical purposes, governed by dam-controlled water levels in the adjacent lake and river. Plans for construction and operation (12) of Unit 4 are such that it is expected that there will be no significant impacts (if indeed there will be any impacts at all) on either of these ground water systems. To the extent that operating equipment containing PCB materials is stored on site, provision for spill prevention should be provided. If a spill occurred and was not recovered, even small amounts of PCB's may have substantial long term impacts. The disposal of PCB's and associated equipment should be carefully controlled and disposed in an appropriate manner. No plans are presently available for ultimate abandonment of the generating facility. If the facility is to be abandoned at some future time in a manner consistent with good engineering and environmental practice (as such practice is understood at present), abandonment should have negligible impact on ground water hydrology.

Unit 4 Ash and SO_2 Scrubber Sludge Pond Site

Primary impacts of pond site work and construction have been identified as:

- Possible accidental spills of liquid fuels, lubricants, and chemicals; and
- Disruption of ground water recharge area on the north side of hill west of pond during excavation of borrow material.

Accidental spills of fuels, lubricants, and chemical are expected to be rare and of very limited volume. If such spills do occur, they probably will have minimal short term and insignificant long term impacts on ground water. The potential for accidental spills will be reduced when pond construction is completed, but spill potential will still exist during post-construction operation of the pond.

Disruption of ground water recharge in the random material borrow area on the north side of the hill may occur during construction and may continue after pond construction is completed. At present, plans for borrow area development and abandonment are vague. In view of the importance of the hill and its peripheral ice contact soil deposits in the local ground water regime, the random borrow area should be developed to minimize short term disruption to ground water recharge, and should be abandoned in such a manner as to minimize long term disruption to ground water recharge. Proper planning, operation, and abandonment of the random borrow area should result in minimal short term and long term impacts on ground water hydrology.

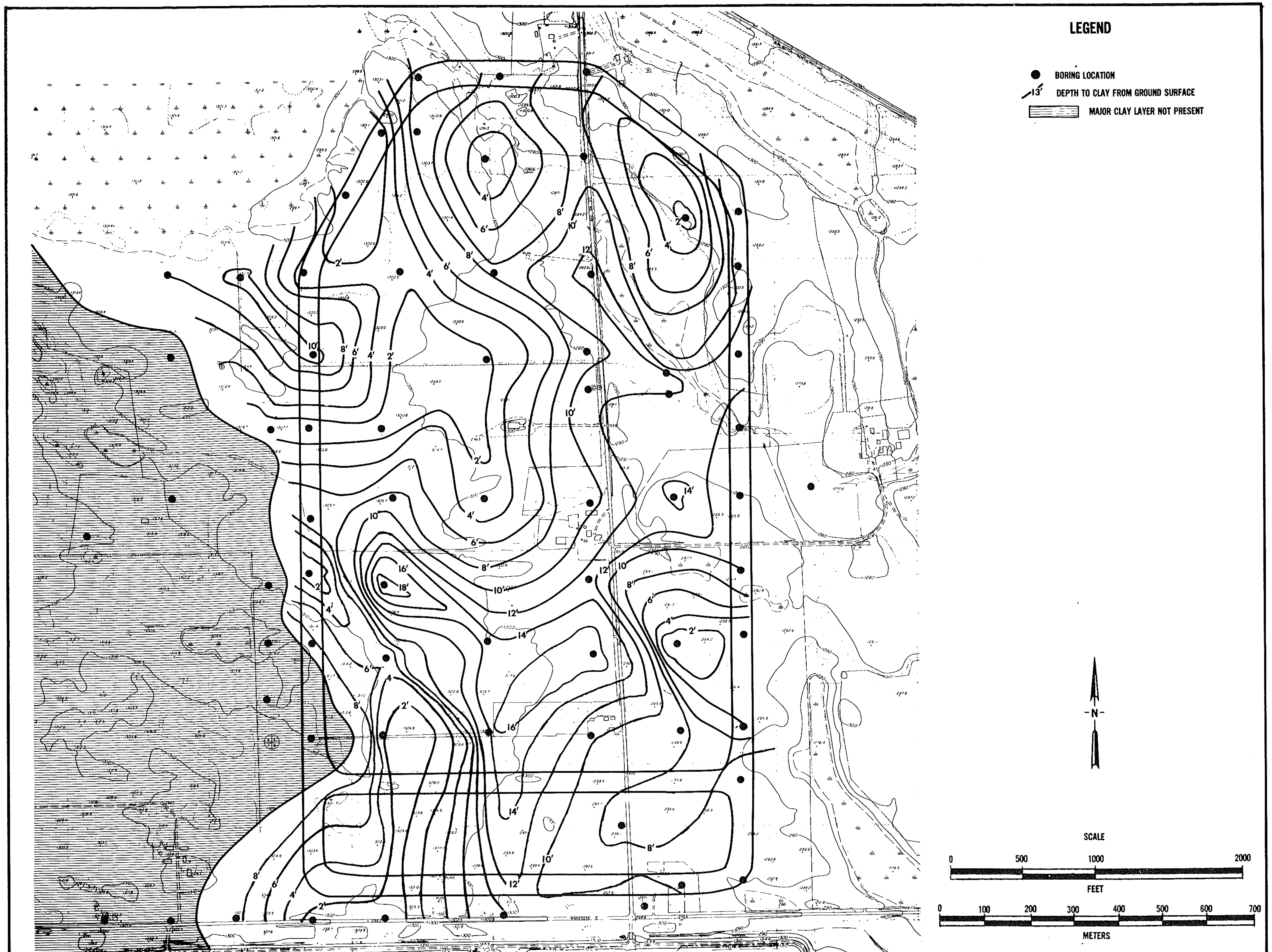
The only primary impact of pond operation and termination (abandonment) is potential leakage of contaminants into the ground water system. Pond designers have recognized this potential and planned features to minimize leakage (13). These features include an impervious clay lining on the inside slope of all perimeter dikes. This lining will connect with a foundation cutoff trench keyed into underlying lacustrine clay. In the southwest corner of the fly ash and SO_2 scrubber slude pond, where lacustrine clay is thin or absent, a 3 ft (0.9 m) clay blanket is to be constructed on the pond bottom; this blanket will be tied into dike linings and lascustrine clay. Clay for construction of dike linings, foundation cutoffs, and blankets is to be obtained from several borrow pits excavated in lacustrine deposits within the fly ash and SO_2 scrubber sludge pond.

Theoretically, the proposed features for minimizing pond leakage appear to be quite effective. However, several details of site geology and soil characteristics (which may or may not have been recognized by the pond designers) tend to raise questions concerning the actual reliability and effectiveness of the proposed leakage control measures.

Interpretations of depositional history and soil conditions at the pond site suggest that the area of thin or absent lacustrine clay in the southwest part of the pond site may be more extensive than indicated in Figures V-1 and V-2. Zones of lacustrine clay encountered in borings along the west side of the pond may not be continuous. Instead, these clay zones may be isolated pockets or lenses deposited along the irregular shoreline of former Lake Aitkin II. Clay borrow pits in the pond area may intersect pervious soil zones extending out of the pond area, well below the levels of foundation cutoffs.

Glacial soil deposits similar to those at the pond site are noted for their heterogeneity and erratic stratification patterns. Generally, the stratification patterns in such glacial soil deposits result in very low overall permeability. This may indeed be true at the pond site. Additional geologic study and interpretation should be done before this premise is accepted. If additional studies do not support this premise, pond design features and/or leakage tolerances must be revised.

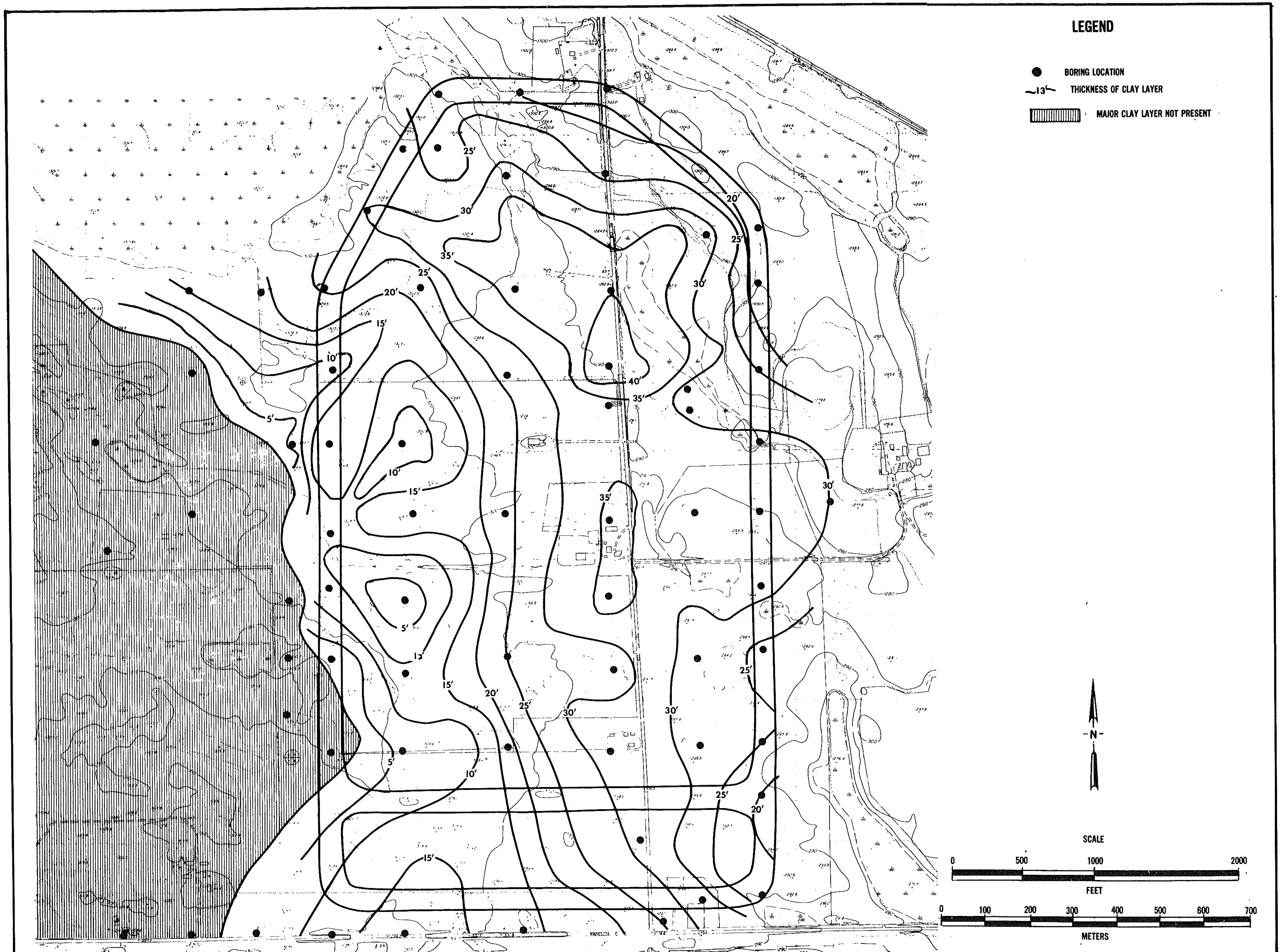
Degradation of the dike liner due to freeze-thaw and wave action could also lead to pond leakage. According to Figure V-3, the upper portion of the clay liner will be abount 4 ft (1.2 m) thick, much less than the maximum depth of frost penetration in northern Minnesota. This upper portion of the liner will be exposed to freezing and thawing for a number of years before pond water levels reach it. When water reaches this liner, it will be subject to wave action.



DEPTH FROM GROUND SURFACE TO CLAY LAYER - PROPOSED UNIT 4 ASH DISPOSAL POND CLAY BOSWELL STEAM ELECTRIC STATION

SOURCE: ADAPTED FROM, "MP&L CLAY BOSWELL STEAM ELECTRIC STATION, UNIT NO. 4, ASH DISPOSAL POND DIKE AND FOUNDATION STUDIES - ENGINEERING REPORT", APRIL 1977, FIGURE 7

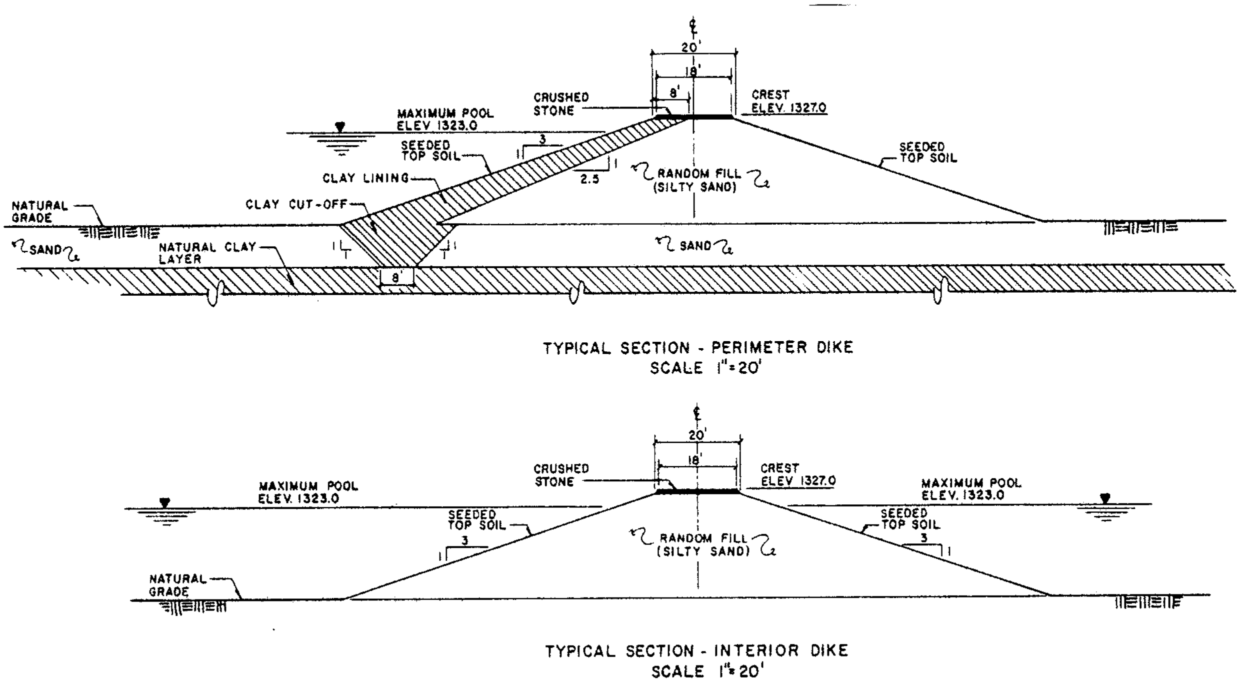
FIGURE V-1



EXTENT AND THICKNESS OF CLAY LAYER - PROPOSED UNIT 4 ASH DISPOSAL POND CLAY BOSWELL STEAM ELECTRIC STATION

SOURCE: ADAPTED FROM, "MP&L CLAY BOSWELL STEAM ELECTRIC STATION, UNIT NO. 4, ASH DISPOSAL POND DIKE AND FOUNDATION STUDIES - ENGINEERING REPORT", APRIL 1977, FIGURE 8

FIGURE V-2



TYPICAL SECTIONS - ASH POND DIKES - PROPOSED UNIT 4 ASH DISPOSAL POND
CLAY BOSWELL STEAM ASH ELECTRIC STATION

SOURCE: "MP&L CLAY BOSWELL STEAM ELECTRIC STATION, UNIT NO. 4, ASH DISPOSAL POND DIKE AND FOUNDATION STUDIES - ENGINEERING REPORT", APRIL 1977, FIGURE 13

FIGURE V-3

It is concluded that operation and (post-operation or abandonment) of the Unit 4 ash and SO_2 scrubber sludge pond may have adverse impacts on ground water hydrology unless more positive measures are taken to control leakage from the pond. Possible leakage control measures include:

- Chemical stabilization of fly ash and SO_2 scrubber sludge;
- Lining the pond with an impervious man-made material not susceptible to frost or wave damage;
- Revision of present leakage control measures to increase their effectiveness, e.g., increasing areal extent of clay blanket and depth of foundation cutoffs in areas of potentially pervious foundation soils and placement of clay core inside dike; and
- Use of impervious borrow materials from sources outside the pond area.

Regardless of which other measures are eventually adopted, all existing water wells in the Unit 4 pond area should be located and grouted for their entire lengths. This will prevent leakage into aquifers underlying the pond.

No plans are available for abandonment and/or reclamation of the Unit 4 ash and SO_2 scrubber sludge pond after it is full, or for modifying the pond to extend its use, once it is full. It is therefore impossible to assess the impacts of the solid waste disposal pond after it is taken out of service.

Ground Water Hydrology Impacts of Alternatives

Waste Wood as Supplemental Fuel

A present environmental concern in northern Minnesota is possible ground water contamination by seepage from surface and landfill disposal sites for waste wood from wood processing facilities. This possible ground water contamination can be reduced if some of the waste wood is used as a supplemental fuel at the Clay Boswell Station. The use of waste wood as a supplemental fuel could thus have beneficial impacts on ground water hydrology and quality. Using waste wood as a supplemental fuel also has the advantage of decreasing solid waste production by about 7% which allows the area of the new ash and SO_2 sludge pond to be reduced slightly. This smaller required pond area might allow a pond configuration which would avoid deposition of ash and SO_2 scrubber sludge in the southwest corner of the presently proposed Unit 4 pond where lacustrine clay is thin or absent. Such a revised pond configuration would reduce or eliminate the area over which a clay blanket is to be constructed on the pond bottom and minimize the potential for ground water contamination.

Facilities for storing waste wood at the Station can be designed, constructed, and operated such that there will be no seepage of waste wood leachates into the ground water system. Thus, there are no adverse ground water hydrology impacts for using waste wood as a supplemental fuel.

Coal Beneficiation

Coal beneficiation will have beneficial ground water hydrology impacts at the Unit 4 ash and SO_2 sludge pond site. With Units 1, 2, 3, and 4 burning beneficiated coal, solid waste production will be decreased from 397,685 tons (360,774 mt) to 264,796 tons (240,219 mt) annually for a 33% decrease when compared to MP&L's proposed action. For Unit 4, solid waste production will decrease from 228,384 tons (207,186 mt) to 144,608 tons (131,186 mt) annually for a 37% decrease. This decrease in solid waste production will significantly reduce the area and volume required for MP&L's proposed new ash and SO_2 sludge pond and thereby require a new pond configuration and layout. Since the pond area will be much smaller, it may be possible to locate the pond only where the lacustrine clay has adequate thickness to form an essentially impervious lining. Thus, potential leakage of contaminants into the ground water system can be reduced greatly by using beneficiated coal at the Clay Boswell Station.

Coal beneficiation possibly could have adverse impacts on ground water hydrology and quality in the vicinity of the Big Sky Mine in Montana. These adverse impacts would result from the disposal of coal cleaning rejects or waste from the coal preparation plant at the mine. Coal rejects possibly can be deposited with the overburden from mining or in a separate waste disposal basin. With good engineering and design and the arid climate at the Big Sky Mine, ground water contamination due to disposal of coal rejects will be minimal.

Dry and Wet/Dry Cooling Towers

Dry and wet/dry cooling towers both will decrease Unit 4 efficiency when compared to MP&L's proposed wet cooling towers. If the Clay Boswell Station is operated at the same gross generating capacity independent of cooling tower type, then the impacts on ground water hydrology and quality will be the same for all three cooling tower types. However, if the Clay Boswell Station is to have the same net generating capacity with all cooling tower types, then dry and wet/dry cooling towers will require increased coal consumption and a resultant increase in solid waste production. For dry cooling towers, solid waste production is expected to increase 1,223 to 12,232 tons (1,109 to 11,907 mt) annually or about 0.5 to 5.0%. For wet/dry cooling towers, solid waste production is expected to increase 122 to 1,223 tons (111 to 1,109 mt) annually or 0.05 to 0.5%. The increase in solid waste production will require a slightly larger pond volume. However, any additional adverse impacts on ground water hydrology and quality will be negligible when compared to the impacts of MP&L's proposed action.

Disposal of Solid Waste in an Abandoned Mine

The disposal of solid waste produced by Unit 4 in an abandoned iron ore mine will eliminate the need for MP&L's proposed new ash and SO_2 sludge pond. Thus, this alternative will eliminate all the impacts of this new pond on the ground water hydrology and quality.

If an abandoned iron ore mine is used for solid waste disposal, chemical stabilization of solid waste probably would be employed. Such chemical stabilization would reduce, but not necessarily eliminate the potential for ground water contamination by seepage from the waste. The extent of possible seepage and ground water contamination as well as other impacts which might result from waste disposal in an abandoned iron ore mine can only be evaluated on a site-specific basis with due consideration of the chemical stabilization process construction methods, operating conditions, geohydrology, surface water hydrology, and other relevant characteristics of the disposal area.

WATER QUALITY

Water Quality Impacts of Proposed Action

Regional Impacts

The construction phase of MP&L's proposed Unit 4 at the Clay Boswell Steam Electric Station is expected to have no significant regional impact upon the water quality of the upper Mississippi River or lakes in the region. Operational impacts of Unit 4 on the water quality will be minimal resulting from Station discharges into the Mississippi River. Increases in the concentrations of chlorides, sulfates, and total hardness may be detectable in the river at distances downstream from the Station, but would fall within the National Pollutant Discharge Elimination System (NPDES) permit and the applicable water quality criteria for the Mississippi River in the Clay Boswell Station vicinity. Termination of facilities operation at some future date should have little, if any, impact upon the water quality of the region.

Site-Specific Impacts

Before discussing the probable site-specific impacts from the construction and operation of proposed Unit 4, mention must be made of relevant State and Federal water quality standards and effluent limitations.

MPCA and EPA Water Quality Standards and Effluent Limitations. Two types of regulations govern discharges into the waters of Minnesota. These are receiving body water quality standards and effluent limitations (refer to Chapter I). Receiving body water quality standards (or water quality standards) govern the concentrations of various chemical constituents in the river flow after the discharge has mixed with a certain portion of the river. Effluent standards govern the concentration (mg per liter) and/or mass discharge loading rate (lb per day) of the discharge before mixing with the river.

The construction and operation of proposed Unit 4 must comply with the following principal regulations and agreements.

1. Criteria for the classification of Interstate Waters of the State and the Establishment of Standards of Quality and Purity - Minnesota Regulation WPC 15.

2. National Pollutant Discharge Elimination System (NPDES) and State Disposal System Permit Programs with permitting authority granted to the MPCA by EPA.

3. MPCA groundwater quality standards and ash pond seepage criteria.

4. Wild rice sulfate stipulation agreement.

Minnesota Regulation WPC 15, defines effluent limitations, as well as the water quality to be maintained in the receiving body of water, according to the best uses determined for that receiving water. The regulation specifies that the addition of effluents to the receiving water shall not result in concentrations exceeding applicable water quality standards. It is also specified that the total mixing zone should contain a maximum of 25% of the cross-sectional area and/or volume of the stream's flow and not extend over more than 50% of the width.

According to Section WPC 15(c)(7), which covers the applicable range of flows for receiving water, the water quality standards must be maintained at the edge of the mixing zone for all stream flows which are equal to or exceeded by the minimum 7 consecutive daily average flow (the lowest weekly flow with a once in 10 year recurrence interval) for the critical month(s). The period of record for determining the specific flow for the stated recurrence interval, where records are available, according to this regulation, shall include at least the most recent 10 years of record, including flow records obtained after flow regulation devices, if any. For the Mississippi River in the Clay Boswell area, the 7 consecutive daily average flow of record has been determined to be 180 cfs (5.1 cu m per sec), occurring during the month of April. At this flow, mixing volume available for diluting discharge concentrations in the river (at 25% of river flow volume) is equal to 45 cfs (1.27 cu m per sec). Minnesota Regulation WPC 15 also requires that waters which are of better quality than the established standards, such as exists in the Mississippi River at the Clay Boswell Station, shall be maintained at that high quality unless a determination is made that a change is justifiable as a result of necessary economic or social development and will not preclude appropriate beneficial present and future uses of the waters (refer to Chapter I). This determination must be made by the MPCA before permits can be issued for the construction of proposed Unit 4.

The stretch of the Mississippi River in the vicinity of the Clay Boswell Station is classified as 2B, 3B, 4A, 4B, 5, and 6 waters. Use classifications 2B and 3B identify a water body that shall be such as to permit fishing and recreation and to permit use for general industrial purposes, respectively. Classifications 4A, 4B, 5 and 6 identify the waters that shall be such as to permit their use for agriculture and wildlife purposes and navigation and waste disposal (14).

The applicable water quality criteria for the river at the Clay Boswell Station are identified in Section WPC 15(d) and are presented in Table IV-21 (Chapter IV).

Standards of quality and purity applying to effluents discharged to interstate waters are contained in Section WPC 15(c)(6). These standards are as follows:

Substance or Characteristic	Limiting Concentration
5 day biochemical oxygen demand	25 mg per liter
Total suspended solids	30 mg per liter
Fecal coliform group organisms	200 most probable number per 100 ml
Total coliform group organisms	1,000 most probable number per 100 mg

Substance or Characteristic	Limiting Concentration
Pathogenic organisms	None
Oil	Essentially free of visible oil
Turbidity value	25 Jackson Turbidity Units (JTU)
pH	6.5 to 8.5
Phosphorus	1 mg per liter
Unspecified toxic or corrosive substances	None at levels acutely toxic to humans or other animals or plant life, or directly damaging to real property.

The MPCA has been delegated authority to issue NPDES permits for the Clay Boswell Station. The permits establish effluent limitations for discharges of Units 1, 2, and 3 to the Mississippi River (refer to Chapter 1). Minnesota regulation WPC 36 was implemented to supplement then existing Minnesota statutes for MPCA to exercise its authority to issue NPDES permits. The MPCA must receive approval by the EPA for all NPDES permits. MP&L received a NPDES Permit for the Clay Boswell Station on November 18, 1975. Concurrent with permit issuance, MP&L agreed to conduct a wild rice sulfate study assessing the impacts on wild rice of sulfate concentrations discharged in excess of 10 mg per liter. Sulfate concentrations while the study is being conducted are limited to 40 mg per liter during the period of April 15 (or ice out in Blackwater Lake, whichever is later) to June 15 (or emergence of wild rice in the aerial leaf stage, whichever is earlier) or 60 mg per liter at all other times.

Significant overlap exists between State effluent standards as specified in the NPDES Permit for the Clay Boswell Station and EPA Effluent Standards (refer to Chapter I). Where this overlap occurs, the more stringent standard will be used as the basis for compliance. Table V-2 indicates those effluent limitations in the existing NPDES Permit which are more stringent than the EPA standards. Note that NPDES Permit conditions apply to Units 1, 2, and 3 with an expiration date of July 31, 1979. If Unit 4 is operational upon permit renewal and effluent standards have been changed or are more stringent, adjustments will have to be made for Unit 4 to assure compliance.

In addition to meeting MPCA standards, MP&L must meet the EPA standards for new sources (Table V-2). These guidelines specify chemical effluent limitations for cooling water, transport water and low volume waste sources associated with the operation of electric generating facilities. Where MPCA and EPA water quality standards apply, the most stringent of the 2 shall govern.

TABLE V-2
CHEMICAL EFFLUENT CONCENTRATION LIMITATIONS IN WATER DISCHARGES FROM CLAY BOSWELL STEAM ELECTRIC STATION, UNITS 1, 2, 3, AND 4

Effluent Source and Characteristic	Clay Boswell NPDES[a] Permit Limitations 7/1/77 to 7/31/79	Federal Effluent Standards for Steam Electric Generating Stations[b] Existing Stations met by 7/1/77	Existing Stations met by 7/1/83	New Stations met upon completion
Once-through cooling water				
Chlorine, mg per liter[c]				
daily maximum	0.2	0.5	0.5	0.5
monthly average	no standard	0.2	0.2	0.2
Oil and grease, mg per liter	no visible film	no standard	no standard	no standard
Floating solids or visible foam	trace amounts	no standard	no standard	no standard
Cooling system blowdown				
Chlorine, mg per liter[c]				
daily maximum	0.2	0.5	0.5	0.5
monthly average	. no standard	0.2	0.2	0.2
Oil and grease, mg per liter	no visible film	no standard	no standard	no standard
Floating solids or visible foam	trace amounts	no standard	no standard	no standard
Total suspended solids (TSS) mg per liter				
daily maximum	30	no standard	no standard	no standard
Turbidity, JTU[d]				
daily maximum	25	no standard	no standard	no standard
pH	6.5 to 8.5	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0
Zinc, mg per liter				
daily maximum	no standard	no standard	1.0	no detectable amount
monthly average	no standard	no standard	1.0	no detectable amount
Chromium, mg per liter				
daily maximum	no standard	no standard	0.2	no detectable amount
monthly average	no standard	no standard	0.2	no detectable amount
Phosphorus, mg per liter				
daily maximum	no standard	no standard	5.0	no detectable amount
monthly average	no standard	no standard	5.0	no detectable amount
Other corrosion inhibiting materials	no standard	no standard	limit established on case by case basis	no detectable amount
Cooling tower basin drainage				
Chlorine, mg per liter[c]				
daily maximum	0.2 not to exceed 2 hr per day	no standard	no standard	no standard
Oil and grease, mg per liter				
daily maximum	no visible film	20	20	20
monthly average	no visible film	15	15	15
Floating solids or visible foam	trace amounts	no standard	no stnadard	no standard
Total suspended solids (TSS) mg per liter				
daily maximum	30	100	100	100
monthly average	no standard	30	30	30
Turbidity, JTU				
daily maximum	25	no standard	no standard	no standard
pH	6.5 to 8.5	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0

TABLE V-2 (continued)
CHEMICAL EFFLUENT CONCENTRATION LIMITATIONS IN WATER DISCHARGES FROM CLAY BOSWELL STEAM ELECTRIC STATION, UNITS 1, 2, 3, AND 4

Effluent Source and Characteristic	Clay Boswell NPDES[a] Permit Limitations 7/1/77 to 7/31/79	Federal Effluent Standards for Steam Electric Generating Stations[b] Existing Stations met by 7/1/77	Existing Stations met by 7/1/83	New Stations met upon completion
Cooling tower roof and floor drainage				
Oil and grease, mg per liter				
daily maximum	15	20	20	20
monthly average	10	15	15	15
Floating solids or visible foam	trace amounts	no standard	no standard	no standard
Total suspended solids (TSS) mg per liter				
daily maximum	30	100	100	100
monthly average	no standard	30	30	30
Turbidity, JTU				
daily maximum	25	no standard	no standard	no standard
pH	6.5 to 8.5	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0
Ash pond effluent				
Oil and grease, mg per liter				
daily maximum	no visible film	20	20[e]	20[f]
monthly average	no visible film	15	15[e]	15[f]
Floating solids or visible foam	trace amounts	no standard	no standard	no standard
Total suspended solids (TSS) mg per liter				
daily maximum	30	100	100[e]	100[f]
monthly average	no standard	30	30[e]	30[f]
Turbidity, JTU				
daily maximum	25	no standard	no standard	no standard
pH	6.5 to 8.5	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0
Ash sluice head tank overflow				
Chlorine, mg per liter[c]				
daily maximum	0.2 not to exceed 2 hr per day	no standard	no standard	no standard
Oil and grease, mg per liter				
daily maximum	no visible film	20	20	20
monthly average	no visible film	15	15	15
Floating solids or visible foam	trace amounts	no standard	no standard	no standard
Metal cleaning wastes and boiler blowdown[g]				
Oil and grease, mg per liter				
daily maximum	h	20	20	20
monthly average	h	15	15	15
Total suspended solids (TSS) mg per liter				
daily maximum	h	100	100	100
monthly average	h	30	30	30

TABLE V-2 (continued)
CHEMICAL EFFLUENT CONCENTRATION LIMITATIONS IN WATER DISCHARGES FROM CLAY BOSWELL STEAM ELECTRIC STATION, UNITS 1, 2, 3, AND 4

Effluent Source and Characteristic	Clay Boswell NPDES[a] Permit Limitations 7/1/77 to 7/31/79	Federal Effluent Standards for Steam Electric Generating Stations[b] Existing Stations met by 7/1/77	Existing Stations met by 7/1/83	New Stations met upon completion
Metal cleaning wastes and boiler blowdown[g] (continued)				
pH	h	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0
Total copper, mg per liter				
daily maximum	h	1.0	1.0	1.0
monthly average	h	1.0	1.0	1.0
Total iron, mg per liter				
daily maximum	h	1.0	1.0	1.0
monthly average	h	1.0	1.0	1.0
Low volume waste sources taken collectively[i]				
Oil and grease, mg per liter				
daily maximum	h	20	20	20
monthly average	h	15	15	15
Total suspended solids (TSS), mg per liter				
daily maximum	h	100	100	100
monthly average	h	30	30	30
pH	h	6.0 to 9.0	6.0 to 9.0	6.0 to 9.0

a MPCA Permit No. MN 0001007. In addition to the limitations listed, the plant discharges shall not raise the sulfate concentration of the receiving water, measured at the Cohasset Bridge, above 40 mg per liter during the period of April 15 (or ice out in Blackwater Lake, whichever is later) to June 15 (or emergence of wild rice in the aerial leaf stage, whichever is earlier), or above 60 mg per liter at other times (75 mg per liter when Units 1 and 2 scrubbers are put on line).

b The daily quantity of pollutants discharged shall not exceed the quantity determined by multiplying the daily average flow times the concentration listed. Where limitations are not specified, they are currently unregulated by Federal standards. In the event that waste streams from various sources are combined for treatment or discharge, the total quantity (mass/time) of each pollutant allowed to be discharged from the treatment system or the combined sources shall not exceed the sum of the quantities of pollutant (mass/time) allowed to be discharged from each separate source. There shall be no discharge of polychlorinated biphenol compounds. (40 C.F.R. pt. 423)

c Chlorination is limited to a total of 2 hr per day and neither free available chlorine nor total residual chlorine may be discharged from the station for more than two hours in any one day. NPDES is for total residual chlorine; Federal standards are for free available chlorine.

d JTU means Jackson Turbidity Unit, which is a measure of light transmitted through a water sample.

e These Federal standards distinguish bottom ash transport water from fly ash transport water. The NPDES permit considers the two combined as the ash pond effluent. The daily quantity of pollutants discharged in bottom ash transport water shall not exceed the quantity determined by multiplying the daily average flow of bottom ash transport water times the concentration listed in the table and dividing the product by 12.5. The fly ash transport water standards are the same as those presented.

f These Federal standards distinguish bottom ash transport water from fly ash transport water. The NPDES permit considers the two combined as the ash pond effluent. The daily quantity of pollutants discharged in bottom ash transport water shall not exceed the quantity determined by multiplying the daily average flow of bottom ash transport water times the concentrations listed in the above table and dividing the product by 20. For fly ash transport water there shall be no discharge of total suspended solids or oil and grease.

g "Metal cleaning wastes" means any cleaning compounds, rinse waters, or any other waterborne residues derived from cleaning any metal process equipment, including, but not limited to, boiler tube cleaning, boiler fireside cleaning, and air preheater cleaning.

h The NPDES permit contains no separate standards for these effluent sources. If these sources are present at the Clay Boswell Station, they are combined with the other effluent sources listed in the table.

i Including wet scrubber air pollution control system, ion exchange water treatment system, water treatment evaporator blowdown, laboratory sampling streams, floor drainage, and recirculating house water system blowdown, taken collectively as though one source.

Construction Impacts. Excavation and construction related to Unit 4, generating facilities and the proposed new ash and SO_2 sludge pond will increase the potential for soil erosion and sediment deposition. This could result in increased turbidity and suspended solids in bodies of water adjacent to construction areas. The use of proper erosion and sedimentation controls can minimize these impacts. The leakage of petrochemical wastes from construction equipment could contaminate adjacent bodies of water. This will result in increased levels of oil, grease, and other contaminants. The potential of leakage occurring can be minimized by proper maintenance and inspection of construction equipment and the installation of waste sumps to contain spills. A maximum of approximately 1,200 construction workers will be present at the Clay Boswell Station during the period of construction. An appropriate number of portable chemical sanitary facilities must be provided on-site to accommodate all construction personnel. Sanitary wastes generated must be disposed of off-site by a licensed contractor in a manner approved by appropriate regulatory agencies. Therefore, no on-site discharge of sanitary wastes is expected during the construction period.

Operational Impacts. During the operation of the proposed Unit 4, the discharge of Station effluents, including cooling water, into the Mississippi River via a discharge canal has the greatest potential for affecting the water quality of the river. The following discussion of the combined impact of Units 1, 2, 3, and 4 upon the water quality of the Mississippi River includes average and "worst case" conditions as well as the incremental impact of Unit 4.

Discharge characteristics were calculated using a "mixing flow" of 45 cfs (1.27 cu m per sec), based on 25% of a critical low flow of 180 cfs (5.1 cu m per sec) (15).

It was determined recently that the critical low flow of the river in the vicinity of the Clay Boswell Station could drop as low as 100 cfs (2.83 cu m per sec). Therefore, the data as presented would not necessarily represent "worst case" conditions as the concentrations of pollutants presented below were based on a critical low flow of 180 cfs (5.1 cu m per sec) rather than 100 cfs (2.83 cu m per sec). It is possible that a number of water quality standards could be violated at a low flow of 100 cfs (2.83 cu m per sec) that would not be violated at a low flow of 180 cfs (5.1 cu m per sec).

In considering the operational impacts of the proposed Unit 4 upon the water quality of bodies of water in the vicinity of the Station site, the following Station systems have been considered: cooling tower system, effluent discharge system, and air quality control system. The operation of a mechanical draft cooling tower, as proposed for Unit 4, will result in ground-level fogging and icing, upper level visible plumes, and the deposition of salts in areas surrounding the cooling tower. Of these impacts, only the salt deposition has the potential for adversely affecting water quality to any extent (15).

The chemical composition of salt emitted from the cooling towers approximates that of the blowdown water, with chloride (Cl^-), calcium (Ca^{++}), and magnesium (Mg^{++}) comprising 57%, 20%, and 7% of the salt, respectively (15).

The maximum average monthly salt deposition rate (spring season) from Units 3 and 4 cooling towers combined, will be about 4.5 lb per acre (5.04 kg per hectare) and will occur approximately within the area of maximum ground level cooling tower induced fogging as shown in Figure V-26 (15).

The maximum average monthly rate off-site will be approximately 0.5 lb per acre (0.56 kg per hectare). The maximum annual salt deposition rates (from both towers) occurring on-site and off-site will be 30 and 8.0 lb per acre (33.6 and 8.96 kg per hectare), respectively.

Salt depositions from the Unit 4 cooling towers will result in salt depositions increases on the Mississippi River ranging from 0.1 to 0.3 lb per acre per month (0.112 to 0.336 kg per hectare per month). Since the salts are highly soluble, the river also will be subject to runoff containing increased salt concentrations. However, the overall concentration of the salts will be extremely low in relation to the average discharge rate and low flow discharge rate of the Mississippi River in the vicinity of the Clay Boswell Station. The salt deposition from the cooling towers will probably not have a significant effect on the Mississippi River, either in the immediate vicinity of the Clay Boswell Station, or downstream from it.

The discussion of chemical discharges includes analyses of concentrations expected under average and worst case water quality conditions.

Table V-3 presents the expected concentrations of chemical constituents at the edge of the mixing zone, with Unit 4 on the line, under average water quality conditions and average annual evaporation from the cooling towers.

Most of the changes in water quality that will result from the operation of Unit 4 are not caused by the direct discharge of wastes from the facility, but rather from a concentration of existing compounds in the cooling water as a result of evaporative losses. Three parameters of the Station effluent discharged to the river may have to be controlled. Two of these, sulfates and total hardness, may have to be controlled under certain conditions to meet water quality standards. The third parameter, chlorine, may have to be controlled to meet effluent standards.

Much of the sulfate discharged by the Clay Boswell Station is contained in the fly ash scrubber blowdown. It is proposed that sulfate concentrations in the river be controlled by the storage of a portion of the blowdown in the Unit 3 fly ash pond during critical periods, based on river flow and the natural concentration of sulfate in the river. The stored blowdown can then be discharged into the river during periods of high river flow and/or low ambient sulfate concentrations such that the NPDES sulfate limits of 40 mg per liter from April 15 to June 15 and 60 mg per liter at all other times, are not exceeded.

The fly ash scrubber blowdown, and to a lesser extent, the Unit 3 cooling tower blowdown, will be the major sources of total hardness in the Station discharges. The experienced maximum and minimal values for hardness in the fly ash scrubber blowdown are 2,000 and 900 mg per liter, respectively. With the addition of the Unit 4 cooling tower blowdown, the Station discharges often will exceed the total hardness water quality standard of 250 mg per liter at the edge of the mixing zone. For this reason, plans have been made to install a lime-soda ash softening system for the purpose of softening the Unit 3 fly ash scrubber

TABLE V-3
DISCHARGE CONCENTRATIONS IN ALLOWABLE MIXING ZONE FOR AVERAGE WATER QUALITY CONDITIONS
UNITS 1, 2, 3, AND 4 - CLAY BOSWELL STEAM ELECTRIC STATION

Parameters	River Standards mg per liter	River Background Concentrations mg per liter	Concentration After Discharge mg per liter
Arsenic	0.05	0.009	.012
Barium	1.0	a	-
Boron	0.5	a	-
Bicarbonates (as $CaCO_3$)	250 (5 meq per liter)	139	139
Cadmium	0.01	0.011	0.014[b]
Chloride	100	4.1	56
Chromium	0.05	a	-
Chromium (+6)	0.05	a	-
Cyanide	0.02	a	-
Fluoride	1.5	0.13	0.17
Lead	0.05	0.036	0.047
Ammonia-N	1.0	0.08	0.10
Oil	0.5	a	-
Phenols	0.01	a	-
Selenium	0.01	0.006	.008
Silver	0.05	a	-
Sodium	≤60% total (as meq per liter) cations	5.6	63.2 (40% total cations)
Hydrogen sulfide	0.02	-	-
Sulfates	40 April 15 to June 15; 60 June 15 to April 15	7.6	45.4[b]
Hardness	250	142	308[b]
Total salts	1,000	251	700
Dissolved salts	700	245	666

[a] No reliable river water quality data are available.

[b] Concentration if discharge were uncontrolled.

blowdown, so that the combined station discharges, including the cooling tower blowdown from Unit 4, will not exceed the total hardness water quality standard (15).

The main condenser cooling system as proposed by MP&L for Unit 4 will utilize an intermittent chlorination system for the prevention of biological fouling in the condenser, the auxiliary cooling system heat exchangers, and the cooling towers. A total residual chlorine limitation of 0.2 mg per liter, not to be exceeded for more than 2 hours per day, has been specified in the existing NPDES permit. This limitation can be met by determining the minimum dosage required to control the extent of biological fouling of the condenser cooling system and to allow adequate operation of the cooling towers. Residual chlorine in the basin can be monitored, and the blowdown can be held up until the residual chlorine total is at or below 0.2 mg per liter. Blowdown can then be discharged to the Mississippi River at levels of total residual chlorine less than 0.2 mg per liter. Chlorine can be eliminated from the condenser cooling water system by utilizing a mechanical cleaning system and appropriate cooling tower design.

With respect to both cadmium and copper, it is important to note that the average values were calculated utilizing the detection limit as the value, even though actual values were below detection. Therefore, the concentrations of metals in the discharge canal will probably be below the detection limit, and the water quality standards will be met (15).

An estimate for the bicarbonate concentration at the edge of the mixing zone has not been performed due to a lack of information on the extent of pH control required at the central treatment facility. However, the concentration at the edge of the mixing zone will probably be less than that found in the river. This is due to the large amount of bicarbonate alkalinity that will be destroyed in the recirculating cooling systems as a result of hydrochloric acid addition.

Concentrations of chemical constituents at the edge of a mixing zone as a result of Units 1, 2, 3, and 4 discharges under conditions of worst case river water quality and maximum cooling tower evaporation rates are shown in Table V-4.

Of the 70 samples analyzed for cadmium, 5 were above the detection limit during the 8-year sampling period (in this case, the detection limit is the MPCA water quality standard). Only once (3/26/74) during the sampling period did the value exceed 20 μg per liter. A value of 73 μg per liter was the maximum value utilized in making a prediction. This maximum value was so exceptionally high, it is very possible that faulty sampling procedures yielded an inaccurate result (15).

Of the 64 samples analyzed for lead, 2 had concentrations above the water quality standard. The maximum value used for the worst case analysis was 450 μg per liter (15), which resulted in the water quality standard being exceeded in the river and consequently in the effluent.

For selenium, the sampling data indicates that the maximum background concentration is at the value of the water quality standard. Consequently, the slight increase in concentration due to the evaporative effects of the cooling towers will, if uncontrolled, increase the concentration at the edge of the mixing zone to a value slightly higher than natural river concentrations. When the concentration of a constituent in the river is higher than the water quality standard concentration, that natural background concentration may be utilized as the governing standard (15).

Although the station may not directly add a certain constituent to the water, evaporation from the cooling towers reduces dilution volume, and consequently, mixing zone concentrations are slightly higher than background concentrations under worst case conditions. Under worst case conditions, river background concentrations of chemical constituents are higher than the standard for 4 parameters: cadmium, lead, copper, and conductivity. Because of evaporation, if the discharge is uncontrolled, concentrations of these parameters will be slightly higher at the edge of the mixing zone than in the river. However, river water quality will be monitored for these parameters and during the time of maximum concentrations, cooling tower blowdown can be stored to insure compliance with water quality standards. The stored water can then be discharged when river conditions are more favorable or after treatment.

Table V-4 summarizes the mixing zone water quality information and serves as the basis for assessing the <u>incremental impact of Unit 4 in comparison to the water quality standards</u>.

The higher mixing zone concentrations found for facilities operation with Unit 4 can generally be traced to Unit 4 cooling tower operation. The greatest discrepancy in mixing zone concentrations between operation of 1, 2, and 3 and operations for Units 1, 2, 3, and 4 exists for chlorides.

This results from the expected addition of hydrochloric acid for pH treatment at the Unit 4 cooling tower. For the remaining parameters, the slightly higher concentrations found for Units 1, 2, 3, and 4 operation can be attributed to evaporative effects of the Unit 4 cooling tower, reducing available dilution volume.

It can be concluded that while the impact of Unit 4 is small, worst case conditions could result in some violations of water quality standards due primarily to the evaporative effects of the Unit 4 cooling towers, which reduces the available dilution volume (Table V-5).

For the chemical constituents chromium, cyanides, barium, silver, and boron for which there exist Mississippi River water quality standards at the Clay Boswell Station, but for which there are no available river water quality data, it is expected that Units 1, 2, 3, and 4 operation will not result in any direct addition of these constituents to Station wastewaters (15). Average dissolved oxygen in the Mississippi River at Cohasset, Minnesota is 8.5 mg per liter. It is expected that discharges from the Clay Boswell Station will not significantly lower dissolved oxygen levels in the mixing zone, thus satisfying the water quality criteria.

Turbidity and fecal coliform water quality standards for the Mississippi River will be complied with through wastewater treatment at the central waste treatment facility and the Units 1, 2, 3, and 4 sewage treatment unit.

Impacts on ground water quality are described in the section on Hydrology.

TABLE V-4
DISCHARGE CONCENTRATIONS IN ALLOWABLE MIXING ZONE FOR WORST CASE WATER QUALITY CONDITIONS
UNITS 1, 2, 3, AND 4 - CLAY BOSWELL STEAM ELECTRIC STATION (17)

Parameters	River Standards mg per liter	River Background Concentrations mg per liter	Concentration After Discharge mg per liter
Arsenic	0.05	0.01	0.014
Barium	1.0	a	-
Boron	0.5	a	-
Bicarbonates	350 (5 meq per liter)	220	-
Cadmium	.01	0.073	0.103[b]
Chloride	100	10	99
Chromium	0.05	a	-
Chromium (+6)	0.05	a	-
Cyanide	0.02	a	-
Fluoride	1.5	0.30	0.42
Lead	0.05	0.45	0.63[b]
Ammonia-N	1.0	0.52	0.73
Oil	0.5	a	-
Phenols	0.01	a	-
Selenium	0.01	0.01[a]	0.014[b]
Silver	0.05	-	-
Sodium	60% total cations (meq per liter)	9.4	130.8 (<40% total cations)
Hydrogen Sulfide	.02	a	-
Sulfates	40 April 15 to June 15; 60 June 15 to April 15	12	67[b]
Hardness	250	210	455[b]
Total salts	1,000	400	800
Dissolved salts	700	362	773

[a] No reliable river water quality data are available.
[b] Concentration if discharge were uncontrolled.

TABLE V-5
IMPACT OF UNIT 4 ON DISCHARGE CONCENTRATIONS IN AN ALLOWABLE MIXING ZONE
CLAY BOSWELL STEAM ELECTRIC STATION (18)

	Average Conditions		Worst Conditions	
Parameter	Units 1, 2, and 3 mg per liter	Units 1, 2, 3, and 4 mg per liter	Units 1, 2, and 3 mg per liter	Units 1, 2, 3, and 4 mg per liter
Arsenic	0.010	0.012	0.012	0.014
Cadmium[a]	0.012	0.014	.086	0.103
Chloride	18	56	51	99
Fluoride	0.14	0.17	0.35	0.42
Lead[a]	0.04	0.05	0.53	0.63
Ammonia-N	0.09	0.10	0.61	0.73
Selenium[a]	0.007	0.008	0.012	0.014
Sodium	40.0 (<30% total cations)	63.2 (<40% total cations)	48.6 (<30% total cations)	131.0 (<20% total cations)
Sulfates[a]	44.6	45.6	66	67
Hardness[a]	281	308	407	455
Total salts	526	700	700	800
Dissolved salts	496	666	673	773

[a] Concentrations if discharge were uncontrolled.

Thermal discharges can affect both the water quality and the aquatic biota of the receiving water body. The following identifies the effects on water quality to be expected from the operation of Unit 4, and provides a comparison of these effects with the thermal regulations outlined in WPC 15 and MP&L's current NPDES permit for Units 1, 2, 3, and 4 at the Clay Boswell Station.

The Mississippi River at Cohasset is currently classified as 2B, 3B, 4A, 4B, 5 and 6 by the MPCA in WPC 25. The applicable thermal regulations, as identified in WPC 15(d) are presented below. Thermal standards must be met at the edge of a mixing zone, which must contain no more than 25% of the cross-sectional area and/or volume of flow of the stream and should not extend over more than 50% of the width.

Substance or Characteristic	Limit or Range
Temperature	5°F (2.8°C) above natural in streams and 3°F (1.67°C) above natural in lakes, based on monthly average on the maximum daily temperature, except in no case shall it exceed the daily average temperature of 86°F (30°C).

Notes: The following temperature criteria will be applicable for the Mississippi River from Lake Itasca to the outlet of the Metro Wastewater Treatment Works in St. Paul in addition to or superseding the above. The weekly average temperature shall not exceed the following temperatures during the identified months:

TABLE V-6
DISCHARGE CONDITIONS AT CULVERT EXIT
CLAY BOSWELL STEAM ELECTRIC STATION (19)

Month	Units 1, 2, and 3				Units 1, 2, 3 and 4				Change due to Unit 4			
	Rate Q[a]		Temperature		Rate Q[a]		Temperature		Rate ΔQ[b]		Temperature ΔT	
	cfs	cu m per sec	°F	°C	cfs	cu m per sec	°F	°C	cfs	cu m per sec	°F	°C
January	241.23	6.831	48.56	9.2	235.27	6.662	48.68	9.26	5.96	0.169	0.12	-17.71
February	241.15	6.829	46.22	7.9	235.63	6.672	46.35	7.97	5.52	0.156	0.13	-17.70
March	241.38	6.835	53.09	11.71	234.70	6.646	53.21	11.78	6.68	0.189	0.12	-17.71
April	241.52	6.839	59.95	15.52	233.42	6.610	60.06	15.58	7.24	0.205	0.11	-17.71
May	241.74	6.845	70.01	21.11	233.42	6.610	70.07	21.15	8.32	0.236	0.06	-17.74
June	241.39	6.835	81.21	27.33	232.97	6.600	81.20	27.33	8.92	0.253	0.01	-17.77
July	242.09	6.855	87.20	30.66	232.17	6.574	87.15	30.63	9.92	0.281	0.05	-17.75
August	242.07	6.855	86.11	30.06	232.27	6.577	86.07	30.03	9.8	0.28	0.04	-17.75
September	241.81	6.847	76.52	24.73	233.25	6.605	76.54	24.74	8.56	0.242	0.02	-17.76
October	241.69	6.844	62.79	17.1	233.61	6.615	62.91	17.17	8.08	0.229	0.12	-17.71
November	241.41	6.836	54.31	12.39	234.65	6.645	54.43	12.46	6.76	0.191	0.12	-17.71
December	241.27	6.832	47.81	8.78	235.11	6.658	47.94	8.85	6.16	0.174	0.13	-17.70

[a] Q means rate of flow.
[b] ΔQ means change in rate of flow.
[c] ΔT means change in temperature.

January	40°F	4.44°C	July	85°F	29.4°C
February	40°F	4.44°C	August	83°F	28.3°C
March	48°F	8.89°C	September	78°F	25.6°C
April	60°F	15.6°C	October	68°F	20.0°C
May	72°F	22.2°C	November	50°F	10.0°C
June	78°F	25.6°C	December	40°F	4.44°C

Proposed Unit 4 will be equipped with a wet evaporative recirculating main condensor cooling system, with cooling effected by a mechanical draft cooling tower. The Unit 4 cooling system blowdown, amounting to between 1.38 and 2.48 cfs (0.039 and 0.070 cu m per sec) will be discharged into the discharge canal, along with cooling discharges and station effluents from the other 3 units.

Table V-6 compares the discharge conditions at the culvert exit, before and after the addition of Unit 4. Evaporation losses from the Unit 4 cooling tower have been incorporated into the estimate. Because the discharge flow is turbulent and Unit 4 will discharge sufficiently upstream from the culvert exit, all discharges have been presumed completely mixed at the culvert exit. The maximum additional temperature rise at the culvert exit due to the addition of Unit 4 is estimated to be about 0.13°F (0.07°C). This temperature rise is judged to be less than the normal water temperature variation of the Mississippi River and is considered negligible. The increase in the rate of total heat discharge will be a maximum of 1.67×10^8 Btu per day or only 1% that of Units 1 and 2 discharge (1.62×10^{10} Btu per day) (15).

Table V-6 presents the downstream temperature rises due to the existing units (1, 2 and 3) and for expected operation of all 4 units. The well mixed temperature change due to the addition of Unit 4 (maximum 0.09 F (0.05 C) is within the diurnal water temperature variation and is thus judged to have insignificant thermal impact (15).

The expected changes in the thermal effects of the Station due to the addition of Unit 4 are estimated to be negligible, as these changes are small compared to the diurnal river water temperature variations. To maintain the conservative analysis, the estimates did not include consideration of the fact that the higher surface water temperature due to Unit 4 will accelerate surface heat loss and further reduce the already small thermal effects predicted above.

However, under low flow conditions of 100 cfs (2.83 cu m per sec) and a Station withdrawal rate of 252 to 268 cfs (7.13 to 7.52 cu m per sec), a reversal of flow in Blackwater Lake would occur between the intake and discharge of the Clay Boswell Station. This recirculation of water could cause a water temperature rise both upstream and downstream from the Station's discharge point, with resultant thermal impacts in the vicinity of the recirculation zone. At a river low flow of 216 cfs (6.12 cu m per sec), a temperature rise of 5°F (2.8°C) will occur immediately downstream and upstream of the discharge point (20). Obviously, a greater increase in temperature is expected at a river low flow of 100 cfs (2.83 cu m per sec). The degree of thermal impact will be determined largely by the duration of the flow reversal.

The addition of Unit 4 will cause increases in air emissions of sulfur dioxide, nitrogen dioxide, particulates and trace elements, due to the increased operational capacity of the facility. One of the problems associated with sulfur dioxide and nitrogen dioxide is that these compounds may undergo atmospheric oxidation to form sulfuric, sulfurous and nitric acids and can substantially lower the pH of rainfall. It has been reported that "The ecological effects of acid rain are as yet largely unknown, but potentially, they are manifold and very complex" (21). While it is extremely unlikely that acid rain will significantly alter the pH of the Mississippi River in the vicinity of the Clay Boswell Station, due to the good buffering capacity and flow-through of the system, it is possible that lakes in the vicinity of the station could undergo gradual changes in pH resulting from acid rain. This concern is complicated by the fact that some lakes in the vicinity of the Station are naturally acidic due to certain geologic and biologic characteristics within their watersheds. This natural low pH condition in lakes increases substantially their susceptibility to impacts from acid rain.

Water Quality Impacts of Alternatives

Waste Wood As Supplemental Fuel

The use of waste wood as a supplemental fuel will result in slight decreases in solid waste production and SO_2 emissions. Solid waste production will decrease about 7% allowing the area of the proposed new ash and SO_2 sludge pond to be reduced slightly. However, this slight decrease in disposal pond area will not alter water quality impacts when compared to MP&L's proposed new pond. For worst case emissions, SO_2 emissions, at 38(%S), decrease from 8,878 lb per hr (4,027 kg per hr) to 7,988 lb per hr (3,623 kg per hr), or a 10% decrease. For average emissions, SO_2 emissions are the same when burning coal and waste wood as when burning coal only. Because of the very slight reduction in SO_2 emissions of the worst case, the use of waste wood has little potential for reducing any impacts to surface water quality due to air emissions from Unit 4.

The burning of waste wood in Unit 4 could have benificial impacts on surface water quality. A present environmental concern in northern Minnesota is possible surface water contamination by seepage from surface and landfill disposal sites for waste wood from wood processing facilities. Reducing the waste wood volume requiring disposal by using waste wood as a supplemental fuel, will reduce the potential for surface water contamination by waste wood.

Coal Beneficiation

Coal beneficiation will have beneficial surface water impacts in Minnesota when compared to MP&L's proposed action. Unit 4 solid waste production will be reduced 37% by using beneficiated coal, resulting in a significant reduction in area and volume required for MP&L's proposed new ash and SO_2 sludge pond. Thus, potential leachate seepage into surface waters from the solid waste disposal pond and possibly adverse surface water contamination can be reduced by using beneficiated coal at the Clay Boswell Station.

Coal beneficiation possibly could have adverse impacts on surface waters in the vicinity of the Big Sky Mine in Montana. These adverse impacts would result from the disposal of coal cleaning rejects or waste from the coal preparation plant at the mine.

With the arid climate at the Big Sky Mine, the coal waste disposal system can be designed and engineered so that surface water contamination will be minimal.

Dry Cooling Towers

The principal advantages of using dry cooling towers are minimal water consumption and the elimination of visible vapor plumes, icing problems, and salt deposition. Thus, dry cooling towers will minimize impacts due to cooling tower evaporation and blowdown. Dry cooling towers will result in consumptive water usage being decreased 3,465 gpm (13,116 lpm), when compared to MP&l's proposed Unit 4 wet cooling towers. The elimination of almost all consumptive water usage and water discharges for Unit 4 will virtually eliminate all water quality impacts on the Mississippi River related to MP&L's proposed Unit 4 wet cooling towers.

Dry cooling towers will decrease Unit 4 efficiency when compared to MP&L's proposed wet cooling towers. If the Clay Boswell Station is operated at the same gross generating capacity independent of cooling tower type, then the water quality impacts related to MP&L's proposed wet cooling towers will be eliminated and the impacts related to other aspects of the Station will remain unchanged. However, if the Clay Boswell Station is to have the same net generating capacity with dry as with wet cooling towers, the dry cooling towers will require increased coal consumption and a resultant increase in solid waste production. This solid waste production increase is estimated to be 0.5 to 5% which will slightly increase the potential for surface water contamination due to leachate seepage from ash and scrubber sludge ponds.

Wet/Dry Cooling Towers

The water quality impacts of wet/dry cooling towers depends on the ratio of wet to dry cooling. Based on wet/dry cooling towers designed for 80% wet or evaporative and 20% dry, wet/dry cooling towers will reduce water consumption 693 gpm (2,623 lpm) when compared to MP&L's proposed Unit 4 wet cooling towers. The wet/dry cooling towers could cause substantially less fogging and drift than MP&L's proposed wet cooling towers. The reduced water consumption of wet/dry cooling towers will decrease the potential for water quality impacts on the Mississippi River. However, this impact reduction is not expected to significantly affect the water quality impacts of the proposed Unit 4.

As with dry cooling towers, wet/dry cooling towers could result in increased solid waste production if the Clay Boswell Station was operated to have the same net generating capacity with wet/dry cooling towers as with MP&L's proposed wet cooling towers. However, the potential for increased surface water contamination due to leachate seepage from ash and scrubber sludge ponds is minimal since solid waste production is estimated to increase 0.05 to 0.5% only.

Disposal of Solid Waste in an Abandoned Mine

The disposal of Unit 4 solid waste in abandoned open pit iron ore mines, rather than in the proposed new ash and SO_2 scrubber sludge pond will decrease the potential for surface water contamination in the vicinity of the Clay Boswell Station, but increase the potential of possible surface water contamination at the abandoned mine disposal site. The degree of impact will be determined largely by the geologic structure of the abandoned mine disposal area. Disposal of the waste in an abandoned open pit iron ore mine will result in the consumption of less water than disposal at MP&L's proposed new ash and SO_2 sludge pond, since the solid wastes will be dewatered prior to disposal in the abandoned mine.

AQUATIC BIOLOGY

Aquatic Biology Impacts of Proposed Action

Regional Impacts

Construction Impacts. The construction phase of the proposed Unit 4 at the Clay Boswell Station is expected to have no regional impacts upon the aquatic biology of the upper Mississippi River or surrounding lakes.

Operational Impacts. It is expected that the operation of the proposed Unit 4 at the Clay Boswell Station will have minimal impact upon the aquatic biology of the upper Mississippi River or lakes of the region. Although station discharges from Unit 4 will alter the existing chemical conditions of the river to some extent, particularly with respect to chlorides and sulfates, the discharges will be further diluted by tributaries flowing into the river and will have no overall impact upon the aquatic biota of the river.

It is anticipated that there will be no significant regional impact upon the aquatic biology of the upper Mississippi River or lakes in the region following the termination of operations at the Clay Boswell Station.

Site-Specific Impacts

Construction Impacts. The construction of a generating facility may have adverse effects on the aquatic biota of the area by causing a temporary loss of habitat through changes in the physical or chemical environment. No temporary or permanent losses of aquatic habitat are expected to result from the construction of the proposed Unit 4. The location of the proposed ash pond site could, however, result in a slight permanent modification to Minnesota Department of National Resources lake number 31-562 (Water Section, Division of Waters, Soils, and Minerals, 1968), and to a small stream which enters the arm of Blackwater Lake located north of Minnesota Trunk Highway 6. Construction of the ash ponds will probably remove a small portion of the watersheds feeding each of these water bodies. The extent of habitat modification is expected to be slight because the portions of the watersheds to be removed are small relative to the total watershed areas.

Temporary habitat modification will consist primarily of local increases in total suspended solids (TSS). These increases will result from site dewatering, runoff, and any in-water construction. The minimum fatal TSS level for *Notemigonus crysoleucus* (golden shiner) at temperatures from 20 to 29°C is 55,000 mg per liter: symptoms of distress are first exhibited by *Micropterus salmoides* (largemouth bass) at 20,000 mg per liter; and the average fatal TSS level for *Lepomis gibbosus* (pumpkinseed) and *Ambloplites rupestris* (rock bass) are 69,000 mg per liter and 38,250 mg per liter respectively (22). Critical levels for spawning of *Micropterus salomides* and *Lepomis macrochirus* (bluegill) are 75 to 100 ppm (23). Furthermore, the National Academy of Sciences (24) found that good to moderate fisheries can be maintained in waters containing 25 to 80 mg per liter TSS. TSS in the dewatering discharge will be treated to reduce TSS concentrations to less than 30 mg per liter.

TSS concentrations in runoff water from the Clay Boswell Station site will be increated because of excavation and ground cover disruption. All sites runoff will be collected and treated to reduce TSS levels to less than a daily maximum of 50 mg per liter before being discharged into the Mississippi River. This concentration is also well below the critical values noted above.

Higher TSS in runoff is also expected as a result of borrowing activity within the watershed of lake 31-562. This runoff could be diverted from the lake. Runoff diverision could cause a slightly lowered water level and a resultant reduction in productivity. An alternative to runoff diversion would be to treat runoff from the borrow area (to less than a daily maximum of 50 mg per liter TSS) and then allow the treated runoff to enter the lake. No impact from TSS should result if this alternative were implemented. However, sedimentation of the suspended solids in the lake could result in a changed benthic community. Either of these alternative could have adverse effects to the biota of lake 31-562.

Other temporary habitat modifications could result from accidental spillage of corrosion inhibitors, oil, etc. Providing care is exercised in the storage and use of these mateials, and providing any spillage is immediately reported and properly dealt with, only minor and temporary impacts should occur.

Operational Impacts. In considering the operational impacts of the proposed Unit 4 upon the aquatic biota of the waters in the vicinity of the Clay Boswell Station, the following facility systems have been considered: water intake system, effluent cooling water and dischage systems, and the air quality control system.

Water intake into the generating facility will usually result in adverse effects on the aquatic biota as organisms smaller than the intake screen mesh size are entrained, and larger organisms are impinged on the intake screen.

Since the proposed rate of water withdrawal for Units 1, 2, 3, and 4 is slightly increased from the volume presently withdrawn for Units 1, 2, and 3 (Table V-7), little or no incremental impact is expected when Unit 4 becomes operational. However, modifications to the intake structure required for the addition of Unit 4 may potentially change the existing degree of intake impact on aquatic biota.

Impingement of organisms could either be increased or decreased by the addition of Unit 4. Because water withdrawal will be only slightly changed, average intake approach and through screen water velocities will be little affected. However, as shown in Tables V-8 and V-9, there is considerable variation in water velocities at different locations in front of the travelling screens. Planned reduction of flow for Units 1 and 2 and increased makeup water withdrawal for Unit 4 will change the distribution of those velocities. If the changed distribution exhibits less variation than is presently the case, lower impingement rates are expected. Higher variation in velocity would probably result in somewhat higher impingement rates (27).

Although water for Units 1, 2, 3, and 4 will be withdrawn at a rate similar to that for the existing units, a smaller proportion of the water withdrawn for

TABLE V-7
WATER WITHDRAWAL AND ENTRAINMENT LOSSES - CLAY BOSWELL STEAM ELECTRIC STATION (25)

	Summer				Winter			
	Average		Maximum		Average		Maximum	
Water Withdrawal	gpm	cu m per sec	gpm	cu m per sec	gpm	cu m per sec	gpm	cu m per sec
Present Operating Conditions								
Units 1, 2, and 3								
Once-through cooling water system	103,125	6.505	103,125	6.505	49,679	3.134	49,679	3.134
Other water systems	14,535	0.917	14,535	0.917	13,981	0.822	13,981	0.882
Total	117,660	7.422	117,660	7.422	63,660	4.016	63,660	4.016
Future Operations								
Units 1, 2, 3, and 4								
Once-through cooling water system	99,000	6.245	99,000	6.245	49,500	3.122	49,500	3.122
Other water systems	17,400	1.098	24,200	1.527	17,400	1.098	24,200	1.527
Total	116,400	7.343	123,200	7.772	66,900	4.220	73,700	4.649
Assumed Mortalities	%		%		%		%	
Ichthyoplankton								
Once-through cooling water system	95		95		95		95	
Other water systems	100		100		100		100	
Zooplankton								
Once-through cooling water system	20		20		20		20	
Other water systems	100		100		100		100	
Phytoplankton								
Once-through cooling water system	0		0		0		0	
Other water systems	100		100		100		100	
Estimated Percent Increase in Mortality Resulting from the Addition of Unit 4								
Ichthyoplankton	-1		5		5		16	
Zooplankton	6		25		14		43	
Phytoplankton	20		67		20		73	

all 4 Units will be used for once through cooling. Where once through cooling kills a proportion of entrained organisms, water used for other purposes usually results in 100% mortality (27) (28). For this reason, mortality resulting from entrainment will be generally higher after Unit 4 is added. The degree to which total mortality at the facility is increased depends upon the mortality rates presently experienced as a result of passage through the once through system of the Clay Boswell Station.

In 316(b) studies conducted for Clay Boswell Units 1, 2, and 3, the conservative assumption of 100% mortality of entrained organisms was made (26). This assumption obviated the need for making determinations of live versus dead organisms. Because specific mortality data are not available for the Clay Boswell Station reliance must be placed on data found in the literature.

Survival rates from passage through a once through cooling system differ for ichthyoplankton, zooplankton, and phytoplankton. Results summarized from 9 studies of ichthyoplankton entrainment mortality (28) indicated that in 4 of these studies, the mortality rate of entrained ichthyoplankton was 100%. The

TABLE V-8
INTAKE VELOCITY PROFILE - JANUARY 28, 1976
CLAY BOSWELL STEAM ELECTRIC STATION[a b] (26)

Unit 1[c]								Unit 2[c]							
Depth		Off-center velocity		Velocity at center of screen		Off-center velocity		Depth		Off-center velocity		Velocity at center of screen		Off-center velocity	
ft	m	fps	m per sec	fps	m per sec	fps	m per sec	ft	m	fps	m per sec	fps	m per sec	fps	m per sec
0	0.00	0.3	0.09	0.6	0.18	0.7	0.21			0.5	0.15	0.4	0.12	0.6	0.18
		0.4	0.12	0.3	0.09	0.4	0.12	1	0.30	0.3	0.09	0.3	0.09	0.4	0.12
2	0.61	0.3	0.09	0.3	0.09	0.5	0.15			0.3	0.09	0.4	01.2	0.5	0.15
		0.3	0.09	0.3	0.09	0.6	0.18	3	0.91	0.2	0.06	0.4	0.12	0.4	0.12
4	1.22	0.3	0.09	0.3	0.09	0.6	0.18			0.4	0.12	0.5	0.15	0.6	0.18
		0.5	0.15	0.4	0.12	0.5	0.15	5	1.52	0.8	0.24	0.8	0.24	1.0	0.30
6	1.83	0.7	0.21	0.4	0.12	0.5	0.15			0.8	0.24	0.9	0.27	0.9	0.27
		0.7	0.21	0.3	0.09	0.3	0.09	7	2.13	0.6	0.18	0.8	0.24	1.0	0.30
8	2.44	0.6	0.18	0.5	0.15	0.3	0.09			0.5	0.15	0.6	0.18	0.8	0.24
		0.5	0.15	0.5	0.15	0.5	0.15	9	2.74	0.7	0.21	0.5	0.15	0.8	0.24
10	3.05	0.6	0.18	0.6	0.18	0.6	0.18			0.4	0.12	0.4	0.12	0.8	0.24
		0.4	0.12	0.9	0.27	0.5	0.15	11	3.35	0.6	0.18	0.3	0.09	1.2	0.37
12	3.66	0.8	0.24	0.3	0.09	0.5	0.15			0.4	0.12	0.5	0.15	0.5	0.15
		0.5	0.15	0.3	0.09	0.6	0.18	13	3.96	0.7	0.21	0.7	0.21	0.8	0.24
14	4.27	0.5	0.15	0.4	0.12	0.5	0.15			0.6	0.18	0.7	0.21	0.8	0.24
		0.4	0.12	0.7	0.21	0.9	0.27	15	4.57	0.6	0.18	0.4	0.12	0.5	0.15
16	4.88	0.4	0.12	0.5	0.15	1.0	0.30			0.8	0.24	0.3	0.09	0.4	0.12
		0.3	0.09	0.6	0.18	1.0	0.30	17	5.18	0.9	0.27	0.3	0.09	0.5	0.15

[a] One pump per unit on.
[b] From Mossier, 1976.
[c] Taken between trash racks and travelling screens.

other 5 studies found "high", 99.7%, 97.5%, 92.4%, and 39% rates of mortality. For the purposes of this impact assessment, a 95% ichthyoplankton mortality rate was assumed for the once through cooling system. Zooplankton entrainment mortality rates exhibit a large amount of variation (from 0 to 100%) depending upon species, size, and the generating facility (28) (29) (30). In 1973, the US Atomic Energy Commission suggested that for zooplankton a 30% mortality rate might be respresentative (28). However, because freshwater species tend to be smaller than marine species (hence less susceptible to mechanical damage), the more conservative value of 20% is used herein. Effects of entrainment on phytoplankton are difficult to assess. Condenser passage frequently depresses primary productivity. The amount of depression appears to be directly related to ambient water temperatures and inversely related to the quanity and duration of biocide additions (31). When the ambient temperature is low, entrainment can cause an increase in productivity. Because productivity of entrained phytoplankton can be either stimulated or depressed, zero mortality in a once through cooling water system has been assumed.

The increase in plankton loss caused by proposed Unit 4 were calculated using data on water withdrawal rates, water use, and mortality rates. The data used, and the calculated results are given in Table V-7.

The effects of entrainment mortalities on the aquatic ecosystem are expected to be slight. Most fish spawn during summer operating conditions

TABLE V-9
INTAKE VELOCITY PROFILE - AUGUST 26, 1975
CLAY BOSWELL STEAM ELECTRIC STATION[a, b] (26)

Unit 2[c]								Unit 1[c]							
Depth		Off-center velocity		Velocity at center of screen		Off-center velocity		Depth		Off-center velocity		Velocity at center of screen		Off-center velocity	
ft	m	fps	m per sec	fps	m per sec	fps	m per sec	ft	m	fps	m per sec	fps	m per sec	fps	m per sec
0	0.00	0.4	0.12	0.3	0.09	0.6	0.18			0.1	0.03	0.4	0.12	0.5	0.15
		0.2	0.06	0.3	0.09	0.5	0.15	1	0.30	0.5	0.15	0.4	0.12	0.6	0.18
2	0.61	0.3	0.09	0.5	0.15	0.5	0.15			0.0	0.00	0.3	0.09	0.4	0.12
		0.1	0.03	0.4	0.12	0.6	0.18	3	0.91	0.0	0.00	0.1	0.03	0.3	0.09
4	1.22	0.3	0.09	0.4	0.12	0.5	0.15			0.0	0.00	0.1	0.03	0.5	0.15
		0.2	0.06	0.4	0.12	0.4	0.12	5	1.52	0.1	0.03	0.2	0.06	0.4	0.12
6	1.83	0.3	0.09	0.8	0.24	0.5	0.15			0.1	0.03	0.1	0.03	0.4	0.12
		1.6	0.49	0.6	0.18	0.8	0.24	7	2.13	0.6	0.18	1.2	0.06	0.7	0.21
8	2.44	1.2	0.37	0.6	0.18	0.9	0.27			1.7	0.52	1.0	0.30	1.0	0.30
		1.3	0.40	0.4	0.12	0.9	0.27	9	2.74	1.2	0.37	0.4	0.12	0.6	0.18
10	3.05	1.0	0.30	0.4	0.12	1.0	0.30			1.4	0.43	0.4	0.12	0.3	0.09
		1.3	0.40	0.6	0.18	0.8	0.24	11	3.35	1.6	0.49	0.1	0.0	0.3	0.09
12	3.66	0.4	0.43	0.4	0.12	0.7	0.21			1.4	0.43	0.5	0.15	0.7	0.21
		0.2	0.06	0.5	0.15	1.2	0.37	13	3.96	0.1	0.03	0.0	0.0	0.8	0.24
14	4.27	0.2	0.06	0.7	0.21	1.5	0.46			0.8	0.24	0.4	0.12	0.6	0.18
		0.4	0.12	0.5	0.15	0.6	0.18	15	4.51	0.5	0.15	0.4	0.12	0.6	0.18
16	4.88	0.7	0.21	1.2	0.37	1.1	0.34			1.6	0.49	0.8	0.24	0.8	0.24
		0.6	0.18	0.8	0.24	1.3	0.40	17	5.18	2.2	0.67	0.6	0.18	1.1	0.34
18	5.49	0.8	0.24	0.6	0.18	1.3	0.40								
		1.0	0.30	0.3	0.09	1.3	0.40	19	-	-	-	-	-	-	-

[a] All pumps on.
[b] From Mossier, 1976.
[c] Taken between trash racks and travelling screens.

(Table IV-36). During this period (May to November) ichthyoplankton mortality is expected to decrease slightly as a result of Unit 4 operation. Ichthyoplankton spawned before May will be subjected to a 5% higher mortality rate when Unit 4 becomes operational than is presently the case. However, only the cisco herring (*Coregonus artedii*) and lake whitefish (*Coregonus clupeaformis*) and burbot (*Lota lota*) have a spawning period the majority of which occurs before May (Table V-10).

When Unit 4 becomes operational, phytoplankton and zooplankton will be subjected to greater increases in mortality than ichthyoplankton. However, these 2 groups of organisms are constantly reproducing, and replacement of destroyed organisms can be extremely rapid. For example, regeneration of copepods after passage through a generating facility has been estimated at 5 days. Replacement periods for, *Ceriodaphnia* and *Simocephalus* populations were found to be 7 and 10 days respectively (28)(32). It was found that phytoplankton productivity returned to normal within a few hours after passage through a power plant (31), and it was reported that phytoplankton can undergo 2 or 3 divisions in a single day. Doubling times for the genus *Asterionella* of 6 hr in the laboratory and 5 to 7 days under natural conditions have also been reported (33). Actual replacement of entrainment losses will require considerably less time as only a portion of each population need be replaced, and because plankton stocks in the discharge embayment will also be contributing individuals to replace those destroyed. Under most operating conditions, replacement of entrainment losses will be compensated by the stimulating effect of the chemical and thermal environment in the discharge embayment.

Predictions for combined Station effluents were made at the discharge point at the Clay Boswell Station. Predicted concentrations of major water quality parameters for average summer, average winter, and worst cause conditions for the existing Units and for all 4 Units are given in Table V-11. Because little or no dilution occurs in the discharge canal and the connecting river embayment (34), water quality is expected to be similar in these 2 locations. Exposure to the predicted concentrations will be short-term for transient plankton and more mobile fish species but long-term for macrophytes, benthic organisms and such resident fish as bass and yellow perch.

The worst case condition was defined as simultaneous outages of Units 1 and 2 requiring the shutdown of all circulating water pumps when river background concentrations are at maximum observed values. It should be noted that simultaneous outages of Units 1 and 2 have occurred only once since Unit 3 went on line in 1973. On this occasion, the combined shutdown was limited to 16 hours and the circulating water pumps were left on. However, Units 1 and 2 are 17 and 19 years old, respectively, and therefore can be expected to experience an increasing frequency of shutdowns. Retirement of these units can be expected before retirement of Units 3 and 4. Both increased outages and retirement will make worst case conditions a more likely occurrence.

Table V-11 indicates that the addition of Unit 4 will have no effect on pH and total suspended solids and will reduce hardness and increase nutrients, especially during worst case conditions; and will increase sulfates and chlorides. The changes in hardness which will result from the addition of Unit 4 will usually cause discharge hardness to more closely approximate amibient river conditions (i.e., 200 mg per liter $CaCO_3$) than is presently the case. Little impact is expected from this.

Under normal operating conditions the increases in phosphorus and silica caused by the addition of Unit 4 are expected to result in little or no perceptible effect. This is because such a small portion of the phosphorus increase will be in a chemical form useable by phytoplankton (36) and because silica concentrations are already at a level sufficient for maximum diatom growth (37). Under worst case conditions, nutrient concentrations are more substantially increased, but little effect is predicted given short-term occurrences of these conditions. If worst case conditions were to persist, extensive algal blooms could be expected. Because nitrates are needed by algae in much higher quantities than phosphorus, the equal concentrations of both nutrients in the discharge will probably result in algal growth limited by nitrates. Blue-green algae could be expected to dominate such a system because they can fix atmospheric nitrogen, are thermophilic, and are less susceptible to zooplankton grazing losses (33), thus resulting in adverse impacts.

In receiving an NPDES Permit for the Clay Boswell Station, permit conditions specified sulfate concentrations as dischanged to the receiving water. As measured at the Cohasset Bridge, sulfate concentrations must not

TABLE V-10

SUMMARY OF ALL FISH COLLECTIONS BY ALL GEAR TYPES[a] - MISSISSIPPI RIVER NEAR CLAY BOSWELL STEAM ELECTRIC STATION - SEPTEMBER 1975 THROUGH AUGUST 1976

	Total Number	Percent Composition Number	Percent Composition Weight	Total Weight kg	Length cm 0 to 3	>3 to 6	>6 to 9	>9 to 12	>12 to 15	>15 to 21	>21 to 27	>27 to 33	>33 to 41	>42 to 51	>51 to 60	>60
Bowfin	430	3.0	18.8	782.03	0	0	0	0	0	0	1	1	9	51	266	102
Cisco herring	9	.1	.1	3.92	0	0	0	0	0	0	0	3	6	9	0	0
Lake whitefish	23	.2	.5	22.66	0	0	0	0	0	0	0	5	7	5	3	3
Central mudminnow	3	0.0	0.9	.03	0	0	3	0	0	0	0	0	0	0	0	0
Northern pike	311	2.2	5.9	245.86	0	0	1	0	0	2	2	7	93	116	53	37
Golden shiner	8	.1	0.0	.04	0	0	6	2	0	0	0	0	0	0	0	0
Shiners	2	0.0	0.0	.01	1	1	0	0	0	0	0	0	0	0	0	0
Common shiner	7	0.0	0.0	.04	0	2	3	1	1	0	0	0	0	0	0	0
Blackchin shiner	4	0.0	0.0	.01	0	4	0	0	0	0	0	0	0	0	0	0
Spottail shiner	55	.4	0.0	.18	0	16	29	10	0	0	0	0	0	0	0	0
Bluntnose minnow	1	0.0	0.0	0.00	0	0	0	0	0	0	0	0	0	0	0	0
Minnows F.	5	0.0	0.0	.01	0	5	0	0	0	0	0	0	0	0	0	0
Longnose sucker	1	0.0	0.0	1.36	0	0	0	0	0	0	0	0	0	1	0	0
White sucker	191	1.3	5.5	229.73	0	1	0	1	1	1	4	7	16	117	43	0
Northern hog sucker	1	0.0	0.0	.02	0	0	0	0	1	0	0	0	0	0	0	0
Redhorses	41	.3	1.6	67.58	0	0	0	0	0	0	0	1	5	15	9	9
Silver redhorse	1	0.0	0.0	.68	0	0	0	0	0	0	0	0	1	0	0	0
Shorthead redhorse	28	.2	.9	35.32	0	0	0	0	0	0	0	3	3	14	4	4
Black bullhead	2,983	20.9	11.8	491.25	0	2	0	5	37	740	2,138	61	0	0	0	0
Yellow bullhead	3,697	25.9	20.2	838.27	0	0	3	2	15	282	3,129	261	5	0	0	0
Brown bullhead	2,925	20.5	18.3	759.53	0	2	1	7	9	232	2,295	367	10	1	0	1
Madtom tadpole	1	0.0	0.0	.01	0	0	1	0	0	0	0	0	0	0	0	0
Burbot	4	0.0	0.0	1.43	0	0	0	0	0	0	0	2	2	0	0	0
Rock bass	908	6.4	5.5	226.23	2	0	3	10	66	300	480	43	2	0	0	0
Pumpkinseed	399	2.8	1.1	45.48	1	0	0	9	118	267	3	1	0	0	0	0
Bluegill	647	4.5	1.4	57.75	1	67	34	124	183	180	58	0	0	0	0	0
Largemouth bass	195	1.4	1.0	39.76	2	10	39	33	37	21	26	7	13	6	1	0
Black crappie	82	.6	.6	26.79	0	0	6	0	0	27	17	31	1	0	0	0
Johnny darter	1	0.0	0.0	0.00	0	1	0	0	0	0	0	0	0	0	0	0
Yellow perch	1,157	8.1	3.8	157.53	6	102	137	33	86	236	449	93	0	0	0	0
Walleye	125	.9	2.8	115.52	0	0	1	0	0	2	10	20	31	34	12	15
Total	14,247			4,149.14	13	214	267	230	555	2,290	8,614	913	204	361	407	171

[a] Zones: Upstream, discharge, intermediate discharge, downstream.

TABLE V-11
DISCHARGE WATER QUALITY COMPARISONS - CLAY BOSWELL STEAM ELECTRIC STATION (35)

	Summer		Winter		Existing Units 1, 2, and 3 Worst Case (i.e. Unit 3 only)	Units 1, 2, 3, and 4 Worst Case (i.e. Units 3 and 4 only)
	Units 1, 2, and 3	Units 1, 2, 3, and 4	Units 1, 2, and 3	Units 1, 2, 3, and 4		
pH	7.7	7.7	7.7	7.7	6.5 to 8.5	6.5 to 8.5
Chloride						
mg per liter	8.0	13	15	25	153	355
Sulfate						
mg per liter	30	36	58	68	577	800
Total suspended solids (TDS)						
mg per liter	30	30	30	30	30	30
Hardness						
mg per liter as $CaCO_3$	165	160	318	304	783	364
Nitrate						
mg per liter	0.11	0.11	0.21	0.21	0.7	1.2
Total phosphorus						
mg per liter	0.07	0.08	0.14	0.15	1.06	1.69
Silica						
mg per liter SiO_2	7.6	8.4	15	16.0	9.7	35

TABLE V-12

SENSITIVITY TO CHLORINE OF GENERA FOUND NEAR CLAY BOSWELL STEAM ELECTRIC STATION[a]

Scientific Name	Common Name	Concentration mg per liter	Duration of Exposure min	Effect
Phytoplankton		0.4	not given	50% decrease in growth
Scenedesmus	green alga	2.0	4,320	decreased growth
		10.0	5,760	mortality threshold
Nitzschia	diatom	2.0	4,320	decreased growth
Microcvstis	blue-green alga	2.0	4,320	decreased growth
Invertebrate Animals				
Protozoa (many species)		2.8	<1	some mortality
Crustacea				
Cyclops		1.0	30	some mortality
Daphnia	water flea	4.0	2,880	mortality threshold
		0.125	240	100% mortality
		0.002	20,160	decreased reporduction
		0.5	4,320	100% mortality
		0.5	60	some mortality
Gammarus	scud	0.023	2,880	50% mortality
		0.035	151,200	80% mortality
		0.22	5,760	50% mortality
		0.0034	151,200	almost 0 reproduction
		0.054	161,280	decreased survival
		0.019	201,600	decreased reproduction
		0.135	43,200	no effect
		0.900	1,440	50% mortality
Insecta				
Chironomus	midge	7.0	1,440	80% mortality
Ephemerella	mayfly	0.027	2,880	50% mortality
Hydropsyche	caddis fly	0.396	480	50% mortality
		0.55	10,080	50% mortality
Stenonama	mayfly	0.502	480	50% mortality

Scientific Name	Common Name	Concentration mg per liter	Duration of Exposure min	Effect
Fish				
Esox	pike	0.7	1,800	100% mortality
	pickerel	1.0	60	100% mortality
Catastomus	suckers	1.0	60	100% mortality
	suckers	0.248	720	50% mortality
Notemigonus	golden shiner	3,000.0 +	0.17	100% mortality
		0.8	240	100% mortality
Notropis	shiner	0.7	76	100% mortality
		0.07	180	100% mortality
		0.7	79	100% mortality
Pimephales		0.7	61	100% mortality
		0.108	43,200	60% mortality
		0.108	43,200	68% mortality
		0.043	10,080	50% mortality
		0.08 to 0.19	5,760	50% mortality
		0.05	5,760	threshold mortality
		0.02	7,200	50% mortality
		0.185	720	50% mortality
		0.110	100,800	no spawning
Ictalurus	bullhead	4.5	440	50% mortality
		1.36	25	some mortality
Micropterus	bass	0.5	900	50% mortality
		0.494	1,440	50% mortality
Pemoxis	crappie	1.36	25	some mortality
Perca	perch	0.72	65	some mortality
		0.365	720	50% mortality
Stizostedion	walleye and sauger	0.267	720	50% mortality

[a] Derived from Mattice and Zittel, 1976

exceed 40 mg per liter during the period of April 15 to June 15 and 60 mg per liter at all other times. The permit also requires that a study be conducted to evaluate the effects of sulfate discharges on wild rice. Preliminary results of the study, as reported in an interim report prepared in January, 1977 indicate that during its submerged phase of growth, wild rice is enhanced by the influence of the Clay Boswell Station. It is not yet known if the difference is due to temperature, chemical, or depth variables, but it is suspected that temperature is the contributing factor. During the later stages of development (floating leaf, emergent, and flowering stages), it appears that the growth of wild rice is affected by interspecific and intraspecific competition and not by the Clay Boswell Station. On the basis of these preliminary findings, it appears that elevated sulfate concentrations from the Clay Boswell Station have no direct toxic impact upon the growth of wild rice, and that no impact from Unit 4 sulfate discharges will occur.

Chloride concentrations as low as 400 mg per liter are reported to be harmful to trout, although most fish are not affected until concentrations exceed 2,000 mg per liter (22). Under normal conditions, chloride concentrations will be well below these values. Under worst case conditions, a concentration of 355 mg per liter is expected. *Coregonus clupeaformis* (lake whitefish) and *Coregonus artedii*(cisco herring) have been occasionally found in the vicinity of the Station. As these species are closely related to trout, they may be repelled or damaged by worst case chloride concentrations. These 2 species do not appear to be significant members of the aquatic ecosystem in the vicinity of the Clay Boswell Station.

In addition to the changed concentrations of chemicals listed in Table V-11, aquatic organisms near the discharge canal will be exposed to chlorine for a longer period of time each day as a result of Unit 4 operation. Chlorine will be added to the circulating water system of Unit 4 for 20 to 30 minutes during each of 3 shifts (35). This is in addition to a maximum possible chlorination time of 120 minutes for Units 1, 2, and 3. Maximum residual chlorine concentrations in the Unit 4 circulating water system will be 0.2 mg per liter (35). During normal operating conditions, a concentration of 0.0016 mg per liter is expected after the Unit 4 discharge mixes with dischange from Units 1, 2, and 3. During worst case conditions (i.e., only Units 3 and 4 operating), chlorine concentrations will be approximately 0.038 mg per liter but chlorination time for the other units will be reduced to 120 minutes. The sensitivity to chlorine of genera indigenous to the Mississippi River in the vicinity of the Clay Boswell Station is summarized in Table V-12. On the basis of the available information, it does not appear that chlorine from Unit 4 will be harmful to any indigenous aquatic organisms, provided that the discharge from Units 1, 2, 3, and 4 does not exceed a daily discharge of 0.2 mg per liter for a total of 2 hours per day, or a continous discharge of 0.03 mg per liter as a daily average, and 0.05 mg per liter as a daily maximum.

Predicted concentrations of heavy metals in the discharge canal are given in Table V-13. During normal operating conditions, average concentrations which will result from operations of Units 1, 2, 3, and 4 will be similar to background concentrations and the concentrations presently resulting from the operation of Units 1, 2, and 3. During worst case conditions (i.e., Units 1 and 2 shutdown and maximum background concentrations of metals), concentrations of heavy

TABLE V-13
ESTIMATED HEAVY METAL CONCENTRATIONS IN COMBINED DISCHARGES AT THE DISCHARGE CANAL
CLAY BOSWELL STEAM ELECTRIC STATION (25)

Heavy Metal	Background Concentrations Average	Background Concentrations Maximum	Units 1, 2, and 3 Average	Units 1, 2, 3, and 4 Average	Units 1, 2, and 3 Worst Case	Units 1, 2, 3, and 4 Worst Case
Copper[a]						
mg per liter	0.011	0.045	0.0127	0.012	0.067	0.110
Lead						
mg per liter	0.036	0.45	0.037	0.04	0.575	1.057
Mercury						
mg per liter	0.00025	0.0014	0.000273	0.000266	0.00189	0 00327
Nickel						
mg per liter	0.018	0.16	0.0185	0.0195	0.206	0.376
Zinc						
mg per liter	0.068	0.39	0.0701	0.0716	0.495	0.895

[a] Does not include possible copper additions from condenser tubing corrosion and erosion.

metals in the plant discharge after Unit 4 becomes operational will be almost double those predicted for the present Units 1, 2, and 3.

Concentrations of lead, nickel, and zinc reported to be fatal to aquatic organisms after short-term exposures in hard water are generally greater than predicted worst case concentrations in the discharge canal. Similarly, average discharge concentrations are less than those reported to cause undesirable effects with chronic exposures. Predicted concentrations of mercury are below most recommended limits. However, long-term exposure of the fathead minnow (an indigenous species) to pure methyl mercury at concentrations less than the concentration of total mercury expected in the discharge (0.0002 mg per liter versus 0.000266 mg per liter) is reported to have detrimental effects on that species. It should be noted that this concentration of methyl mercury is also less than the background concentration of total mercury in the Mississippi River (0.00025 mg per liter).

The accuracy of predicted copper concentrations is questionable. The predictions are based on background data from the MPCA using analysis methods which could have resulted in measurement error (39).

Copper condenser tubing corrosion and erosion were not included in discharge copper concentration estimates because of difficulties in quantifying this source of copper. Using published rates of corrosion (40), copper concentrations in excess of 1 mg per liter were predicted for the Units 3 and 4 blowdown. However, these values are not supported by measurements of copper concentrations in existing closed cycle cooling systems (41) which found average increases in total copper in the condenser water ranging from 0.062 to 0.067 mg per liter.

If the assumption is made that copper concentrations as high as 1 mg per liter could result from copper condenser tubing corrosion and erosion, the worst case copper levels from the tubing and combined Station discharges could be as high as 1.11 mg per liter. Assuming the more conservative estimate of condenser tubing levels of approximately 0.065 mg per liter (41), average copper levels of 0.077 mg per liter are expected.

There are numerous published studies involving the acute and chronic effects of copper upon species of aquatic life. The effects of copper upon aquatic organisms can be categorized both on the basis of biotic effect and the temporal characteristics of copper exposure. Ingestion of copper is essential for many organisms. Thus, extremely low concentrations of copper can be beneficial. Higher concentrations of copper have detrimental effects which may be either lethal or sublethal. Lethal effects are those directly resulting in the death of the exposed organism. Sublethal effects are those in which copper does not directly cause death of an organism, but may cause changes in behavior, reproductive success, etc. It should be noted that sublethal effects can result in the death of an organism, but only in an indirect manner. For example, copper exposure may change a behavioral pattern such that vulnerability to predators is increased. Temporal categorization is based on the length of time an organism is exposed to copper. Short-term exposures are termed acute while long-term exposures are referred to as chronic. In distinguishing between chronic and acute exposures, the proportion of the exposure time to an organism's life expectancy should be taken into account.

The toxicity of copper to aquatic organisms in a given water body is dependent on the degree to which the cupric ion is complexed. Copper has been shown to be less toxic in waters with higher concentrations of dissolved organic material and/or hardness (22) (42) (43) (44) (45) (46). It has been stated that the hardness effect is probably due to increased alkalinity (47) (48). As a result of these observations, it has been hypothesized that the cupric ion was the major toxic form of copper (48). However, the evidence intended to support their hypothesis is not convincing. No difference has been found in rainbow trout mortalities when cupric ion concentrations were varied by a factor of 10 by adjusting pH (49). Some evidence has been found that both copper (II) and colloidal carbonate complexes were toxic to the snails (*Stagnicola* and *Physa* spp.) (46).

Certain copper toxicity values (42) (50) and the values in certain hard water tests (45) are probably most indicative of the effects of copper on the aquatic biota in the vicinity of the Clay Boswell Station. This is because the species tested are also found in the Mississippi River, and because the water they used had a similar hardness. Of the species tested, *Ictalurus nebulosus* (brown bullhead) was most sensitive to acute exposures (96 hr TL_{50} of 0.170 mg per liter). The cronic exposure of *Pimephales promelas* (fathead minnow) to copper concentrations as low as 0.034 mg per liter is reported to inhibit spawning.

A comparison of these data to the estimated average concentration of 0.077 mg per liter indicates that impacts relating to chronic copper toxicity could result. It should be emphasized that the value of 0.077 mg per liter is only a rough estimate of the copper concentrations to be expected in station discharge and that higher or low concentrations could result.

Unit 4 of the Clay Boswell Station will utilize a mechanical draft cooling tower with recirculating flow. Originally, it was calculated that the operation of Unit 4 would increase station discharges by a maximum of 0.07°C in the winter and decrease discharge temperatures by a maximum of 0.28°C in the summer (51). A water management study completed in February, 1977 (35) indicates that under average flow conditions, the addition of Unit 4 will result in even smaller changes in temperature than originally anticipated. Since the overall thermal effects of Unit 4 will be negligible, no thermal impacts upon the aquatic ecosystem of the Mississippi River are anticipated under average flow conditions. However, under low flow conditions of 100 cfs (2.83 cu m per sec) and a Station withdrawal rate of 252 to 268 cfs (7.13 to 7.52 cu m per sec), a reversal of flow in Blackwater Lake would occur between the intake and discharge of the Clay Boswell Station. This recirculation of water could cause a water temperature rise both upstream and downstream from the Station's discharge point, with resultant thermal impacts upon the aquatic biota in the vicinity of the recirculation zone. At a river low flow of 216 cfs (6.12 cu m per sec), a temperature rise of 5°F (2.8°C) will occur immediately downstream and upstream of the discharge point (34). Obviously, a greater increase in temperature is expected at a river low flow of 100 cfs (2.83 cu m per sec). The degree of thermal impact will be determined largely by the duration of the flow reversal, the ambient temperature of the water, and the season in which the flow reversal occurs.

The addition of Unit 4 at the Clay Boswell Station will cause increases in emissions of sulfur dioxide, nitrogen dioxide, particulates, and trace elements, due to the increased operational capacity of the Station. Although the emission levels of trace elements will be very low, there exists the potential for some trace element build-up in the sediments of the Mississippi River and surrounding lakes. There is insufficient data available to determine whether the increases will be great enough to adversely affect the aquatic ecosystems of the waters.

Sulfur dioxide and nitrogen dioxide may undergo atmospheric oxidation to form sulfuric, sulfurous, and nitric acids, which can substantially alter the pH of rainfall. It is doubtful that acid rain will significantly alter the pH of the Mississippi River in the vicinity of the Clay Boswell Station, because of the good buffering capacity of the system and the flow of the water. It is possible, however, that lakes in the vicinity of the Station could undergo gradual changes in pH, with resulting changes in the species composition of the lake, toward more acid tolerant species. The acid rain phenomenon has not been documented for Minnesota waters, but has recently been observed in the northeastern states (52).

Termination of operations of Unit 4 at the Clay Boswell Station will have a negligible impact upon the aquatic biology of the Mississippi River and nearby lakes. The thermal discharges from the Unit 4 will result in discharge temperatures differing by less than 0.25° C from those of Units 1, 2, and 3. Chemical discharges of sulfates, chlorides, and total hardness from the Station will decrease slightly, due to the elimination of Unit 4 discharges. A number of other parameters which will undergo slight increases in concentration due to the evaporative losses of Unit 4 will also decrease slightly, more closely approaching the ambient concentrations of the river. None of the changes brought about by the termination of Unit 4 will be substantial enough to bring about any changes in the community structure of aquatic ecosystems in the vicinity of the Clay Boswell Station.

Aquatic Biology Impacts of Alternatives

Waste Wood as Supplemental Fuel

The use of waste wood as a supplemental fuel source will result in a 7% decrease in solid waste production, due to the low ash content of wood. In addition, SO_2 emissions will decrease by approximately 10% for worst case conditions, from 8,878 lb per hr (4,027 kg per hr) to 7,988 lb per hr (3,623 kg per hr). For average operating conditions, SO_2 emissions will be the same when burning coal and waste wood as when burning coal only. Because of the very slight reduction of SO_2 emissions, the use of waste wood has little potential for reducing any impacts to aquatic biota due to air emissions from Unit 4.

A present environmental concern in northern Minnesota is possible surface water contamination by seepage from waste wood disposal sites. The utilization of waste wood by Unit 4 could have beneficial impacts on aquatic biota near waste wood disposal sites by reducing the amount of waste wood requiring disposal in landfill areas and, hence, reducing the potential for seepage.

Coal Beneficiation

Coal beneficiation will have beneficial aquatic biology impacts in Minnesota when compared to MP&L's proposed action. Unit 4 solid waste production will be reduced 37% by using beneficiated coal, resulting in a significant reduction in area and volume required for MP&L's proposed new ash and SO_2 sludge pond. Thus, potential leachate seepage into surface waters from the disposal pond and possibly adverse aquatic biology impacts can be reduced by using beneficiated coal at the Clay Boswell Station.

Coal beneficiation possibly could have adverse impacts on aquatic biota in the vicinity of the Big Sky Mine in Montana. These adverse impacts would result from the disposal of coal cleaning rejects or waste from the coal preparation plant at the mine.

With the arid climate at the Big Sky Mine, the coal waste disposal system can be designed and engineered so that impacts to aquatic biota will be minimal.

Dry Cooling Towers

When compared to MP&L's proposed Unit 4 wet cooling towers, the use of dry cooling towers will result in consumptive water usage being decreased 3,465 gpm (13,116 lpm). This will eliminate almost all of the consumptive water usage and water discharges from Unit 4 and will virtually eliminate the potential for impacts to the aquatic biota of the Mississippi River relating to MP&L's proposed Unit 4 wet cooling towers.

Dry cooling towers will decrease Unit 4 efficiency when compared to MP&L's proposed wet cooling towers. If the Clay Boswell Station is operated at the same gross generating capacity independent of cooling tower type, then the water quality impacts related to MP&L's proposed wet cooling towers will be eliminated and the impacts related to other aspects of the Station will remain unchanged. However, if the Clay Boswell Station is to have the same net generating capacity with dry as with wet cooling towers, the dry cooling towers will require increased coal consumption and a resultant increase in solid waste production. This solid waste production increase is estimated to be 0.5 to 5%, which will slightly increase the potential for surface water contamination due to leachate seepage from ash and scrubber sludge ponds.

Wet/Dry Cooling Towers

The aquatic biology impacts of wet/dry cooling towers depends on the ratio of wet to dry cooling. Based on wet/dry cooling towers designed for 80% wet or evaporative and 20% dry, wet/dry cooling towers will reduce water consumption 693 gpm (2,623 lpm) when compared to MP&L's proposed Unit 4 wet cooling towers. The reduced water consumption of wet/dry cooling towers will decrease the potential for impacts to the aquatic biota of the Mississippi River. However, this impact reduction is not expected to significantly alter the overall aquatic biota impacts of the proposed Unit 4.

As with dry cooling towers, wet/dry cooling towers could result in increased solid waste production if the Clay Boswell Station was operated to have the same net generating capacity with wet/dry cooling towers as with MP&L's proposed wet cooling towers. However, the potential for increased impact to aquatic biota due to leachate seepage from ash and scrubber sludge ponds is minimal since solid waste production is estimated to increase 0.05 to 0.5% only.

Disposal of Solid Waste in an Abandoned Mine

The disposal of Unit 4 solid waste in abandoned open pit iron ore mines, rather than in the proposed new ash and SO_2 scrubber sludge pond will decrease the potential for impacts to aquatic species in the vicinity of the Clay Boswell Station but increase the potential of impacts to aquatic species in the vicinity of the abandoned mine disposal site. The degree of impact will be determined largely by the geologic structure of the abandoned mine disposal area.

METEOROLOGY

Meteorology Impacts of Proposed Action

No significant impacts relative to weather and climate are anticipated as a result of the construction or operation of MP&L's proposed Unit 4 at the Clay Boswell Station. Influences on the atmosphere will occur, but they are not necessarily negative, and they will be minimized by the favorable meteorology of the area surrounding the Clay Boswell Station.

Operation of Unit 4 will result in emission of a liquid-water plume which will reduce the amount of sunshine available at the earth's surface. Due to the configuration of the facility and the surrounding terrain, the plume will reduce the sunshine only a fraction of a percent of the time at any point outside the Clay Boswell Station property boundaries. The plume will not be present to a significant extent during the growing season, so solar energy to crops should not be reduced or impaired.

Operation of the Clay Boswell Station could cause a very slight increase in precipitation, but this would probably be regarded as a positive impact.

Increased amounts of heat, in addition to increased carbon dioxide and particulate emissions, will be added to the atmosphere as a result of the Station's operation, adding a very small amount to the world total. These factors all affect the world climate, but addition of these to the atmosphere from any single electric generating facility is insignificant. However, there is concern regarding the meteorology impact of cumulative emissions from many point sources.

Meteorology Impacts of Alternatives

None of the reasonable alternatives to MP&L's proposed action are expected to have any significant impacts relative to weather and climate. However, the use of dry or wet/dry cooling towers could eliminate or substantially decrease the liquid-water plume which will occur with MP&L's proposed Unit 4 wet cooling towers.

AIR QUALITY

Introduction

Air pollution is a source-transport-effect phenomenon which may be viewed on several scales; e.g. local, state, national, continental, or global. The time frames within which problems appear and remedial measures can be taken correspondingly range from hours to decades. While this Environmental Impact Statement can present details on only the proposed Clay Boswell Station Unit 4 and alternatives, it nonetheless is important to outline the Minnesota, national, and global air pollution perspectives. This is done following the discussion of the ambient air pollutant concentrations projected to result from the emissions of the proposed Unit 4 and alternatives.

Air Quality Impacts of the Proposed Action

The major types of pollutants emitted by large coal-fired steam electric stations are particulates, nitrogen oxides (NO_x), sulfur dioxide (SO_2), trace elements, and sulfates. The ambient concentrations of particulates, NO_x, SO_2, trace elements, and sulfates projected to result from the emissions of the proposed action were calculated by the use of diffusion modeling. The models, methodology, and meteorological data utilized for this process were the same as used for the emissions of the pre-modified and modified Units 1, 2, and 3 at the Clay Boswell Station and are discussed in the Air Quality section of Chapter IV. Tables IV-48 through IV-53 present data on the regional air quality in northern Minnesota. Tables IV-60 and IV-63 present the calculated pollutant concentrations resulting from the emissions of pre-modified Units 1, 2, and 3, while Tables IV-66 and IV-68 do the same for modified Units 1, 2, and 3. Tables V-14 through V-17 list the coal analyses, stack exhaust characteristics, and pollutant emission rates used for the diffusion modeling of the emissions of proposed Unit 4.

The various ambient air quality standards (AAQS) and prevention of significant air quality deterioration (PSD) regulations (Table IV-47) are assumed to provide valid indices of the probable environmental impacts of the proposed action and alternatives (refer to Chapter I and the Air Quality section of Chapter IV). The results of diffusion modeling indicate that the emissions of the proposed Unit 4 will comply with the PSD regulations, but when combined with the emissions of modified Units 1, 2, and 3, the total emissions of the Clay Boswell Station will cause the applicable AAQS to be exceeded by substantial amounts. The AAQS violations are primarily due to the high sulfur content and low heating value of the coal which MP&L has proposed to burn at the Clay Boswell Station. MP&L has the authority under its present coal contract with its supplier, Peabody Coal Company, to negotiate "rejection points" for coal received, but to date these have not been established. The discussions of the needed characteristics of this "compliance coal" and the associated ambient pollutant concentrations are presented after the discussion of the proposed action.

TABLE V-14
COAL ANALYSES USED FOR AIR QUALITY DIFFUSION MODELING
PROPOSED UNIT 4 - DESIGN PERFORMANCE COAL
CLAY BOSWELL STEAM ELECTRIC STATION

Parameter	Annual Average	Worst Case
Heating value		
Btu per lb	8,610	7,509
kg-cal per lb	4,783	4,172
Ash		
%	9.35	15.99[a]
Sulfur		
%	1.03	4.55[b]
Arsenic, ppm[c]	1.75	na[d]
Barium, ppm	425.00	na
Beryllium, ppm	0.63	na
Cadmium, ppm	0.10	na
Chromium, ppm	2.75	na
Cobalt, ppm	0.88	na
Copper, ppm	6.93	na
Fluorine, ppm	63.50	na
Gallium, ppm	2.75	na
Lead, ppm	7.00	na
Manganese, ppm	26.25	na
Mercury, ppm	0.07	na
Molybdenum, ppm	5.43	na
Nickel, ppm	2.75	na
Strontium, ppm	162.50	na
Titanium, ppm	252.50	na
Uranium, ppm	0.70	na
Vanadium, ppm	6.60	na
Zinc, ppm	4.70	na

[a] For Unit 4 to comply with New Source Performance Standards (NSPS) limiting particulate emissions to 0.1 lb per million Btu (0.180 kg per million kg-cal) input, a particulate removal efficiency of 99.73% is necessary, and coal must have an ash content of 32.71% or less and a highest heating value of 7,509 Btu per lb (4,172 kg-cal per kg) or more. A fly ash to bottom ash ratio of 85% to 15% is assumed.

[b] For Unit 4 to comply with NSPS limiting SO_2 emissions to 1.2 lb per million Btu (2.16 kg per million kg-cal) input, a SO_2 removal efficiency of 85% is necessary, and coal must have a sulfur content of 3.16% or less and a highest heating value of 7,509 Btu per lb (4,172 kg-cal per kg) or more. The emission rate is based on 38(%S) or 95% of the sulfur leaving the boiler.

[c] ppm means parts per million.

[d] na means not available.

TABLE V-15
STACK EXHAUST CHARACTERISTICS USED FOR AIR QUALITY DIFFUSION MODELING
PROPOSED UNIT 4 - CLAY BOSWELL STEAM ELECTRIC STATION

Parameter	Characteristic
Stack height	
ft	600
m	183.5
Stack diameter	
ft	22.75
m	6.96
Exhaust temperature	
°F	155[a]
°C	68.33[a]
Average gas flow rate	
cfm	1,531,199
cu m per sec	729

[a] This is the temperature with plume reheat. Without reheat, the temperature is 129°F (53.89°C).

TABLE V-16
PARTICULATES, NO_x, AND SO_2 EMISSION RATES USED FOR
AIR QUALITY DIFFUSION MODELING
PROPOSED UNIT 4 - DESIGN PERFORMANCE COAL
CLAY BOSWELL STEAM ELECTRIC STATION

Pollutant	Annual Average	Worst Case
Particulates[a]		
lb per hr	514	514
kg per hr	233	233
NO_x[b]		
lb per hr	3,598	3,598
kg per hr	1,632	1,632
SO_2		
lb per hr	6,169[c]	8,894[d]
kg per hr	2,798[c]	4,034[d]

[a] Average and worst case emissions based on 0.1 lb per million Btu (0.180 kg per million kg-cal) input (NSPS).

[b] Average and worst case emissions based on 0.7 lb per million Btu (1.26 kg per million kg-cal) input (NSPS).

[c] Average emissions based on 1.2 lb per million Btu (2.16 kg per million kg-cal) input (NSPS).

[d] Worst case emissions based on worst case coal and worst case scrubber control efficiencies.

TABLE V-17
TRACE ELEMENT AND SULFATE EMISSION RATES
USED FOR AIR QUALITY DIFFUSION MODELING
PROPOSED UNIT 4 - DESIGN PERFORMANCE COAL
CLAY BOSWELL STEAM ELECTRIC STATION

Pollutant	lb per hr	kg per hr
Arsenic	0.24	0.11
Barium	14.56	6.60
Beryllium	0.02	0.01
Cadmium	0.02	0.01
Chromium	0.33	0.15
Cobalt	0.03	0.01
Copper	0.47	0.21
Fluorine	20.84	9.45
Gallium	0.75	0.34
Lead	1.92	0.87
Mercury	0.04	0.02
Manganese	1.80	0.82
Molybdenum	0.75	0.34
Nickel	0.19	0.09
Strontium	5.58	2.53
Sulfates	49.40[a]	22.41[a]
Titanium	27.02	12.26
Uranium	0.02	0.01
Vanadium	0.89	0.40
Zinc	1.30	0.59
Total	125.79	57.06

[a] Sulfates emissions estimated to be 50% non-acid sulfates.

Note: Unit 4 will have a wet particulate scrubber and spray tower absorbers. The estimated removal efficiencies are 95% for metals and mists and 10% for gaseous trace elements. The maximum air emissions are based on coal with a heating value of 7,509 Btu per lb (4,172 kg-cal per kg).

Particulates

The projected ambient particulate concentrations resulting from the emissions of proposed Unit 4 are presented in Table V-18 (the coal analyses and emission rates used for proposed Unit 4 are those for the design performance ("expected") coal proposed by MP&L and presented in Tables V-14 and V-16. Figures V-4 and V-5 illustrate the spatial distribution of the annual geometric mean and 24-hr maximum particulate concentrations, respectively, for proposed Unit 4.

TABLE V-18
PROJECTED PARTICULATES, NO_x, AND SO_2 CONCENTRATIONS RESULTING FROM EMISSIONS OF MODIFIED UNITS 1, 2, AND 3, AND PROPOSED UNIT 4 - DESIGN PERFORMANCE COAL
CLAY BOSWELL STEAM ELECTRIC STATION

Pollutant	Units 1, 2, and 3 µg per cu m	Proposed Unit 4 µg per cu m	Measured Background[a] µg per cu m	Total[b] µg per cu m	PSD[c] Increment µg per cu m	Minnesota Secondary Standard µg per cu m
Particulates						
Annual geometric mean	0.2	0.2	18	18.4	10	60
24-hr maximum	13.5	3.8	107	124.3	30	150
NO_x						
Annual arithmetic mean	0.5	1.2	14	15.7	no standard	100
SO_2						
Annual arithmetic mean	1.0	2.0	0.4	3.4	15	60
24-hr maximum	244	66	5	315	100	260
3-hr maximum	861	252	15	1,128	700	655

[a] Estimations of background concentrations are discussed in Air Quality section of Chapter IV.

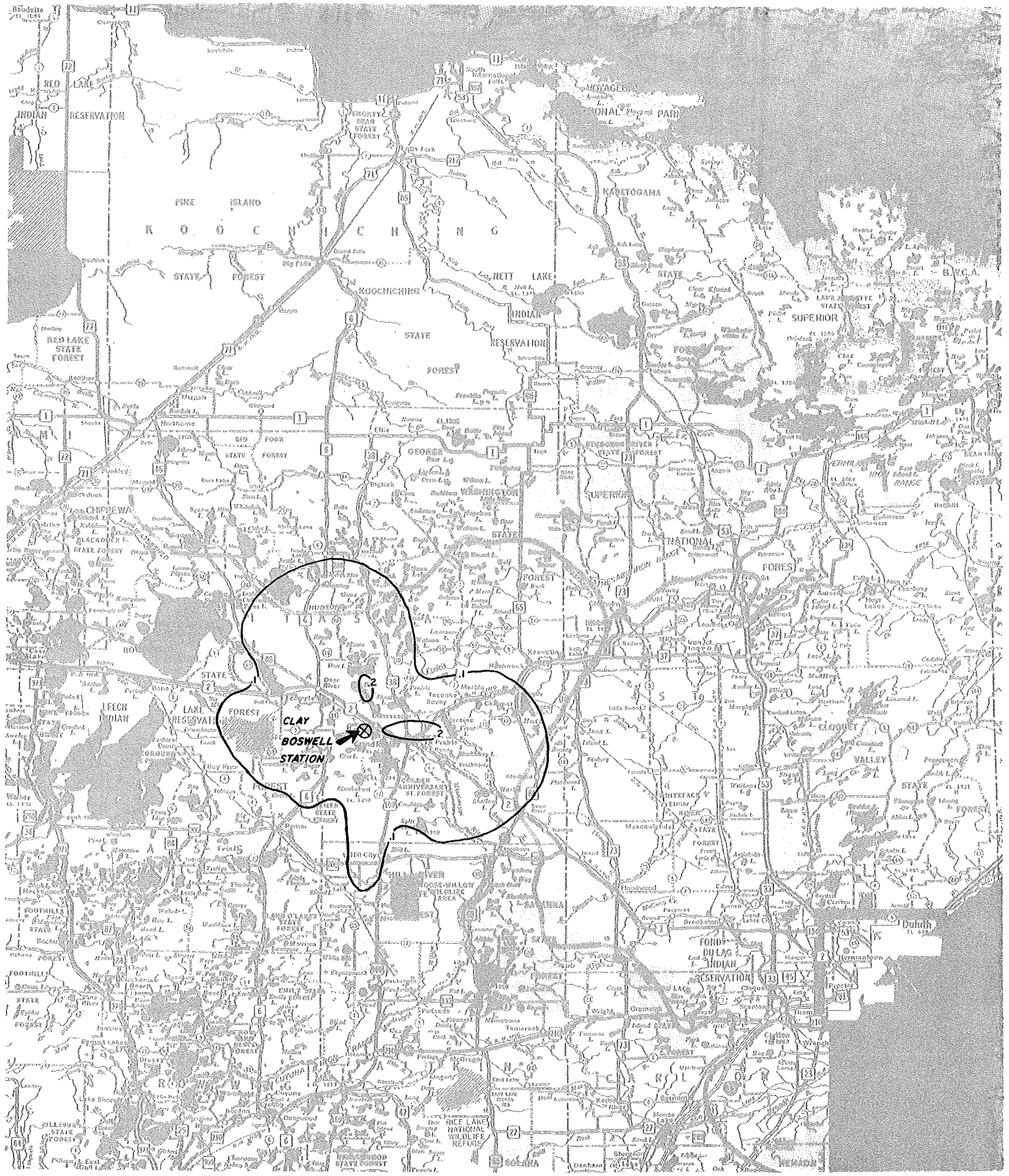
[b] Concentrations resulting from proposed Unit 4 may not occur during the same time periods or at the same locations as concentrations resulting from modified Units 1, 2, and 3, but have been added here for worst case comparisons.

[c] PSD regulations apply only to Unit 4.

Table V-18 includes the Class II PSD increment regulations which apply to Unit 4 at the Clay Boswell Station. The proposed Unit 4 is projected to contribute approximately 12.7% of the allowable 24-hr particulate increment, and 2% of the annual particulate increment. Note that there are no PSD regulations for NO_x, trace elements, or sulfates, nor do the PSD regulations apply to modified Units 1, 2, and 3 (refer to Chapter I).

Table V-18 also includes the concentrations resulting from modified Units 1, 2, and 3, and the measured background concentrations for the Clay Boswell Station locality. The ambient pollutant concentrations resulting from the emissions of the proposed Unit 4 may not occur during the same time periods nor at the same locations as the ambient concentrations resulting from the emissions of modified Units 1, 2, and 3. The concentrations have been added, however, to allow a worst case comparison with the applicable AAQS. Table V-18 indicates that Units 1, 2, 3, and 4 will comply with the particulate AAQS (the secondary AAQS are the applicable standards; refer to Chapter I). Figures V-6 and V-7 present the particulate isopleths for the combined operation of modified Units 1, 2, and 3 and proposed Unit 4.

Table V-19 presents the particle size distribution of the particulates to be emitted by modified Units 1, 2, and 3 and proposed Unit 4 (refer to Air Quality section of Chapter IV for methodology). Note that 90% of the particulates from Units 1, 2, and 3 and 76% of the particulates from proposed Unit 4 are in the relatively hazardous size class of less than 5 microns (see later discussion).



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

BASE MAP LEGEND

INTERSTATE
MULTILANE DIVIDED HIGHWAY
MULTILANE UNDIVIDED HIGHWAY
INTERMEDIATE TYPE
GRAVEL SURFACED
SECONDARY ROAD-HARD SURFACED
SECONDARY ROAD-GRAVEL
NATIONAL FOREST
STATE FOREST
WILDLIFE MANAGEMENT AREA

-N-

10 0 10 20
MILES

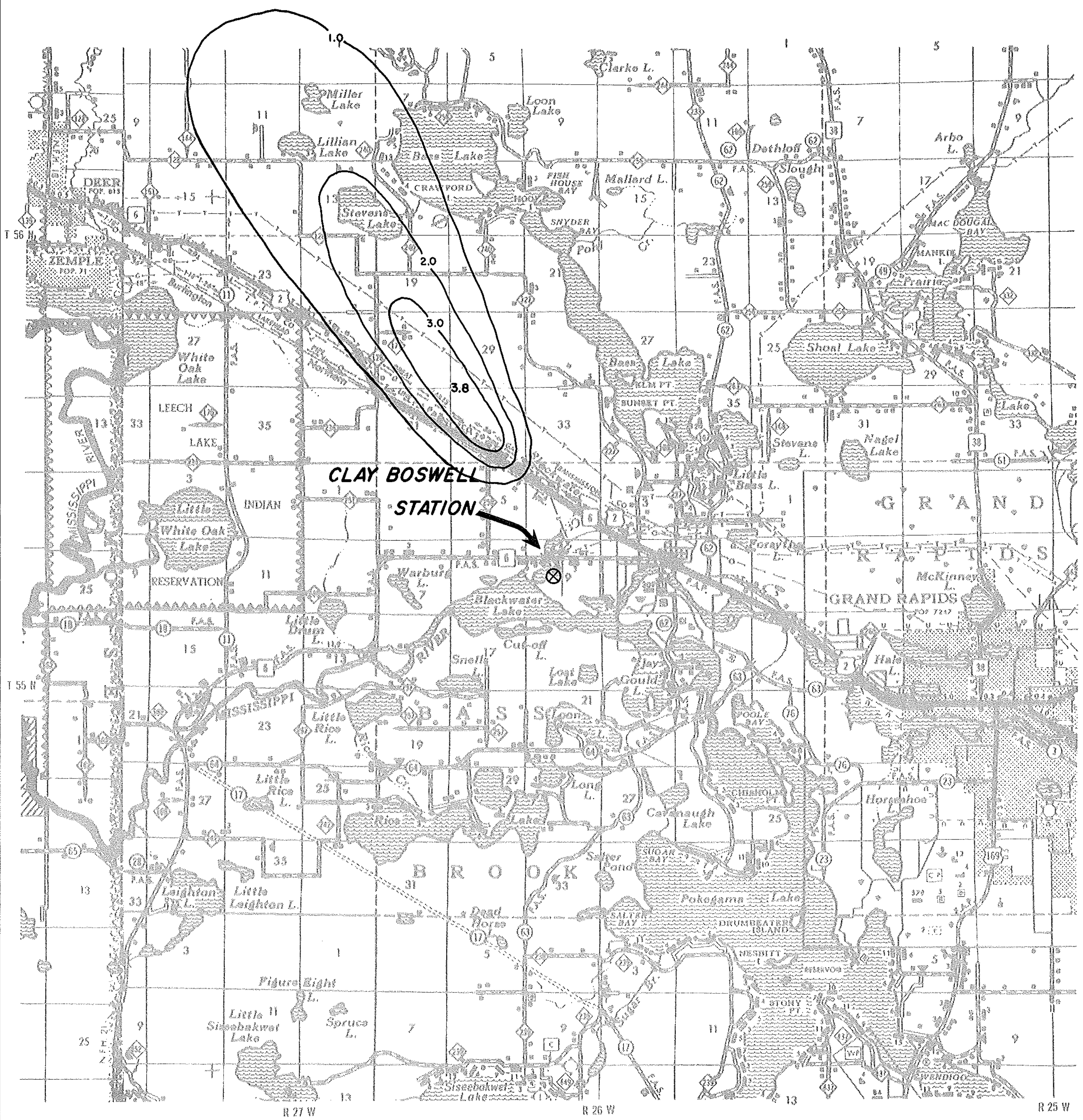
10 0 10 20
KILOMETERS

PROJECTED ISOPLETHS OF ANNUAL GEOMETRIC MEAN PARTICULATE CONCENTRATIONS

PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-4



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

-N-

0 1 2 3
MILES

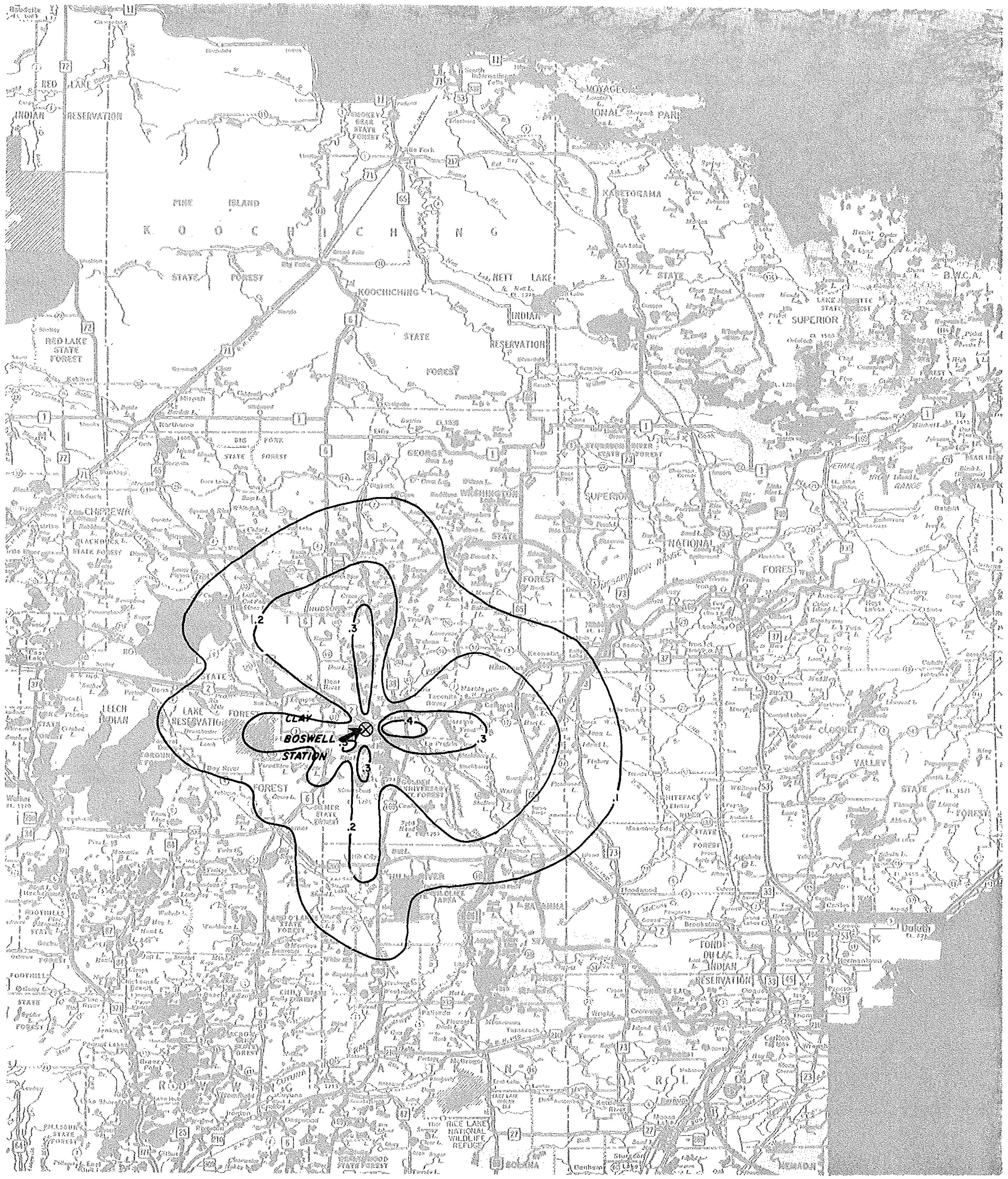
0 1 2 3
KILOMETERS

PROJECTED ISOPLETHS OF 24-HR MAXIMUM PARTICULATE CONCENTRATIONS

PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-5



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 18 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

- INTERSTATE
- MULTILANE DIVIDED HIGHWAY
- MULTILANE UNDIVIDED HIGHWAY
- INTERMEDIATE TYPE
- GRAVEL SURFACED
- SECONDARY ROAD-HARD SURFACED
- SECONDARY ROAD-GRAVEL
- NATIONAL FOREST
- STATE FOREST
- WILDLIFE MANAGEMENT AREA

N

10 0 10 20
MILES

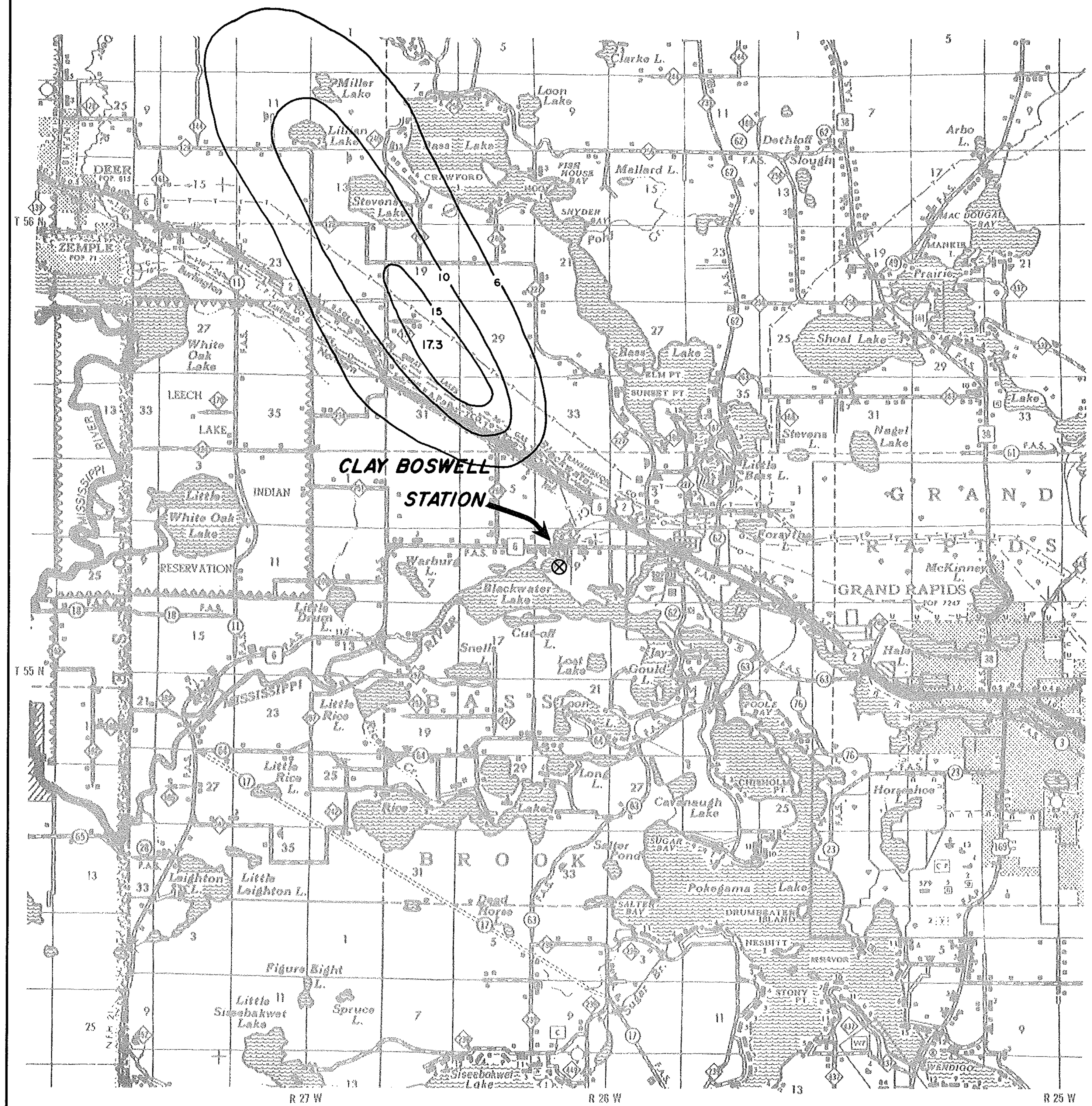
10 0 10 20
KILOMETERS

PROJECTED ISOPLETHS OF
ANNUAL GEOMETRIC MEAN
PARTICULATE CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3
AND PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-6



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 107 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

MILES: 0 1 2 3

KILOMETERS: 0 1 2 3

PROJECTED ISOPLETHS OF 24-HR MAXIMUM PARTICULATE CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-7

TABLE V-19
SIZE DISTRIBUTION OF PARTICULATES EMITTED
BY MODIFIED UNITS 1, 2, AND 3, AND PROPOSED UNIT 4
DESIGN PERFORMANCE COAL
CLAY BOSWELL STEAM ELECTRIC STATION

Particle Size (microns)	Percent by Weight of Particulates at Stack Outlet Units 1, 2, and 3[a]	Unit 4[b]
0 to 5	90	76
5 to 10	6	24
10 to 20	4	0
20 to 40	0	0
40 and greater	0	0

[a] Modified Units 1, 2, and 3 will discharge through common 700 ft (213.4 m) stack.

[b] Assumes particulate control by Venturi scrubber only.

Nitrogen Oxides

Table V-18 includes the results of the diffusion modeling for the NO_x emissions of modified Units 1, 2, and 3 and proposed Unit 4. The total contribution of Units 1, 2, 3, and 4 is only equivalent to 12% of the background NO_x concentration. Figure V-8 presents the isopleths for proposed Unit 4, and Figure V-9 presents the isopleths for the combined operation of modified Units 1, 2, and 3, and proposed Unit 4.

Sulfur Dioxide

Table V-18 includes the results of the diffusion modeling for SO_2. Note that, with respect to the PSD regulations, the proposed Unit 4 will contribute approximately 66% of the 24-hr SO_2 increment, 36% of the 3-hr increment, and 13% of the annual increment. Table V-18 indicates that the total SO_2 concentration resulting from the operation of the Clay Boswell Station, when added to the background levels, will exceed the MPCA secondary 24-hr maximum AAQS by 21% and the 3-hr maximum AAQS by 72%. Second worst case concentrations are more appropriate for comparisons with the AAQS, but are not presented (refer to Air Quality section of Chapter IV).

Figures V-10 through V-12 present the SO_2 isopleths for the proposed Unit 4, and Figures V-13 through V-15 present the SO_2 isopleths for the combined operation of modified Units 1, 2, and 3, and proposed Unit 4. Note that the very high 3-hr and 24-hr concentrations are projected to occur northwest of the Clay Boswell Station. No information is given for the concentrations over the Grand Rapids area.

Trace Elements

Table V-20 presents the projected trace element concentrations resulting from the emissions of the proposed Unit 4 and the combined emissions of modified Units 1, 2, and 3 and proposed Unit 4. Isopleths of ambient concentrations have not been drafted for trace elements. The ambient concentrations of most of the trace elements would be distributed similar to those for particulates (Figures V-4 through V-7).

TABLE V-20
PROJECTED TRACE ELEMENTS AND SULFATE CONCENTRATIONS RESULTING FROM EMISSIONS OF MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4 - DESIGN PERFORMANCE COAL
CLAY BOSWELL STEAM ELECTRIC STATION

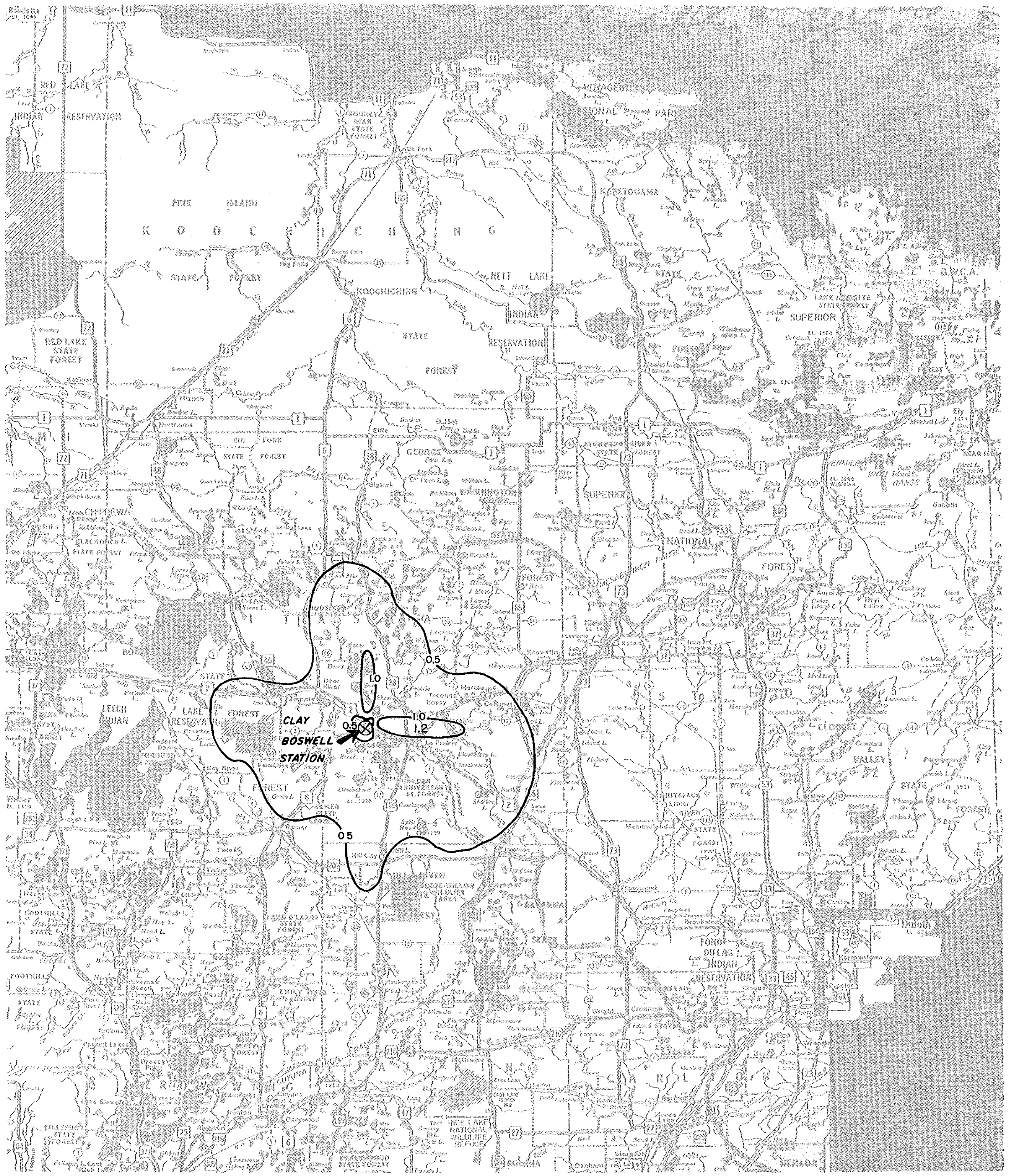
Pollutant	Annual Arithmetic Mean μg per cu m				24-Hr Maximum μg per cu m			
	Units 1, 2, and 3	Unit 4	Measured Background	Total[a]	Units 1, 2, and 3	Unit 4	Measured Background	Total[a]
Arsenic	0.00003153	0.00008171	na[b]	0.00011324[c]	0.00166213	0.00155253	na	0.00321467[c]
Barium	0.00190000	0.00494000	na	0.00684000[c]	0.10025000	0.09382000	na	0.19407000[c]
Beryllium	0.00000310	0.00000780	0.00004	0.00005090	0.00021790	0.00014790	0.00100	0.00136580
Cadmium	0.00000360	0.00000930	0.00100	0.00101290	0.00019080	0.00017660	0.00400	0.00436740
Chromium	0.00004920	0.00012780	0.00378	0.00395700	0.00259340	0.00242790	0.06426	0.06928130
Cobalt	0.00000390	0.00001020	0.00076	0.00077410	0.00020420	0.00019420	0.01900	0.01939840
Copper	0.00007230	0.00018290	0.03250	0.03275520	0.00506410	0.00347470	0.19400	0.20353880
Fluorine	0.00207838	0.00737354	na	0.00945192[c]	0.10955902	0.14009728	na	0.24965630[c]
Gallium	0.00009820	0.00025681	na	0.00035501[c]	0.00517639	0.00487938	na	0.10055770[c]
Lead	0.00003520	0.00074710	0.06800	0.06878230	0.02040000	0.01419460	0.11900	0.15359460
Manganese	0.00027380	0.00070040	0.03830	0.03927420	0.01916670	0.01330740	0.22980	0.26227410
Mercury	0.00000360	0.00001556	na	0.00001916[c]	0.00018996	0.00029572	na	0.00048567[c]
Molybdenum	0.00009695	0.00025357	na	0.00035052[c]	0.00511051	0.00481728	na	0.00992779[c]
Nickel	0.00002930	0.00007390	0.00900	0.00910320	0.00205110	0.00140470	0.03200	0.03545580
Strontium	0.00072757	0.00190273	na	0.00263030[c]	0.03835234	0.03615177	na	0.07450411[c]
Titanium	0.00405410	0.01050580	0.03700	0.05155990	0.21370420	0.19961090	0.14800	0.56131510
Uranium	0.00000312	0.00000817	na	0.00001129[c]	0.00016470	0.00015525	na	0.00031995[c]
Vanadium	0.00013730	0.00034630	0.00280	0.00328360	0.00961540	0.00657980	0.07000	0.08619520
Zinc	0.00016739	0.00043774	na	0.00060513[c]	0.00882339	0.00831713	na	0.01714052[c]
Sulfates	2.0	1.0	5.0	8.0	49.0	8.0	10.0	67.0

[a] Concentrations resulting from proposed Unit 4 may not occur during the same time periods or at the same locations as concentrations resulting from modified Units 1, 2, and 3, but have been added here for worst case comparisons.

[b] na means not available.

[c] Total concentration excludes background due to unavailable data.

Trace element deposition rates have been computed for the proposed Unit 4 and are presented in Table V-21 (refer to Air Quality section of Chapter IV for methodology). Figures V-16 and V-17 identify the areas of maximum trace element deposition. The values shown on Figures V-16 and V-17 are fractions of the maximum deposition rates given in Table V-21. The trace element ambient concentrations and deposition rates may vary from the data given by factors of 2 or 3, because of the variability in the coal analyses.



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (µg per cu m)

BASE MAP LEGEND

- INTERSTATE
- MULTILANE DIVIDED HIGHWAY
- MULTILANE UNDIVIDED HIGHWAY
- INTERMEDIATE TYPE
- GRAVEL SURFACED
- SECONDARY ROAD-HARD SURFACED
- SECONDARY ROAD-GRAVEL
- NATIONAL FOREST
- STATE FOREST
- WILDLIFE MANAGEMENT AREA

N

10 0 10 20
MILES

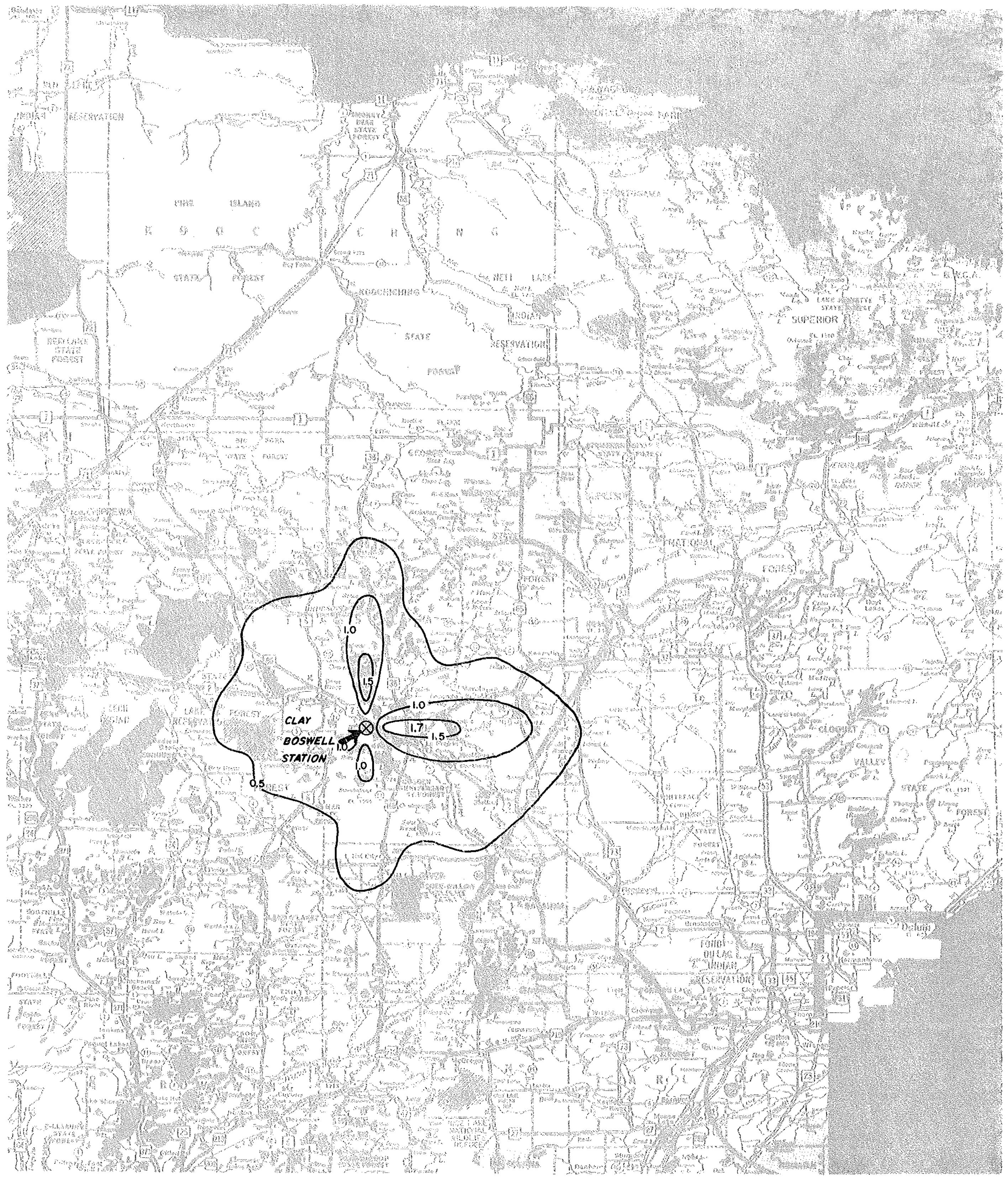
10 0 10 20
KILOMETERS

PROJECTED ISOPLETHS OF ANNUAL ARITHMETIC MEAN NO_x CONCENTRATIONS

PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-8



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 14 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

- INTERSTATE
- MULTILANE DIVIDED HIGHWAY
- MULTILANE UNDIVIDED HIGHWAY
- INTERMEDIATE TYPE
- GRAVEL SURFACED
- SECONDARY ROAD-HARD SURFACED
- SECONDARY ROAD-GRAVEL
- NATIONAL FOREST
- STATE FOREST
- WILDLIFE MANAGEMENT AREA

10 0 10 20
MILES

10 0 10 20
KILOMETERS

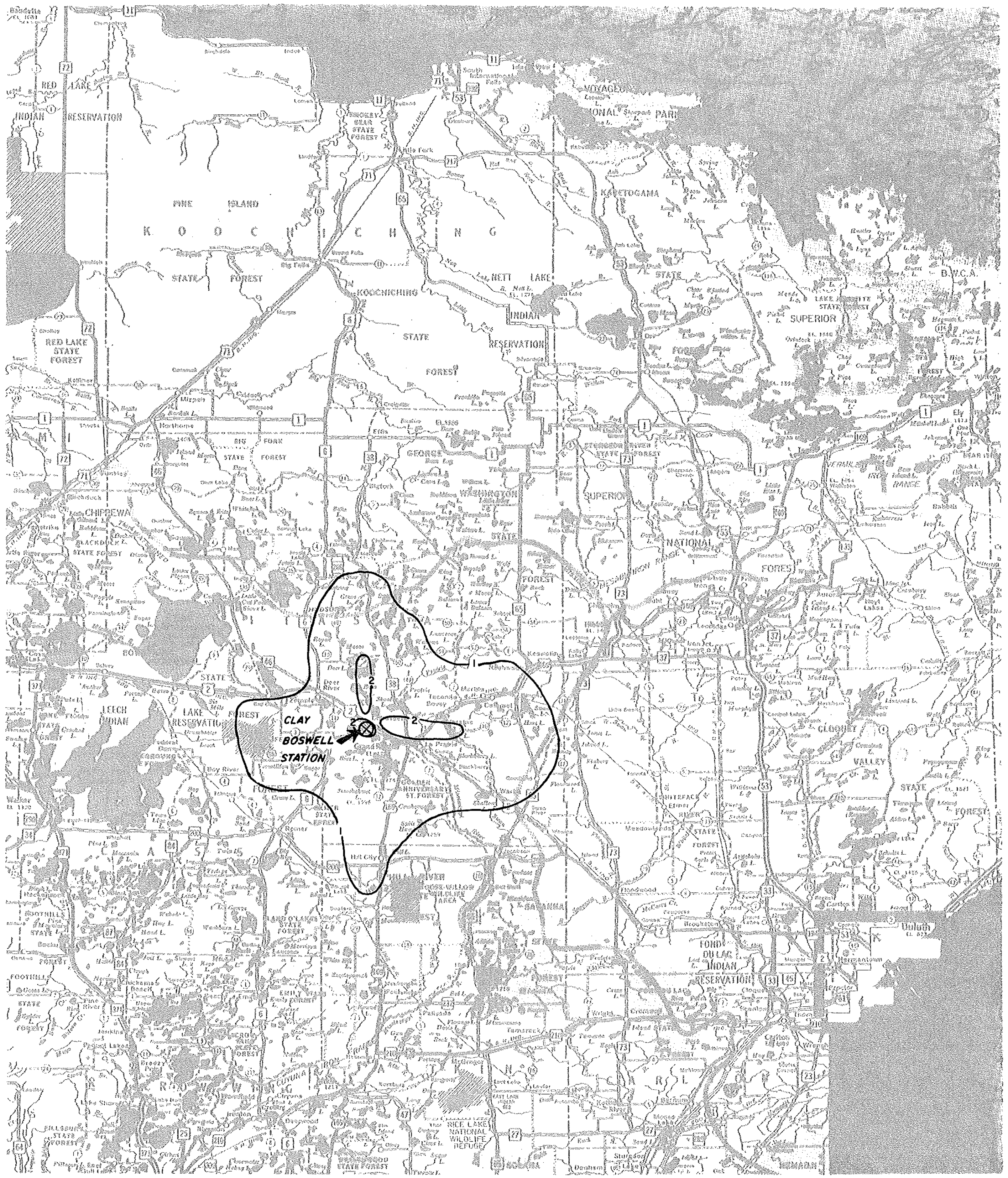
N

PROJECTED ISOPLETHS OF ANNUAL ARITHMETIC MEAN NO_x CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-9



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

BASE MAP LEGEND

- INTERSTATE
- MULTILANE DIVIDED HIGHWAY
- MULTILANE UNDIVIDED HIGHWAY
- INTERMEDIATE TYPE
- GRAVEL SURFACED
- SECONDARY ROAD-HARD SURFACED
- SECONDARY ROAD-GRAVEL
- NATIONAL FOREST
- STATE FOREST
- WILDLIFE MANAGEMENT AREA

N

10 0 10 20
MILES

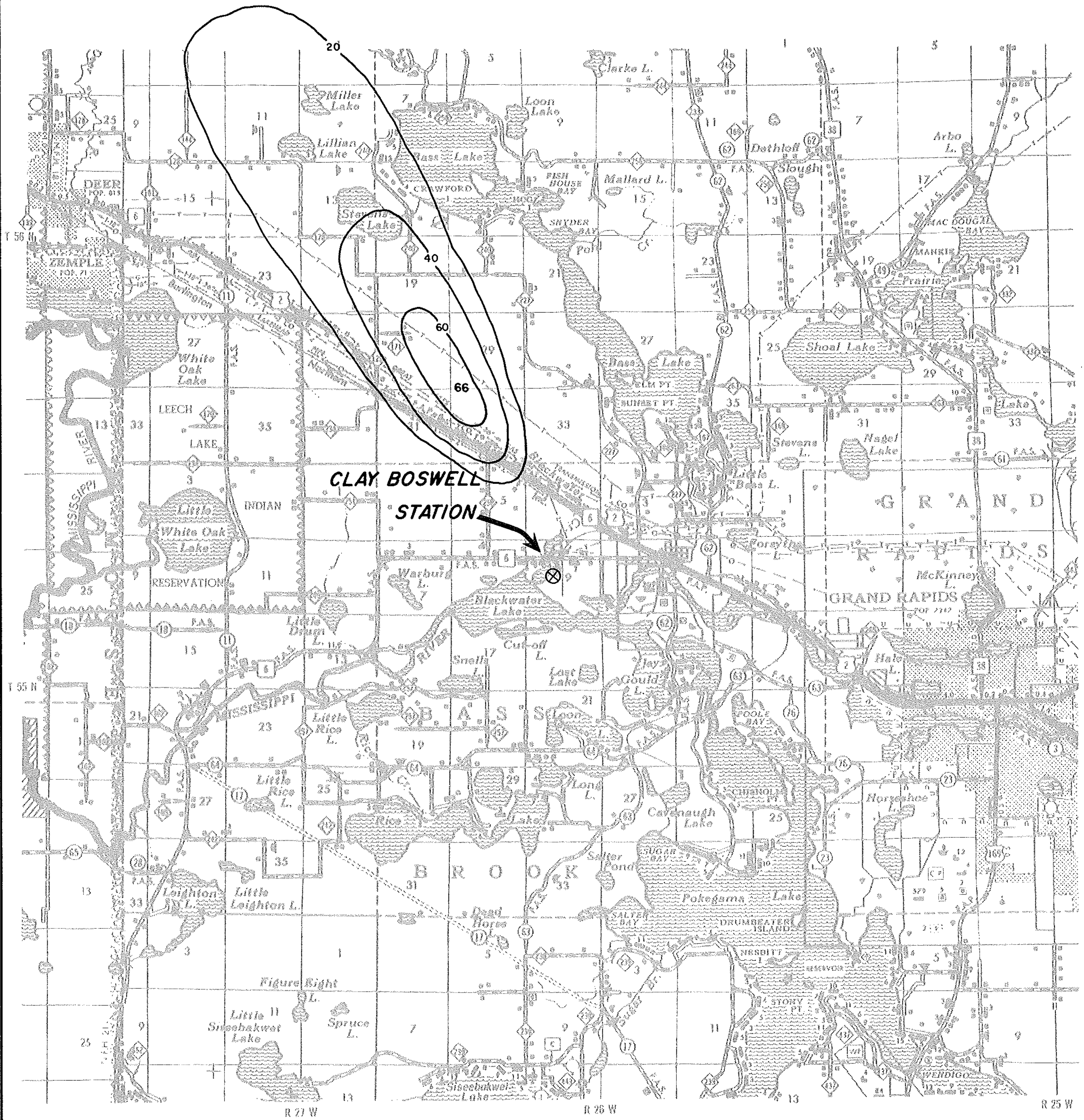
10 0 10 20
KILOMETERS

PROJECTED ISOPLETHS OF ANNUAL ARITHMETIC MEAN SO_2 CONCENTRATIONS

PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-10



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (µg per cu m)

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3 MILES

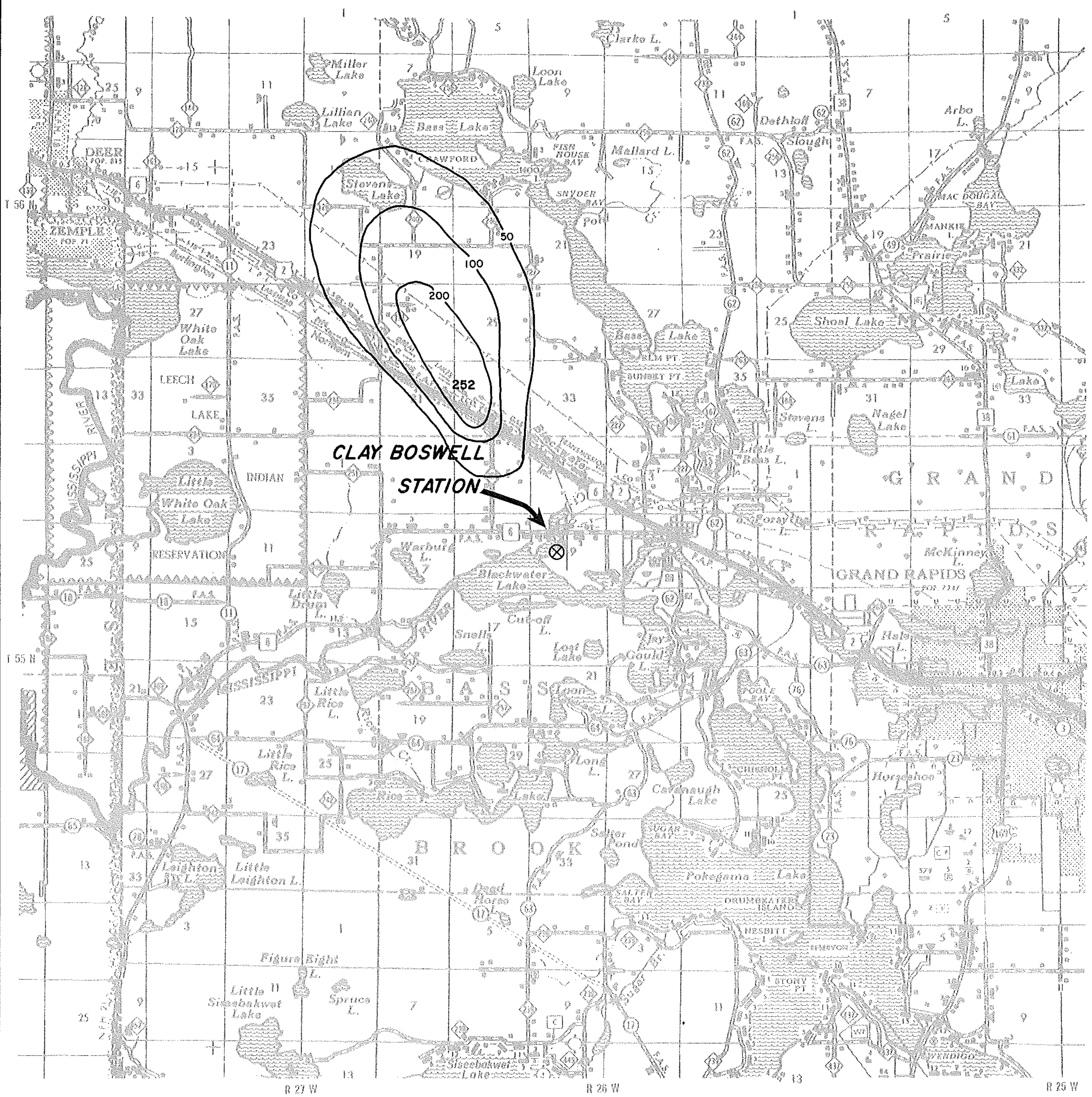
0 1 2 3 KILOMETERS

PROJECTED ISOPLETHS OF 24-HR MAXIMUM SO_2 CONCENTRATIONS

PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-11



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3
MILES

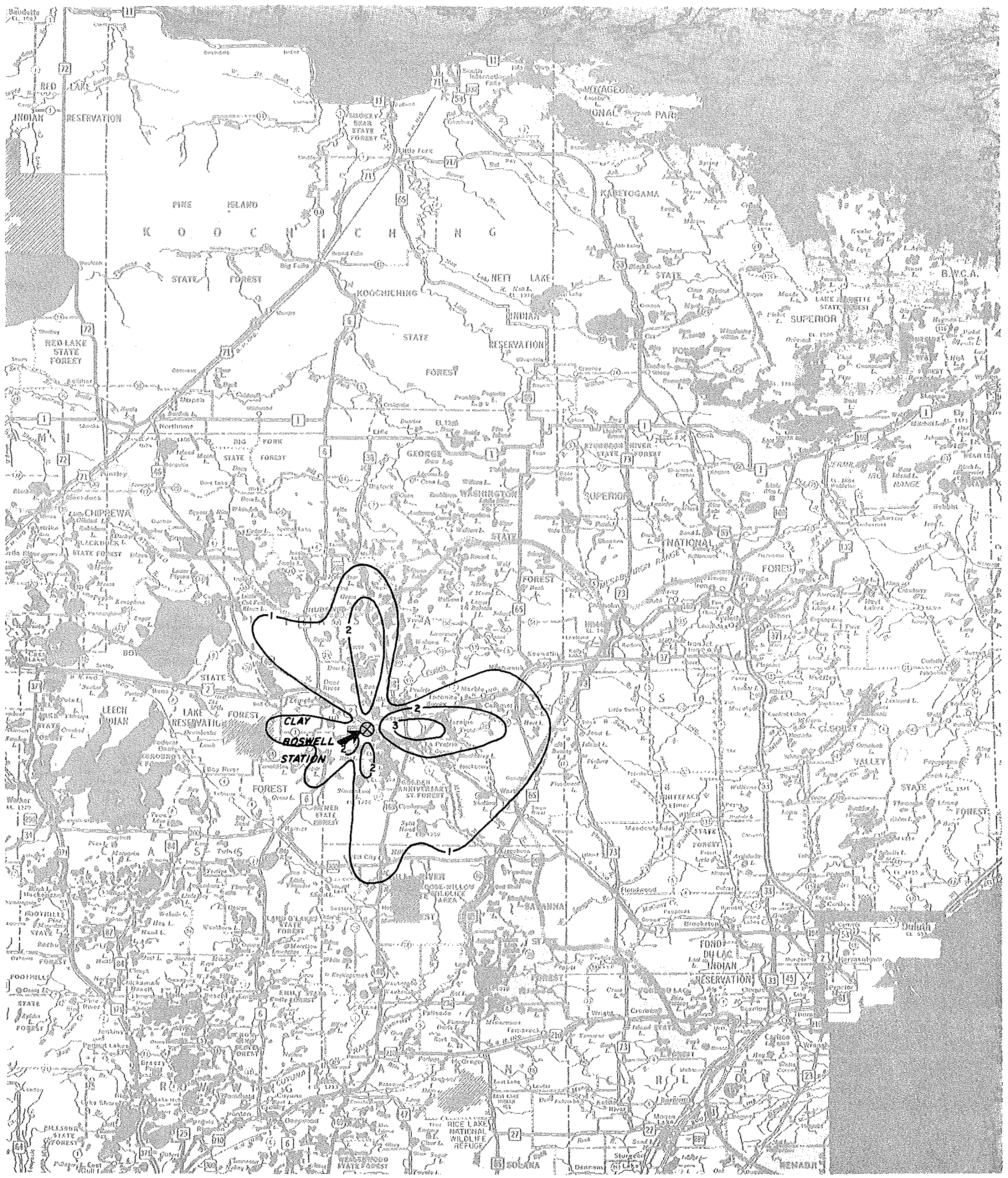
0 1 2 3
KILOMETERS

PROJECTED ISOPLETHS OF 3-HR MAXIMUM SO_2 CONCENTRATIONS

PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-12



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 0.4 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

- INTERSTATE
- MULTILANE DIVIDED HIGHWAY
- MULTILANE UNDIVIDED HIGHWAY
- INTERMEDIATE TYPE
- GRAVEL SURFACED
- SECONDARY ROAD-HARD SURFACED
- SECONDARY ROAD-GRAVEL
- NATIONAL FOREST
- STATE FOREST
- WILDLIFE MANAGEMENT AREA

10 0 10 20
MILES

10 0 10 20
KILOMETERS

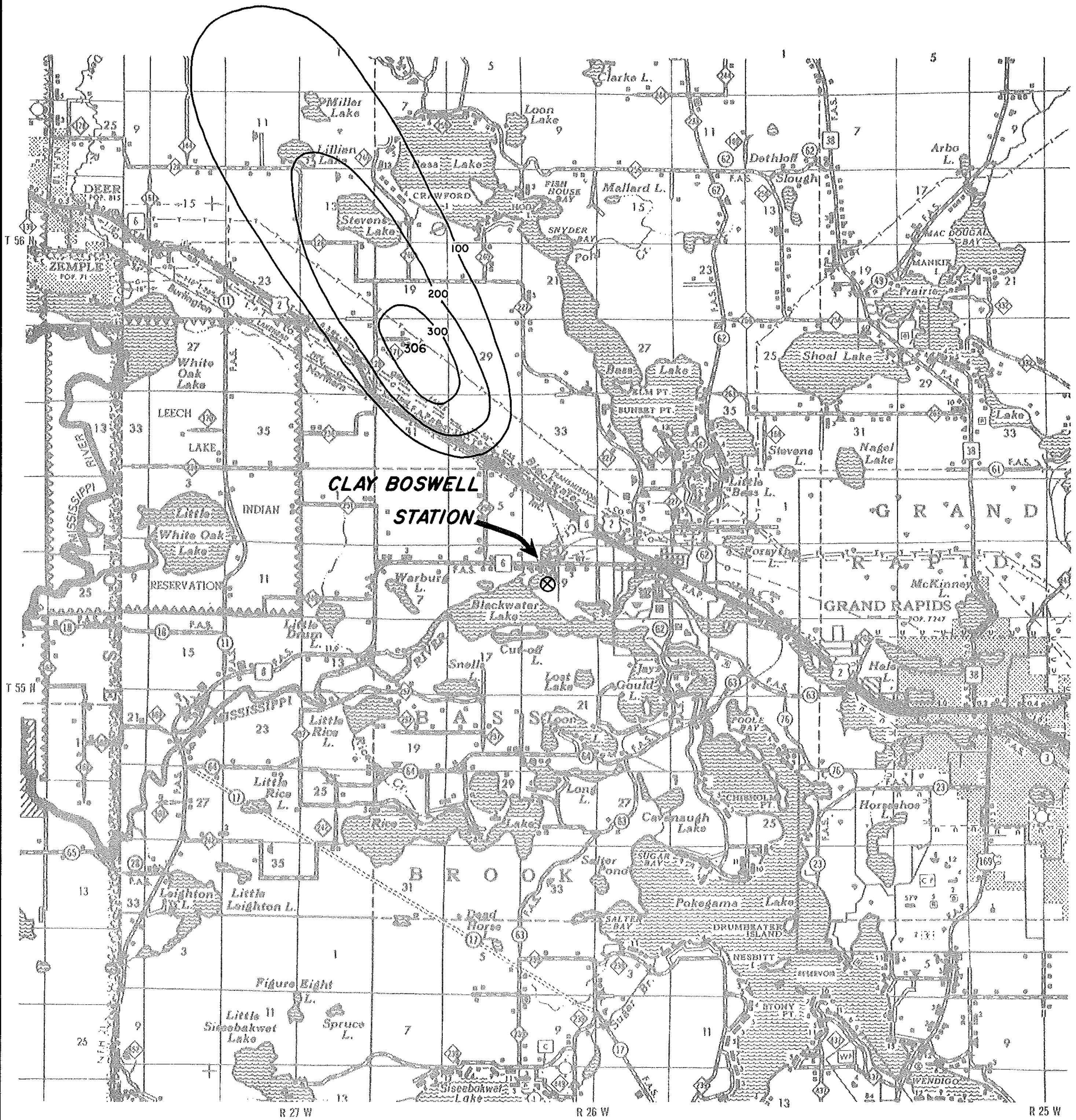
N

PROJECTED ISOPLETHS OF ANNUAL ARITHMETIC MEAN SO_2 CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-13



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 5 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3
MILES

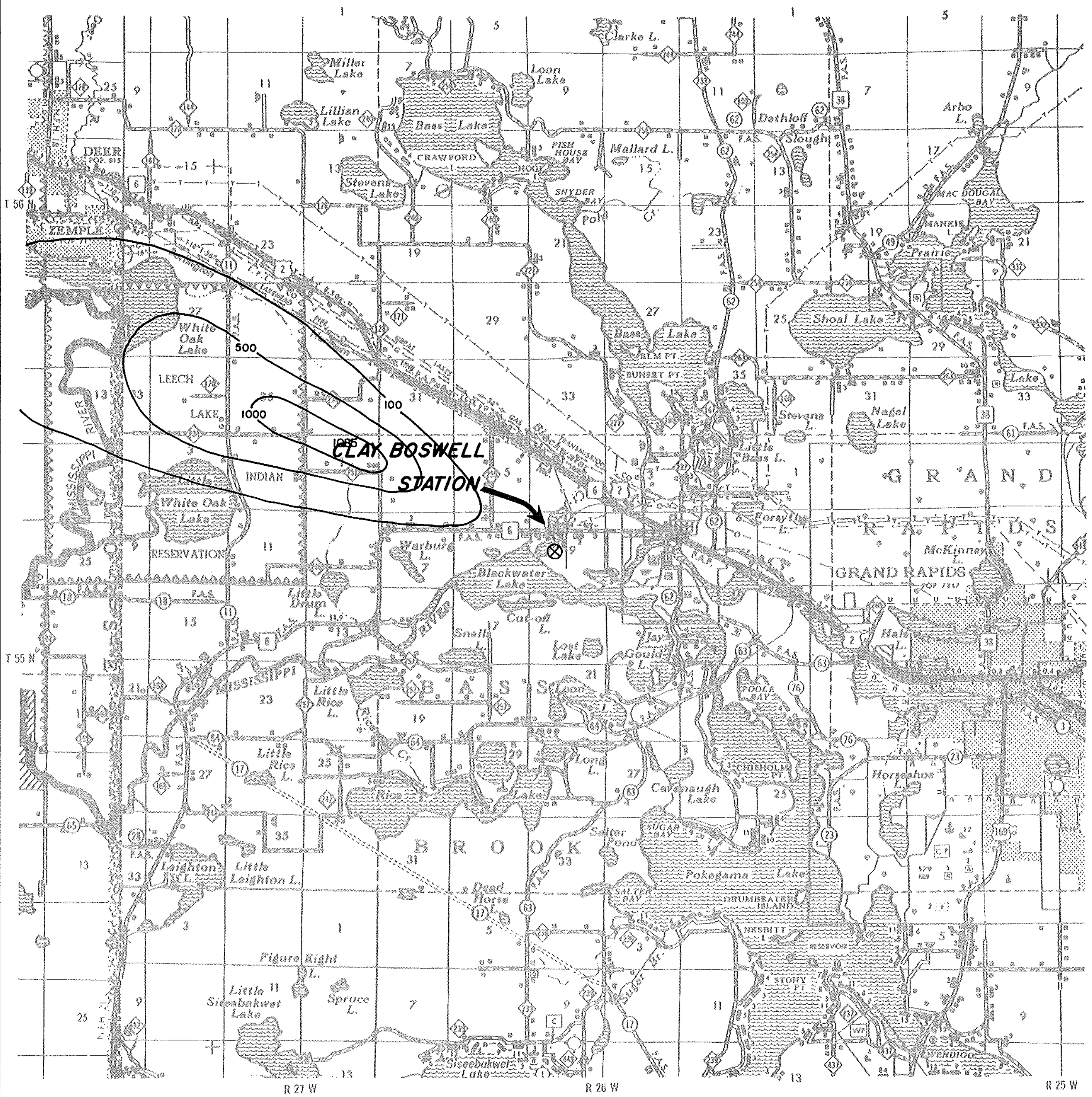
0 1 2 3
KILOMETERS

PROJECTED ISOPLETHS OF 24-HR MAXIMUM SO_2 CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-14



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 15 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3
MILES

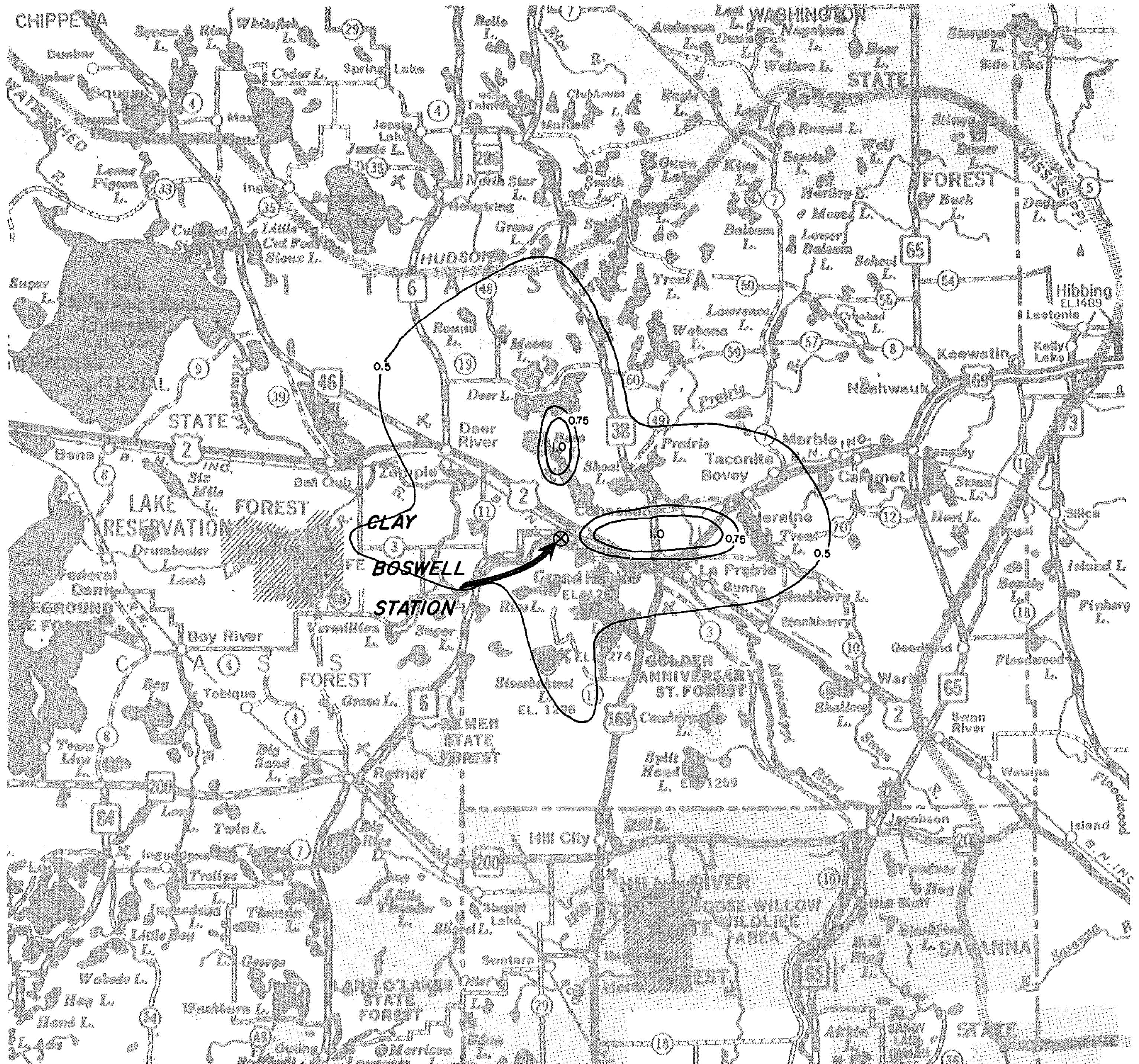
0 1 2 3
KILOMETERS

PROJECTED ISOPLETHS OF 3-HR MAXIMUM SO_2 CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-15



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: VALUES SHOWN ARE FRACTIONS OF MAXIMUM ANNUAL DEPOSITION RATES PRESENTED IN TABLE V-21. FOR ACTUAL DEPOSITION RATE FOR EACH TRACE ELEMENT, MULTIPLY VALUES IN TABLE V-21 BY THE FRACTIONS SHOWN IN THIS FIGURE.

BASE MAP LEGEND

- MULTILANE DIVIDED HIGHWAY
- MULTILANE UNDIVIDED HIGHWAY
- INTERMEDIATE TYPE
- SECONDARY ROAD-HARD SURFACED
- SECONDARY ROAD-GRAVEL
- NATIONAL FOREST
- STATE FOREST
- WILDLIFE MANAGEMENT AREA

N

5 0 5 10
MILES

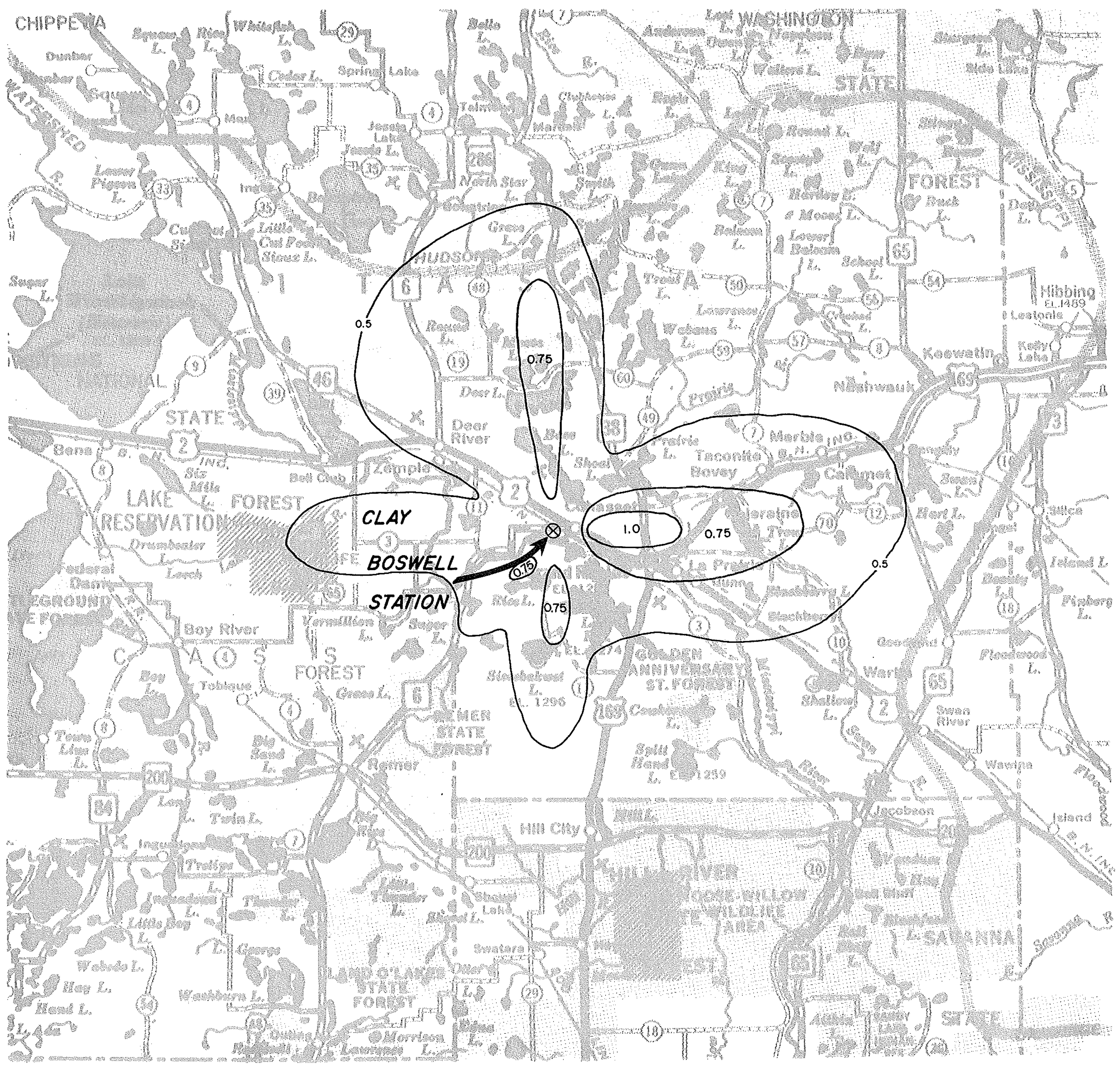
0 5 10
KILOMETERS

PROJECTED AREAS OF MAXIMUM TRACE ELEMENT DEPOSITION

PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-16



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: VALUES SHOWN ARE FRACTIONS OF MAXIMUM ANNUAL DEPOSITION RATES PRESENTED IN TABLE V-21. FOR ACTUAL RATE FOR EACH TRACE ELEMENT, MULTIPLY VALUES IN TABLE V-21 BY THE FRACTIONS SHOWN IN THIS FIGURE

BASE MAP LEGEND

- MULTILANE DIVIDED HIGHWAY
- MULTILANE UNDIVIDED HIGHWAY
- INTERMEDIATE TYPE
- SECONDARY ROAD-HARD SURFACED
- SECONDARY ROAD-GRAVEL
- NATIONAL FOREST
- STATE FOREST
- WILDLIFE MANAGEMENT AREA

N

5 0 5 10
MILES

0 5 10
KILOMETERS

PROJECTED AREAS OF MAXIMUM TRACE ELEMENT DEPOSITION

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

DESIGN PERFORMANCE COAL

FIGURE V-17

TABLE V-21
PROJECTED MAXIMUM ANNUAL TRACE ELEMENT DEPOSITION RATES
MODIFIED UNITS 1, 2, AND 3, AND PROPOSED UNIT 4 - DESIGN PERFORMANCE COAL
CLAY BOSWELL STEAM ELECTRIC STATION

	Deposition Rate[a] µg per sq m per yr		
Trace Element	Units 1, 2, and 3	Unit 4	Total[b]
Arsenic	10	26	36[c]
Barium	599	1,557	2,156[c]
Beryllium	1	2	16
Cadmium	1	3	319
Chromium	16	40	1,247
Cobalt	1	3	243
Copper	23	58	10,328
Fluorine	655	2,325	2,980[c]
Gallium	31	81	112[c]
Lead	110	233	21,690
Manganese	86	220	12,384
Mercury	1	5	6[c]
Molybdenum	31	80	111[c]
Nickel	9	23	2,870
Strontium	229	600	829[c]
Titanium	1,278	3,313	16,258
Uranium	1	3	4[c]
Vanadium	43	109	1,035
Zinc	53	138	191[c]

[a] Fallout velocity of 0.01 m per sec assumed throughout. Deposition rates are for point of maximum ground level ambient concentrations only.

[b] Total includes background deposition except as noted.

[c] Does not include background due to unavailable data.

Sulfates

The methodology used for projecting sulfate concentrations resulting from emissions of the Clay Boswell Station is discussed in the Air Quality section of Chapter IV. SO_2 to sulfate conversion rates of 5% and 15% per hr were assumed for computing the annual arithmetic mean and 24-hr maximum sulfate concentrations, respectively. The results of the sulfate diffusion modeling are presented in Table V-20. Note the relatively high 24-hr maximum concentration of 67.0 µg per cu m. No isopleths were compiled for ambient sulfate concentrations. The sulfates will probably be distributed in a pattern similar to the ambient SO_2 concentrations (Figures V-10, V-11, V-13, and V-14), with peak values extending farther from the Station.

Probable Pollutant Concentrations Resulting from Emissions Using Compliance Coal

The ambient SO_2 concentrations resulting from combustion of MP&L's proposed design performance coal (Tables IV-55 and V-14) in Units 1, 2, 3, and 4 at the Clay Boswell Station will exceed the MPCA AAQS by large amounts. Consequently, MP&L will probably be required to negotiate "rejection points" with its coal supplier for sulfur content, ash content, and heating value. To determine the characteristics of the compliance coal, diffusion modeling was performed for Units 1, 2, 3, and 4 using a variety of coal analyses. The coal analyses used were those assumed to be achievable by blending coal from the Big Sky Mine (i.e., the possibility of a new coal contract with a different supplier was not considered). Table V-22 presents the heating value, ash, and sulfur analyses of the coal which will result in compliance for the Clay Boswell Station. Table V-23 presents the emission rates for the Clay Boswell Station using compliance coal. Other emission factors given in Tables IV-55 through IV-58 and Tables V-14 through V-17 were assumed to remain constant for the compliance coal modeling.

TABLE V-22
ANALYSES OF COMPLIANCE COAL
CLAY BOSWELL STEAM ELECTRIC STATION

	Modified Units 1, 2, and 3		Unit 4	
Parameter	Annual Average	Worst Case	Annual Average	Worst Case
Heating value				
Btu per lb	8,610	7,509	8,610	7,509
kg-cal per kg	4,783	4,172	4,783	4,172
Ash				
%	9.35	14.72	9.35	29.45
Sulfur				
%	1.03	1.58	1.03	3.16

Table V-24 presents the results of the diffusion modeling of the emissions of Units 1, 2, 3, and 4 using compliance coal. Trace element concentrations will not change significantly. Substantial reductions in short term SO_2 and sulfate concentrations are indicated by comparing Table V-24 with Table V-18. The isopleths for compliance coal are not significantly different from those for design performance coal for Unit 4 annual geometric mean particulates (Figure V-4), 24-hr maximum particulates (Figure V-5), annual arithmetic mean NO_x (Figure V-8), and annual arithmetic mean SO_2 (Figure V-10). The distribution of 24-hr and 3-hr maximum SO_2 concentrations are projected to change with the difference in coal, as illustrated by Figures V-18 and V-19. For the combined operation of Units 1, 2, 3, and 4, the diffusion modeling indicates that the compliance coal will result in significantly different distributions of 24-hr maximum

TABLE V-23
PARTICULATES, NO_x, AND SO_2 EMISSION RATES FOR COMPLIANCE COAL
CLAY BOSWELL STEAM ELECTRIC STATION

Pollutant	Modified Units 1, 2, and 3 Annual Average	Modified Units 1, 2, and 3 Worst Case	Unit 4 Annual Average	Unit 4 Worst Case
Particulates				
lb per hr	2,220	2,283	514	514
kg per hr	1,008	1,036	233	233
NO_x				
lb per hr	5,332	5,332	3,598	3,598
kg per hr	2,419	2,419	1,632	1,632
SO_2				
lb per hr	10,111	19,936	6,169	6,169
kg per hr	4,586	9,043	2,798	2,798

particulates and SO_2 concentrations, and 3-hr maximum SO_2 concentrations. The isopleths for these pollutants for modified Units 1, 2, and 3 change substantially, as illustrated by comparing Figures IV-69, IV-72, and IV-73 with Figures V-20 through V-22. The isopleths showing the distributions of 24-hr maximum particulates and SO_2 concentrations and 3-hr maximum SO_2 concentrations resulting from the combined emissions of Units 1, 2, 3, and 4 using compliance coal are presented in Figure V-23 through V-25. Note on Figure V-25 that the location of the 3-hr maximum concentration is projected to change from the northwest (Figure V-15), to directly south of the Clay Boswell Station. This location change is due to the type of diffusion modeling used, which expresses only worst case values. Relatively high second worst case concentrations would not appear on the figures until some change in the emission factors caused it to become a worst case concentration. This has occurred on Figure V-25. The differences between the relative source strengths of modified Units 1, 2, and 3 and Unit 4 are not nearly as great when using compliance coal as when using design performance coal. Consequently, when the emissions of the 4 units are added together, the isopleth pattern is not as dominated by the influence of modified Units 1, 2, and 3 with compliance coal as it is with design performance coal. This changes the location of worst case concentrations as illustrated by comparing Figures V-15 and V-25.

Probable Fogging, Icing, and Salt Deposition Resulting from the Proposed Cooling Tower

MP&L has proposed a rectangular, mechanical draft wet cooling tower for Unit 4 at the Clay Boswell Station (refer to Chapter II). Table V-25 lists the principal design parameters of this tower which were used for the fogging, icing, and salt deposition analyses (refer to Air Quality section of Chapter IV

TABLE V-24

PROJECTED PARTICULATES, NO_x, AND SO_2 CONCENTRATIONS RESULTING FROM EMISSIONS OF MODIFIED UNITS 1, 2, AND 3, AND UNIT 4 - COMPLIANCE COAL

CLAY BOSWELL STEAM ELECTRIC STATION

Pollutant	Units 1, 2, and 3 µg per cu m	Proposed Unit 4 µg per cu m	Measured Background[a] µg per cu m	Total[b] µg per cu m	PSD[c] Increment µg per cu m	Minnesota Secondary Standard µg per cu m
Particulates						
Annual geometric mean	0.2	0.2	18	18.4	10	60
24-hr maximum	10.7	3.8	107	121.5	30	150
NO_x						
Annual arithmetic mean	0.5	1.2	14	15.7	no standard	100
SO_2						
Annual arithmetic mean	1.0	2.0	0.4	3.4	15	60
24-hr maximum	95	46	5	146	100	260
3-hr maximum	335	175	15	525	700	655
Sulfates						
Annual arithmetic mean	2.0	1.0	5.0	8.0	no standard	no standard
24-hr maximum	19.0	6.0	10.0	35.0	no standard	no standard

[a] Estimations of background concentrations are discussed in Air Quality section of Chapter IV.

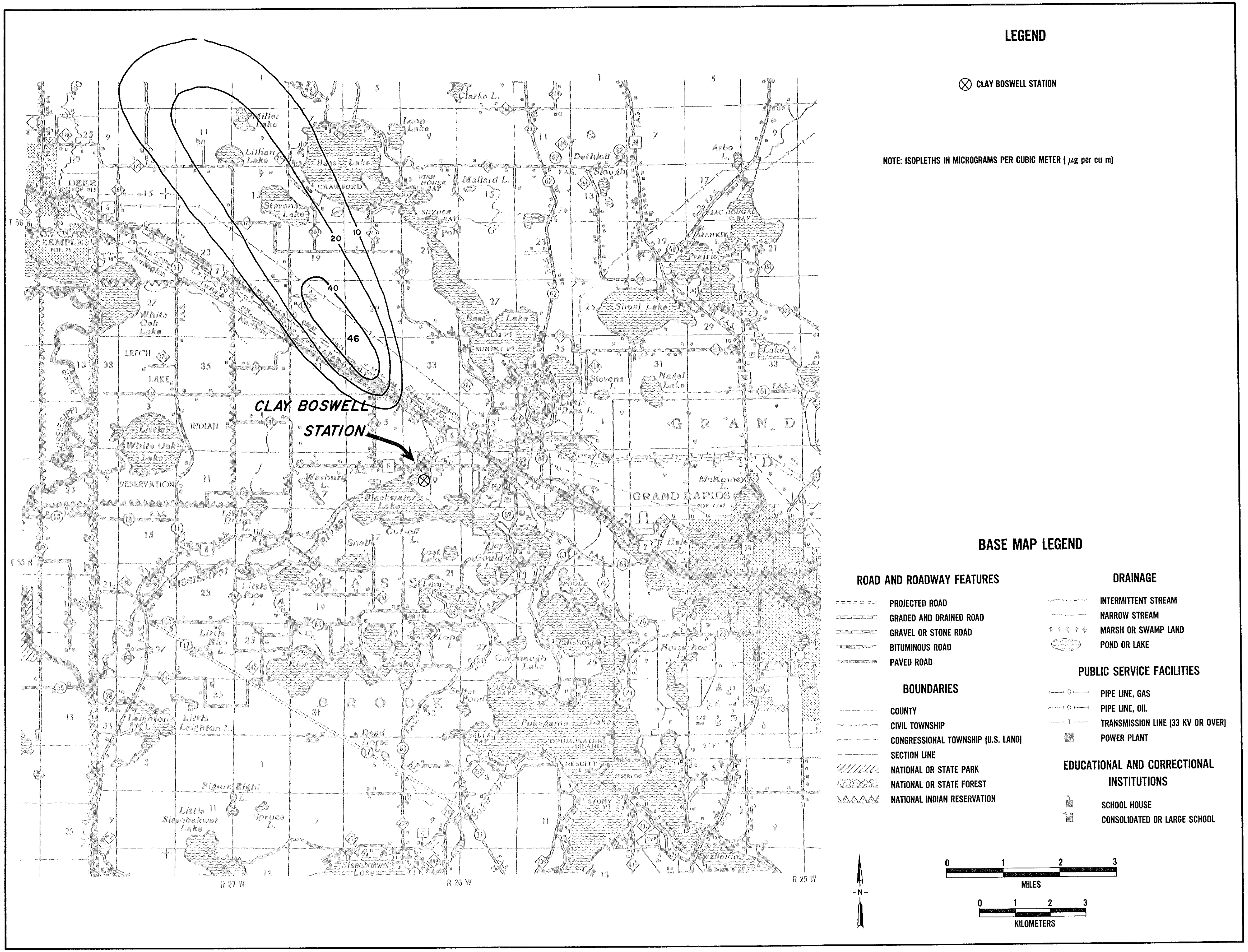
[b] Concentrations resulting from proposed Unit 4 may not occur during the same time periods or at the same locations as concentrations resulting from modified Units 1, 2, and 3, but have been added here for worst case comparisons.

[c] PSD regulations apply only to Unit 4.

for methodology). Table V-26 presents the results of the modeling for the combined operation of the proposed Unit 4 wet cooling tower and the Unit 3 cooling tower. Figure V-26 illustrates the locations where the maximum cooling tower-induced ground level fogging are projected to occur.

Icing induced by the Unit 3 and proposed Unit 4 cooling towers will occur approximately 100 hr per year at a distance of 0.5 km from the towers (55). Icing will be negligible at distances of 10 km or greater (55).

MP&L has proposed to control water vapor and droplet drift from the Unit 4 cooling tower with high-efficiency drift eliminators. Therefore, salt deposition resulting from the operation of the proposed Unit 4 cooling tower will be less than 7.8 lb per acre (8.7 kg per hectare) per yr at a distance of 0.5 km from the tower, and less than 1.2 lb per acre (1.3 kg per hectare) at a distance of 5 km from the tower (56). Salt deposition resulting from the combined operation of the Unit 3 and proposed Unit 4 cooling towers will amount to less than 8 lb per acre (9.0 kg per hectare) per year at a distance of 0.5 km from the Unit 4 tower, and less than 2.0 lb per acre (2.2 kg per hectare) at a distance of 5 km from the Unit 4 cooling tower (57). The distribution of salt deposition around the cooling towers will approximately follow the same pattern as the induced fogging presented in Figure V-26.

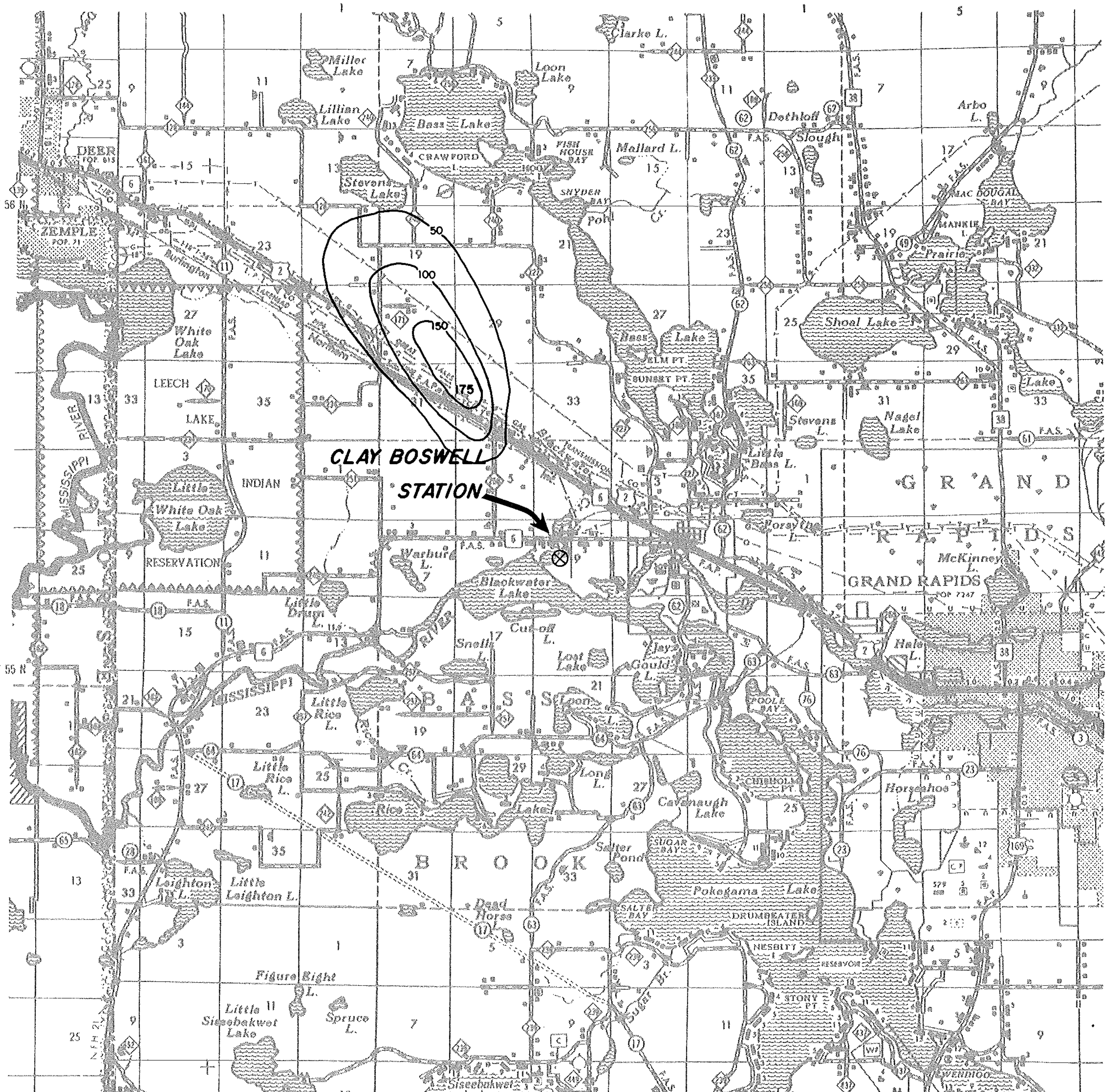


PROJECTED ISOPLETHS OF 24-HR MAXIMUM SO_2 CONCENTRATIONS

PROPOSED UNIT 4

COMPLIANCE COAL

FIGURE V-18



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3
MILES

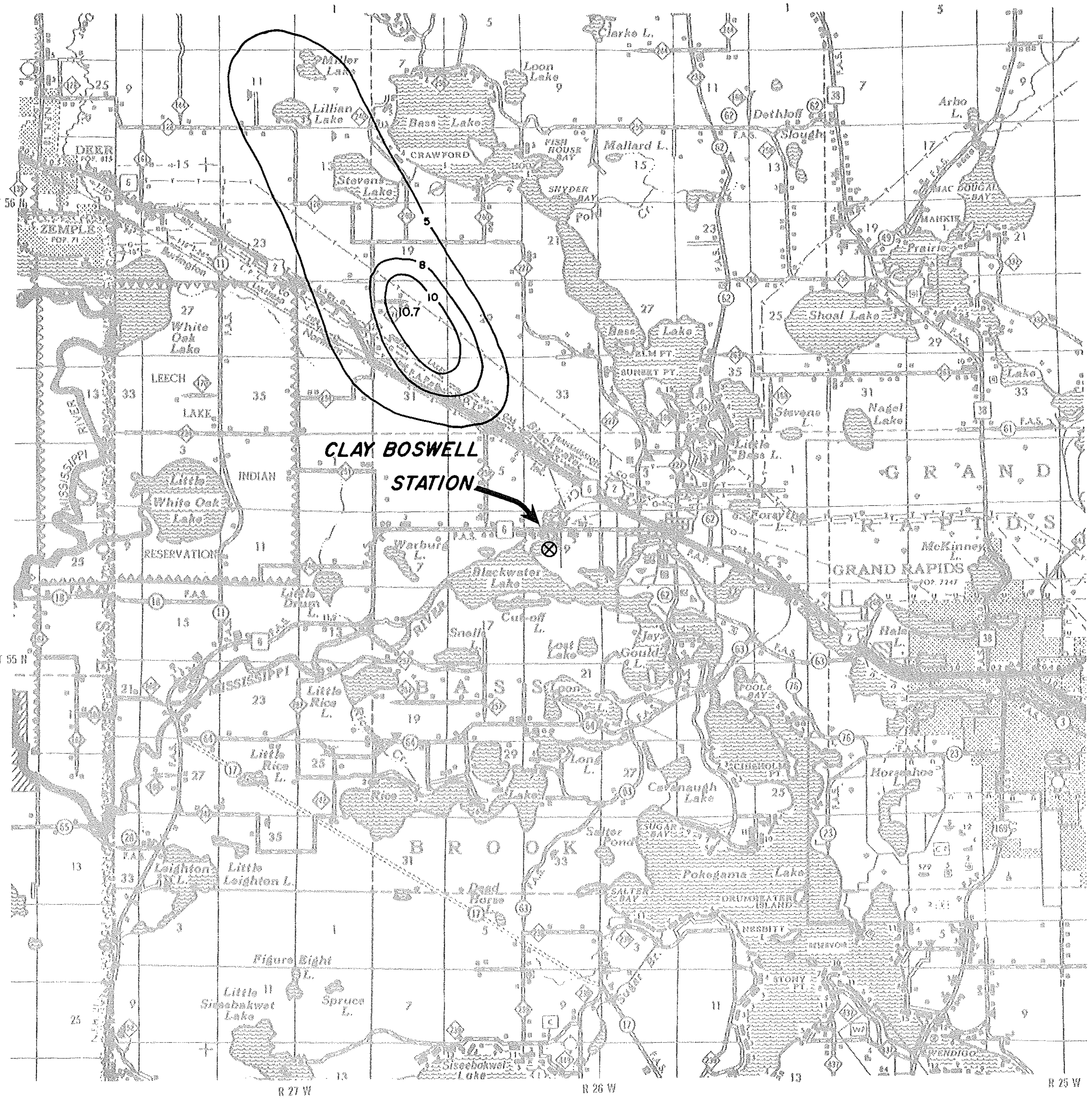
0 1 2 3
KILOMETERS

PROJECTED ISOPLETHS OF 3-HR MAXIMUM SO_2 CONCENTRATIONS

PROPOSED UNIT 4

COMPLIANCE COAL

FIGURE V-19



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 107 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3 MILES

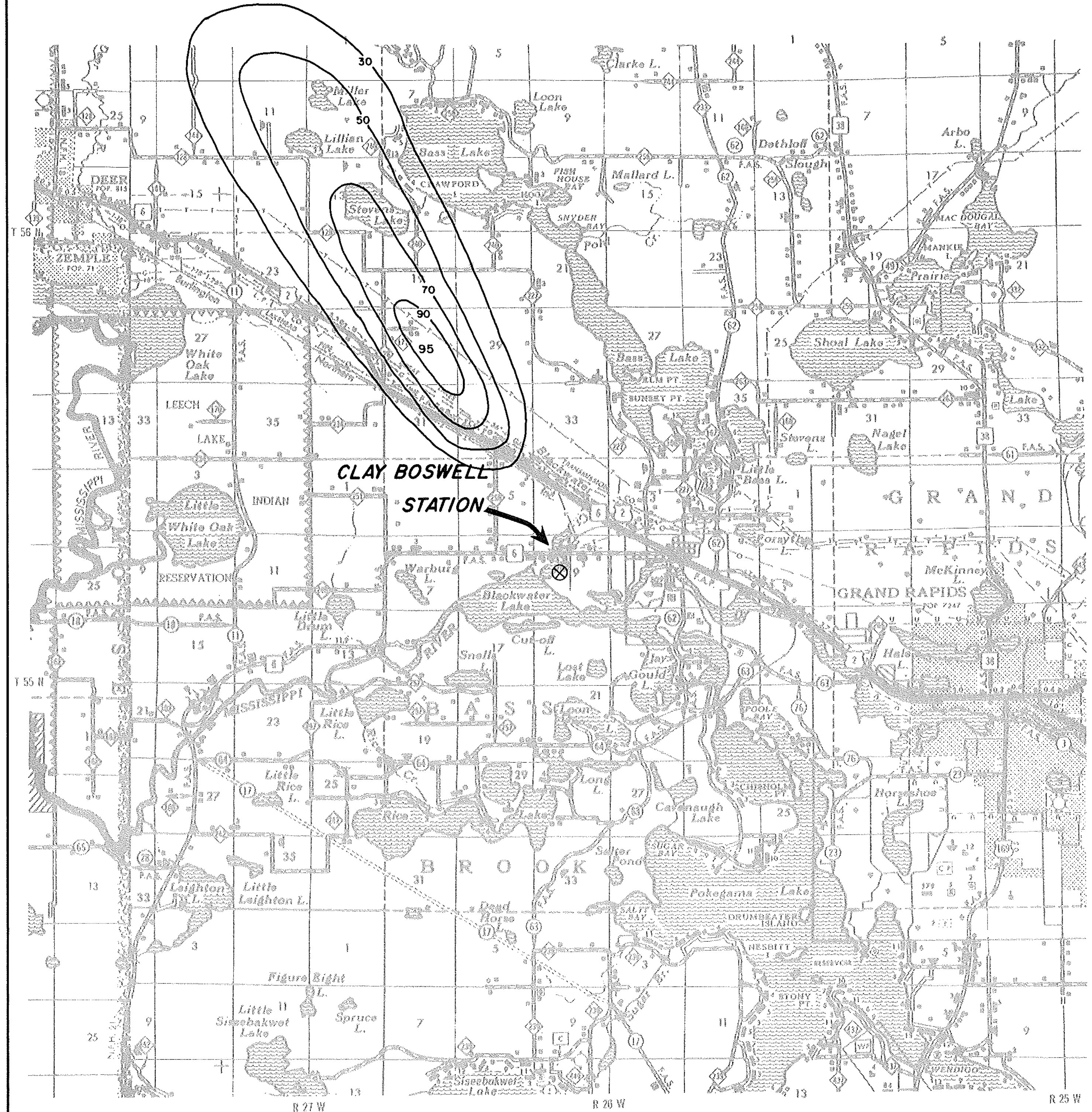
0 1 2 3 KILOMETERS

PROJECTED ISOPLETHS OF 24-HR MAXIMUM PARTICULATE CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3

COMPLIANCE COAL

FIGURE V-20



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 5 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
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- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3 MILES

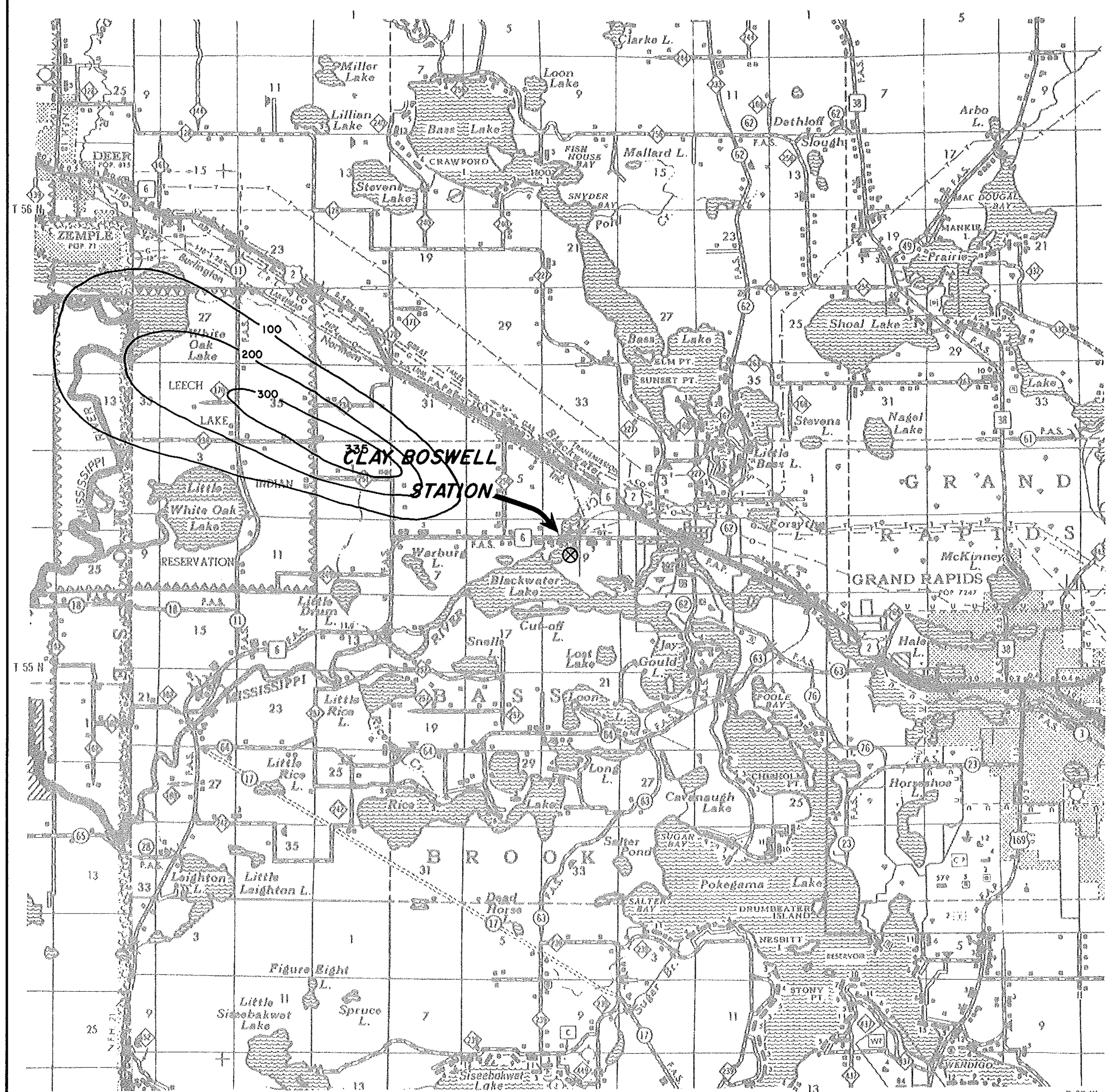
0 1 2 3 KILOMETERS

PROJECTED ISOPLETHS OF 24-HR MAXIMUM SO_2 CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3

COMPLIANCE COAL

FIGURE V-21



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 15 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES
- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES
- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE
- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES
- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS
- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

0 1 2 3 MILES

0 1 2 3 KILOMETERS

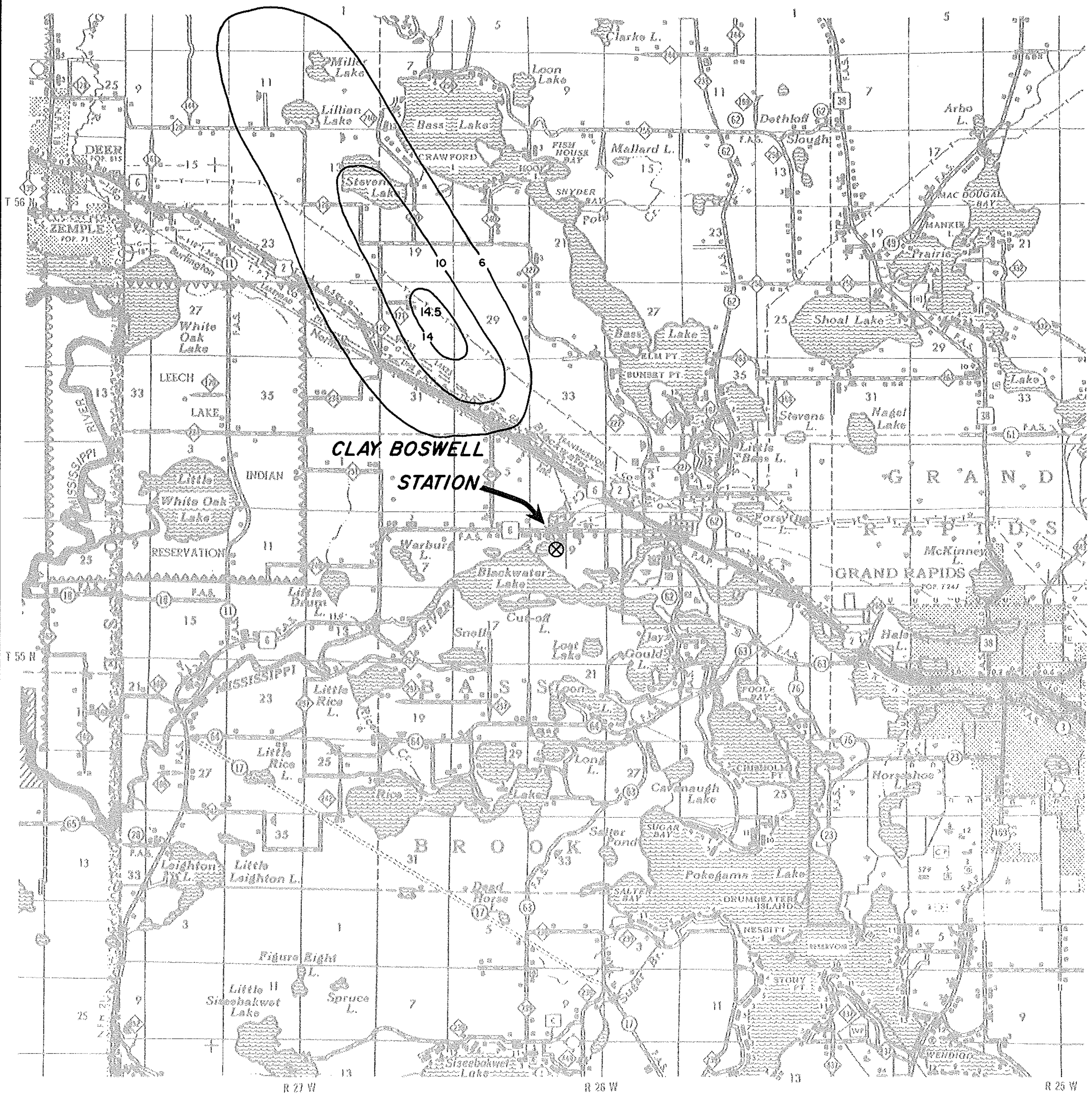
N

PROJECTED ISOPLETHS OF 3-HR MAXIMUM SO_2 CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3

COMPLIANCE COAL

FIGURE V-22



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 107 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

-N-

0 1 2 3
MILES

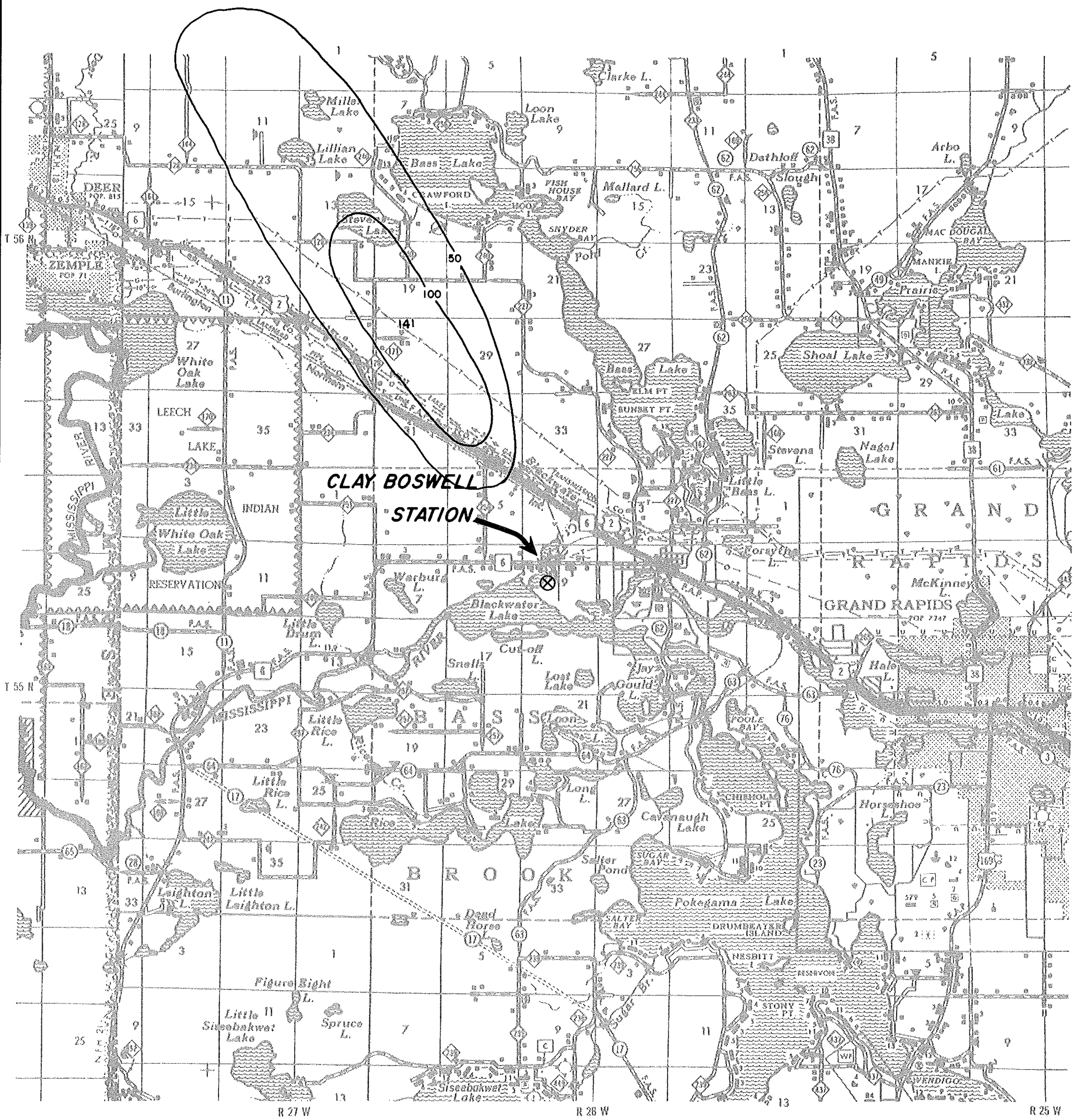
0 1 2 3
KILOMETERS

PROJECTED ISOPLETHS OF 24-HR MAXIMUM PARTICULATE CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

COMPLIANCE COAL

FIGURE V-23



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 5 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

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- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3 MILES

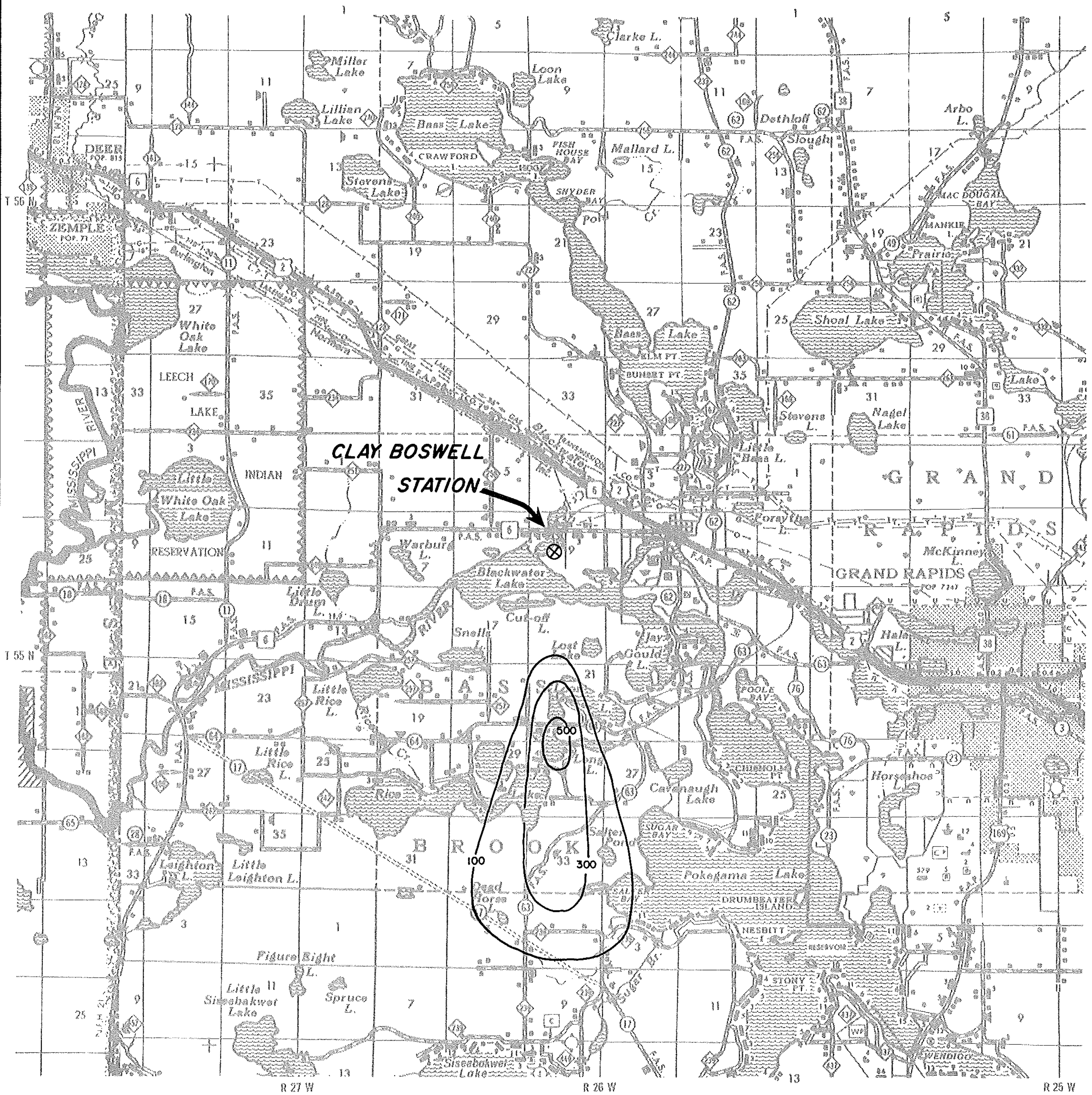
0 1 2 3 KILOMETERS

PROJECTED ISOPLETHS OF 24-HR MAXIMUM SO_2 CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

COMPLIANCE COAL

FIGURE V-24



LEGEND

⊗ CLAY BOSWELL STATION

NOTE ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 15 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3 MILES

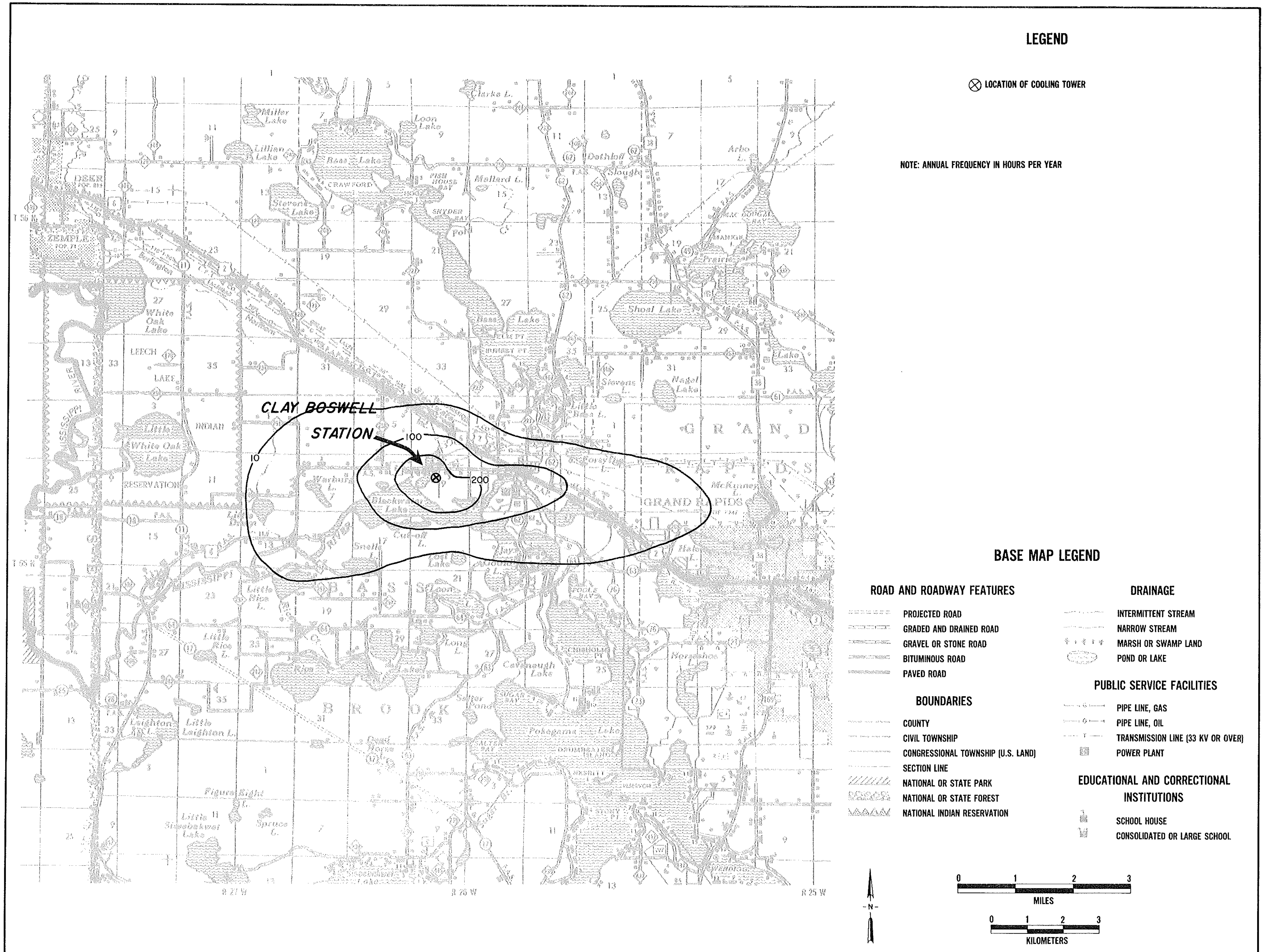
0 1 2 3 KILOMETERS

PROJECTED ISOPLETHS OF 3-HR MAXIMUM SO_2 CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

COMPLIANCE COAL

FIGURE V-25



PROJECTED LOCATIONS OF MAXIMUM GROUND-LEVEL FOGGING

UNIT 3 COOLING TOWER AND PROPOSED UNIT 4 WET COOLING TOWER

FIGURE V-26

TABLE V-25
PROPOSED UNIT 4 COOLING TOWER PARAMETERS USED FOR FOGGING, ICING, AND SALT DRIFT ANALYSES (53)
CLAY BOSWELL STEAM ELECTRIC STATION

Design Parameter	Design Condition
Heat rejection rate	
Btu per hr	2.5×10^9
kg-cal per hr	0.63×10^9
Dry bulb temperature	
°F	82.0
°C	27.8
Wet bulb temperature	
°F	71.0
°C	21.7
Approach to wet bulb temperature	
°F	16.0
°C	8.9
Vertical velocity of plume at exit	
fps	21.4
m per sec	6.5
Circulating water flow	
lb per hr	8.1×10^7
kg per hr	3.7×10^7
Salt concentration of circulating water, (ppm)	1,400
Drift rate (% of circulating water)	0.008
Fan air volume	
cu ft per hr	8.50×10^8
cu m per hr	0.241×10^8
Fan radius	
ft	20.0
m	6.10
Assumed unit capacity factor (%)	100
Tower height	
ft	62.0
m	18.9
Tower width	
ft	67.0
m	20.4
Tower length	
ft	422.0
m	128.6
Number of cooling cells	7
Tower orientation (long axis)	north-south

TABLE V-26
PROJECTED AVERAGE FREQUENCY OF FOGS INDUCED BY UNIT 3
AND PROPOSED UNIT 4 COOLING TOWERS[a] (54)
CLAY BOSWELL STEAM ELECTRIC STATION

	Average Frequency in Hr Per Season or Year				
Distance from Towers	Winter	Spring	Summer	Fall	Annual
0.5 km	58.4	64.3	28.9	67.1	218.7
1.0 km	43.8	41.1	13.8	42.3	140.9
3.0 km	10.3	13.0	4.4	11.9	39.6
5.0 km	4.5	6.8	0.5	4.1	15.9
10.0 km	0.2	0.4	0.0	0.1	0.7

[a] Resulting from the combined operation of both towers.

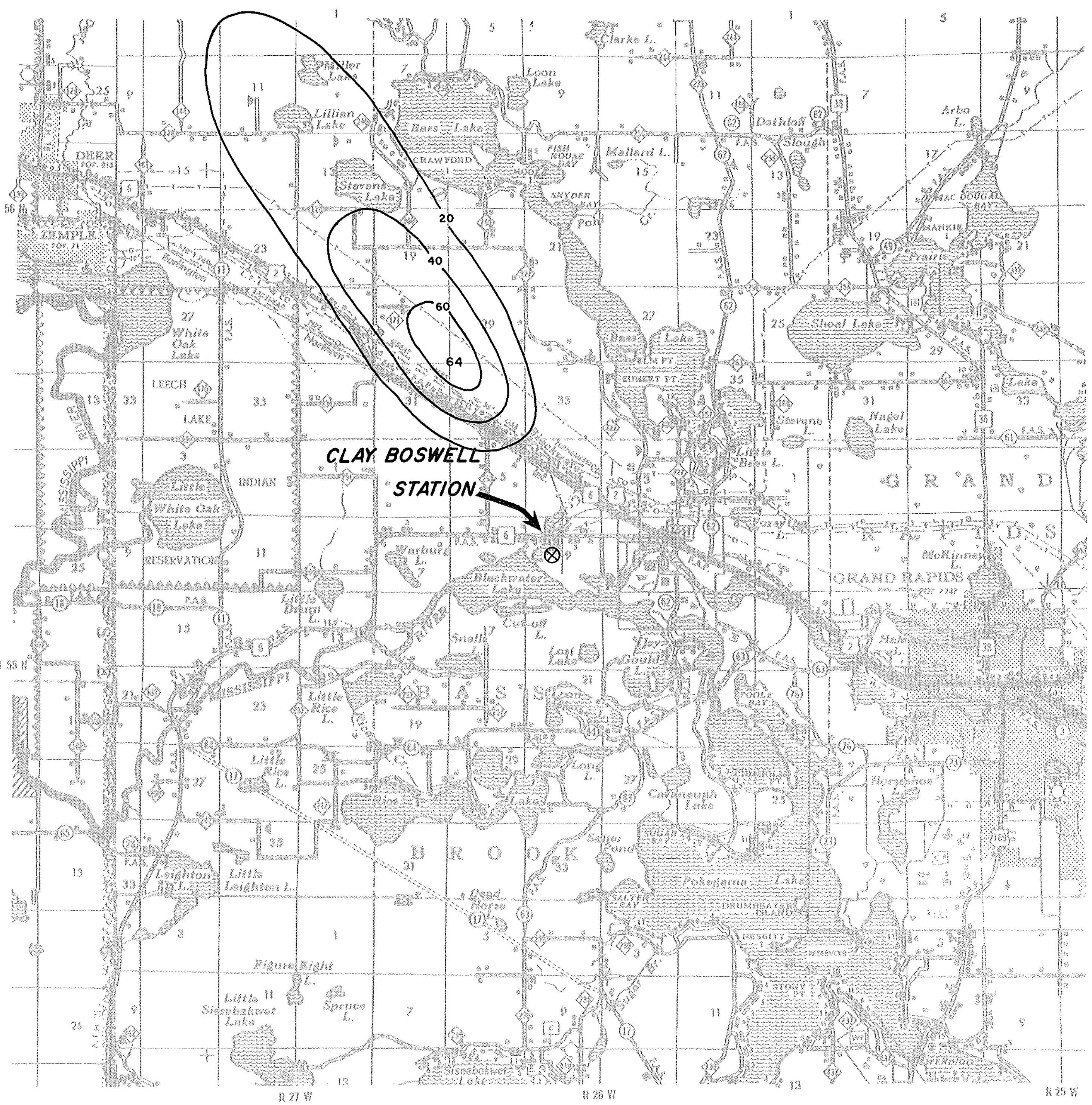
Air Quality Impacts of Alternatives

Waste Wood or Supplemental Fuel

The estimated emission rates of Unit 4 using coal (design performance) and waste wood are presented in Tables III-12 through III-14. Table V-27 presents the results of diffusion modeling for waste wood. It is assumed that waste wood could be used as a supplemental fuel only in Unit 4. The 24-hr and 3-hr maximum SO_2 concentrations resulting from emissions of Unit 4 are projected to decrease by 3.0% and 10.3% respectively, if Unit 4 used coal and waste wood rather than coal alone. The other pollutant concentrations are not significantly affected by this alternative to the proposed action. Figures V-27 and V-28 present the isopleths of 24-hr maximum and 3-hr maximum SO_2 concentrations resulting from emissions of Unit 4 burning coal and waste wood.

Beneficiated Coal

The heating value, ash content, and sulfur content analyses for beneficiated coal are given in Tables III-19 and III-20. Since it would be highly unlikely that MP&L would use beneficiated coal in only Unit 4, the diffusion modeling was done only for the combined emissions of Units 1, 2, 3, and 4 at the Clay Boswell Station. The results of this analysis are presented in Table V-28. This Table also presents the comparison between ambient concentrations resulting from the proposed action, the 2 reasonable alternatives, and Unit 4 using compliance coal. Short term SO_2 and sulfate concentrations are significantly lower for beneficiated coal than the proposed action or any of the other alternatives.



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3 MILES

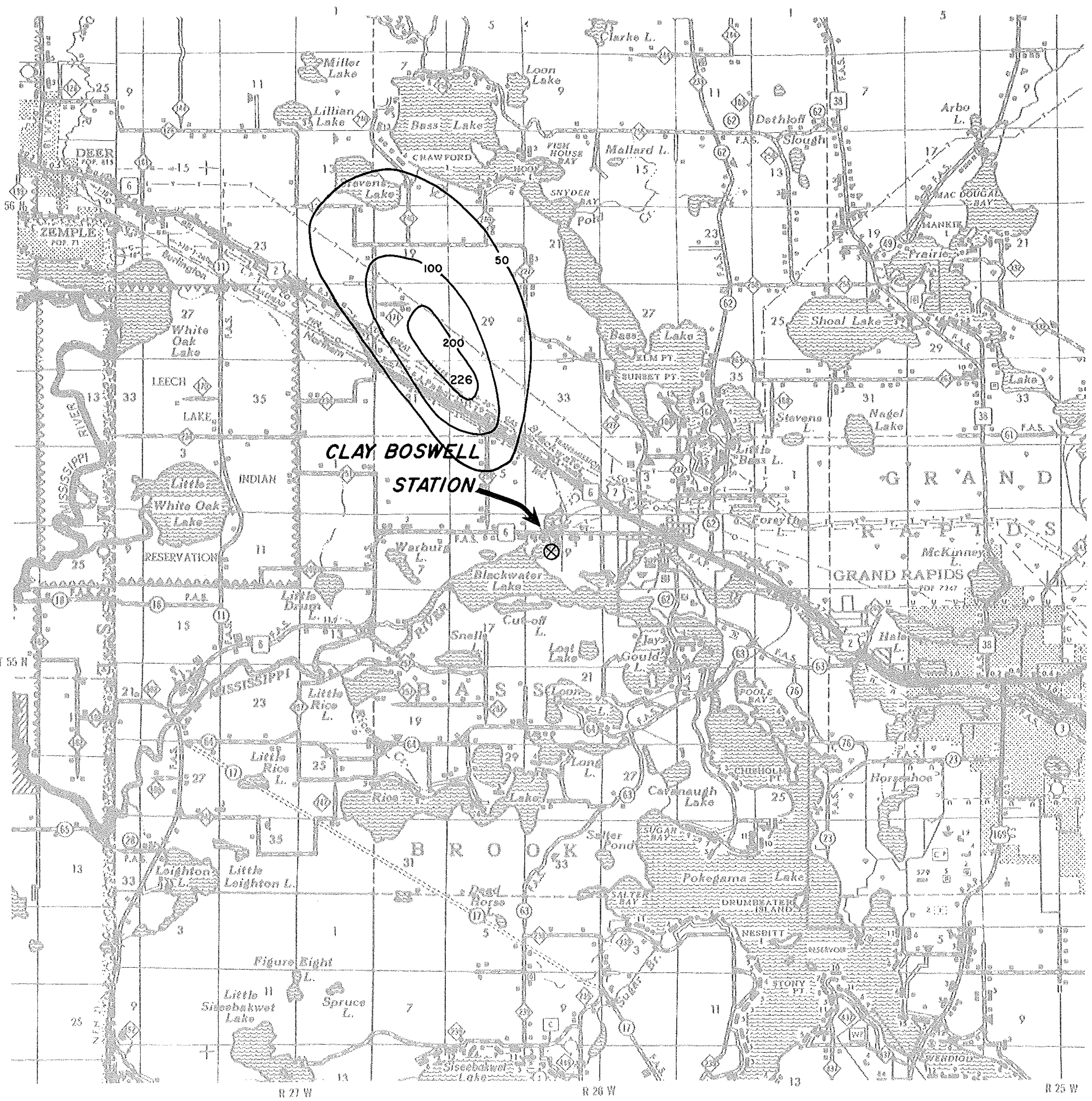
0 1 2 3 KILOMETERS

PROJECTED ISOPLETHS OF 24-HR MAXIMUM SO_2 CONCENTRATIONS

PROPOSED UNIT 4

DESIGN PERFORMANCE COAL AND WASTE-WOOD

FIGURE V-27



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

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DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
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- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3 MILES

0 1 2 3 KILOMETERS

PROJECTED ISOPLETHS OF 3-HR MAXIMUM SO_2 CONCENTRATIONS

PROPOSED UNIT 4

DESIGN PERFORMANCE COAL AND WASTE-WOOD

FIGURE V-28

TABLE V-27
PROJECTED PARTICULATE, NO_x, AND SO_2 CONCENTRATIONS
RESULTING FROM EMISSIONS OF UNIT 4
DESIGN PERFORMANCE COAL AND WASTE WOOD
CLAY BOSWELL STEAM ELECTRIC STATION

Pollutant	Ambient Concentration µg per cu m
Particulates	
Annual geometric mean	0.2
24-hr maximum	3.8
NO_x	
Annual arithmetic mean	1.2
SO_2	
Annual arithmetic mean	2.0
24-hr maximum	64[a]
3-hr maximum	226[b]

a Supplemental waste wood firing for 8 of 24 hr contributes only 3.3% of the boiler heat input.

b Supplemental waste wood firing for 3 of 3 hr contributes 10% of the boiler heat input.

TABLE V-28
COMPARISON OF POLLUTANT CONCENTRATIONS RESULTING FROM EMISSIONS
OF MODIFIED UNITS 1, 2, AND 3 AND PROPOSED ACTION AND ALTERNATIVES[a]
CLAY BOSWELL STEAM ELECTRIC STATION

Pollutant	Design Performance Coal µg per cu m	Design Performance Coal and Waste Wood[b] µg per cu m	Compliance Coal µg per cu m	Beneficiated Coal[c] µg per cu m
Particulates				
Annual geometric mean	0.4	0.4	0.4	0.4
24-hr maximum	17.3	17.3	14.5	14.1
NO_x				
Annual arithmetic mean	1.7	1.7	1.7	1.7
SO_2				
Annual arithmetic mean	3.0	3.0	3.0	2.4
24-hr maximum	310	308	141	65
3-hr maximum	1,113	1,087	510	223
Sulfates				
Annual arithmetic mean	3.0	∿ 3	3.0	2.0
24-hr maximum	57.0	∿ 57	25.0	13.0

a Concentrations are for Units 1, 2, 3, and 4 and do not include background.

b Only Unit 4 will use supplemental waste wood.

c Based on cleaned coal having a heating value of 8,340 Btu per lb (4,633 kg-cal per kg) and 0.49% sulfur and 6.43% ash.

Annual concentrations of particulates and NO_x will not change significantly with the use of beneficiated coal. Figures V-29 through V-32 present the isopleths for the pollutant concentrations which are projected to change if beneficiated coal is used. These are 24-hr maximum particulates, and annual arithmetic mean, 24-hr maximum, and 3-hr maximum SO_2 concentrations. The diffusion modeling indicates that the use of beneficiated coal would reduce the air pollution from the Clay Boswell Station by a very substantial amount.

Dry Cooling Tower

Utilization of a dry cooling tower will essentially eliminate the fogging, icing, and salt deposition caused by the cooling system of the proposed Unit 4 at the Clay Boswell Station.

Wet/Dry Cooling Tower

Utilization of a wet/dry cooling tower would result in a lower induced fog frequency than that for the proposed wet cooling tower. Assuming that the wet/dry cooling tower would evaporate water at a rate 80% that of the proposed wet cooling tower, the average annual frequency of induced fogging from the combined operation of the Unit 3 tower and Unit 4 wet/dry tower would be about 191 hr per year. This is a 12.5% reduction of the frequency resulting from the combined operation of the Unit 3 cooling tower and the proposed Unit 4 wet cooling tower. Figure V-33 presents the projected locations of maximum ground level fogging induced by the Unit 3 cooling tower and the alternative Unit 4 wet/dry cooling tower.

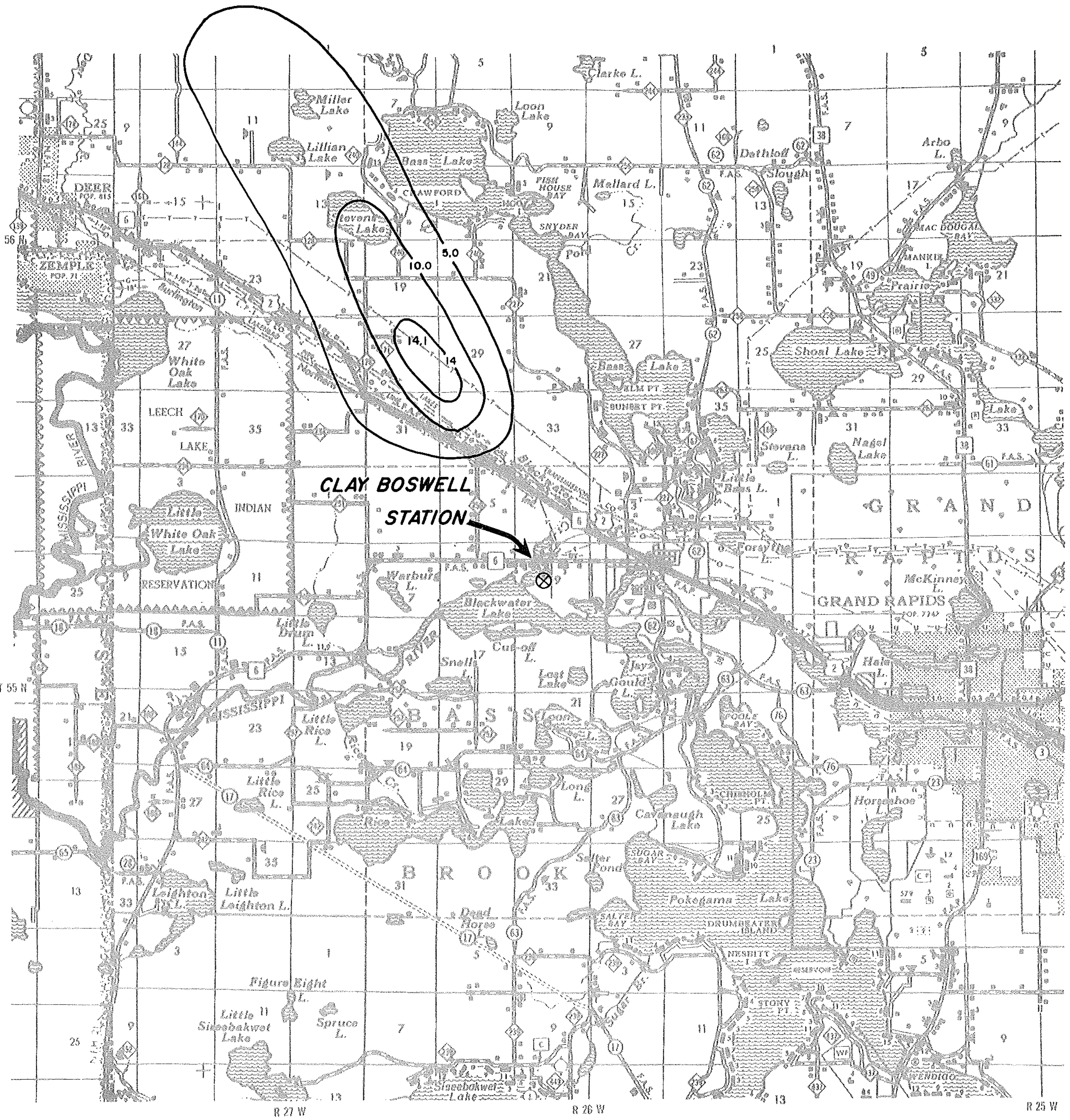
The extent of icing and salt deposition caused by the alternative wet/dry cooling tower would be approximately 20% less than the icing and salt deposition caused by the proposed wet cooling tower.

Disposal of Solid Waste in an Abandoned Mine

The disposal of solid waste in an abandoned mine will eliminate the need for the proposed ash and SO_2 slurry pond. This will eliminate the potential for fugitive dust emissions from the solid waste disposal system at the Clay Boswell Station. In addition, the chemical fixation of the ash and SO_2 slurry will minimize the potential for fugitive dust emissions at the abandoned mine disposal site.

Clay Boswell Steam Electric Station Emissions Compared With State, National, and Global Air Pollution

The broad phrasing of the Minnesota Environmental Policy Act establishes the requirement that, in State actions involving major sources of pollution, consideration be given to protection of the resources of areas extending beyond Minnesota's borders (58). The air pollutant emissions of the Clay Boswell Station, when compared with the State, national, and global emissions, are a small but nonetheless important encroachment upon the assimilative capacity of the atmosphere and ecological systems. Thus, it is important to place the emissions into perspective with the Minnesota, national, and global air pollution situations.



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 107 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

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- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

N

0 1 2 3
MILES

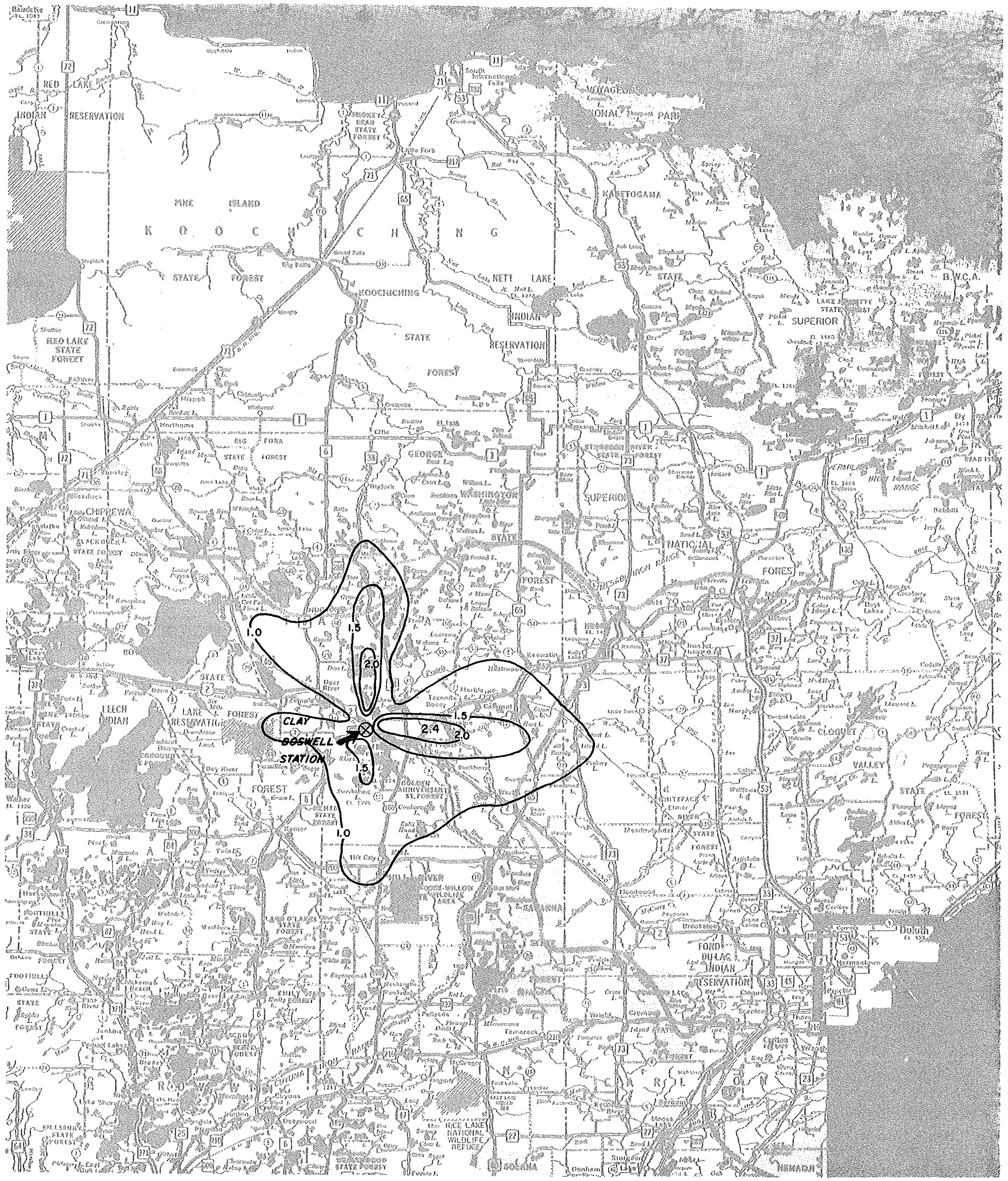
0 1 2 3
KILOMETERS

PROJECTED ISOPLETHS OF 24-HR MAXIMUM PARTICULATE CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

BENEFICIATED COAL

FIGURE V-29



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 0.4 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

- INTERSTATE
- MULTILANE DIVIDED HIGHWAY
- MULTILANE UNDIVIDED HIGHWAY
- INTERMEDIATE TYPE
- GRAVEL SURFACED
- SECONDARY ROAD-HARD SURFACED
- SECONDARY ROAD-GRAVEL
- NATIONAL FOREST
- STATE FOREST
- WILDLIFE MANAGEMENT AREA

10 0 10 20
MILES

10 0 10 20
KILOMETERS

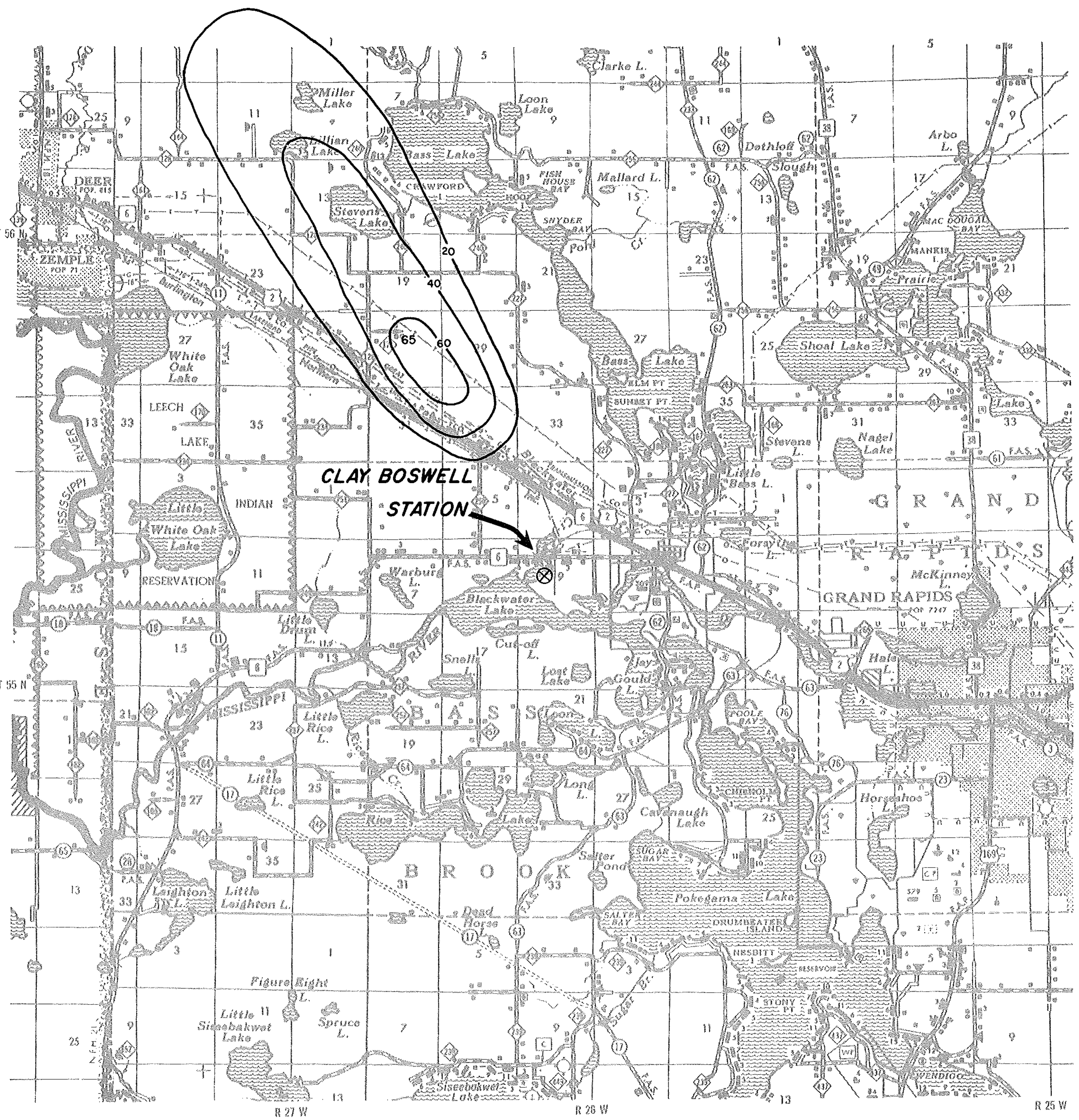
N

PROJECTED ISOPLETHS OF ANNUAL ARITHMETIC MEAN SO_2 CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

BENEFICIATED COAL

FIGURE V-30



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 5 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES
- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES
- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE
- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES
- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS
- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

MILES 0 1 2 3

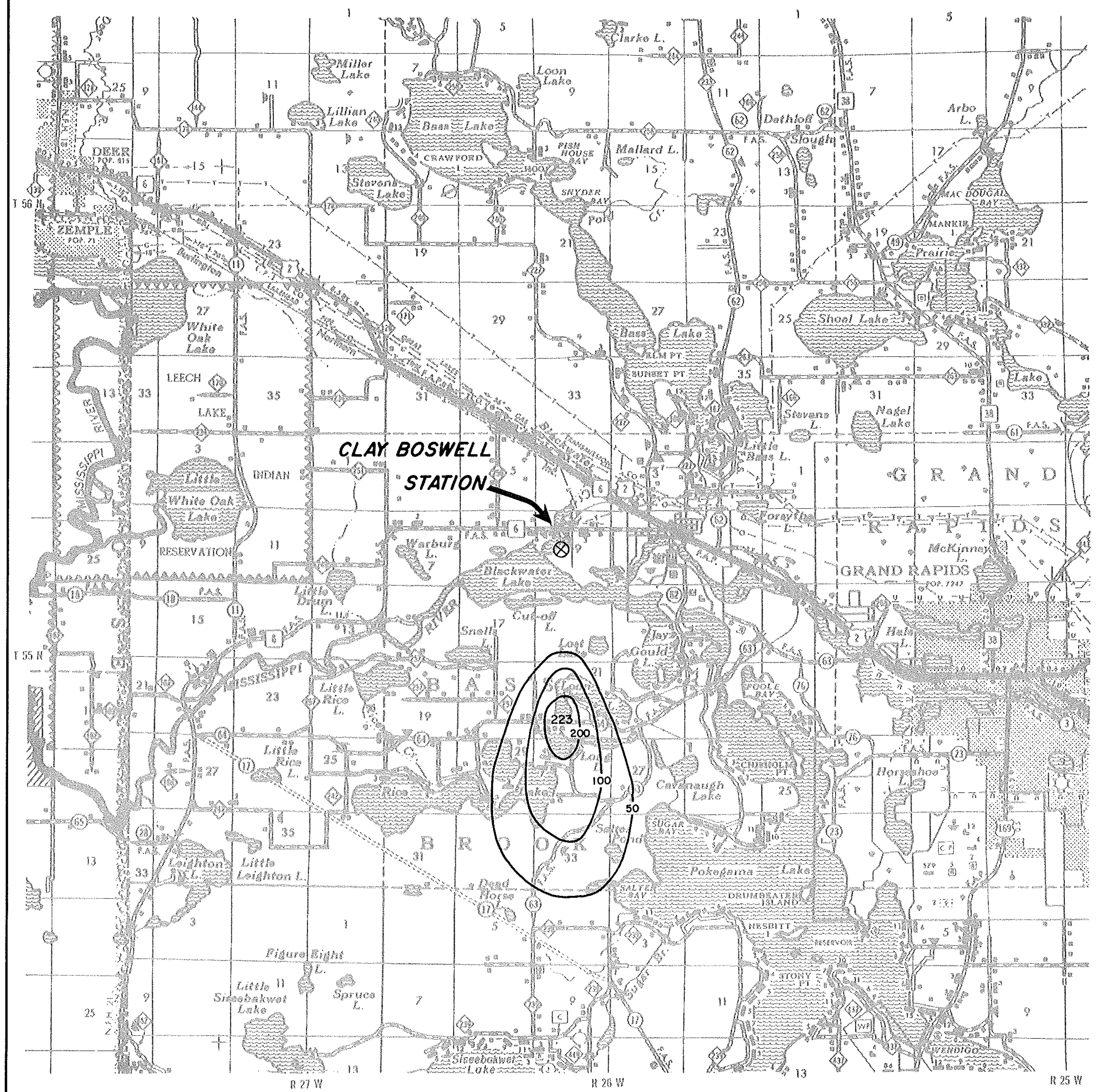
KILOMETERS 0 1 2 3

PROJECTED ISOPLETHS OF 24-HR MAXIMUM SO_2 CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

BENEFICIATED COAL

FIGURE V-31



LEGEND

⊗ CLAY BOSWELL STATION

NOTE: ISOPLETHS IN MICROGRAMS PER CUBIC METER (μg per cu m)

FOR TOTAL WITH BACKGROUND, ADD 15 μg per cu m TO EACH ISOPLETH VALUE

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

-N-

0 1 2 3 MILES

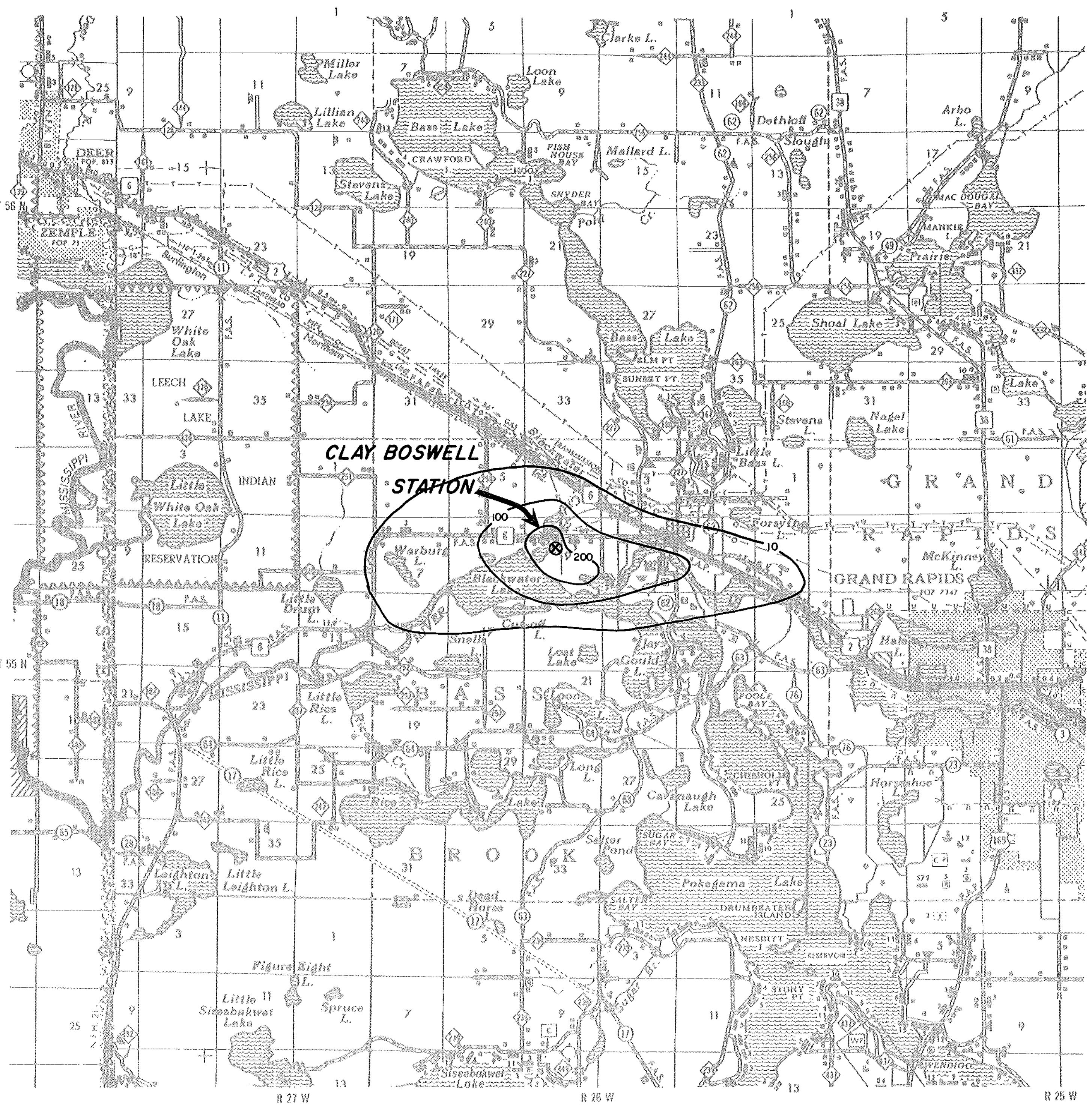
0 1 2 3 KILOMETERS

PROJECTED ISOPLETHS OF 3-HR MAXIMUM SO_2 CONCENTRATIONS

MODIFIED UNITS 1, 2, AND 3 AND PROPOSED UNIT 4

BENEFICIATED COAL

FIGURE V-32



LEGEND

⊗ LOCATION OF COOLING TOWER

NOTE: ANNUAL FREQUENCY IN HR PER YR

WET/DRY COOLING TOWER IS ASSUMED TO HAVE AN EVAPORATION RATE OF 80% THAT OF THE PROPOSED UNIT 4 WET COOLING TOWER

BASE MAP LEGEND

ROAD AND ROADWAY FEATURES

- PROJECTED ROAD
- GRADED AND DRAINED ROAD
- GRAVEL OR STONE ROAD
- BITUMINOUS ROAD
- PAVED ROAD

BOUNDARIES

- COUNTY
- CIVIL TOWNSHIP
- CONGRESSIONAL TOWNSHIP (U.S. LAND)
- SECTION LINE
- NATIONAL OR STATE PARK
- NATIONAL OR STATE FOREST
- NATIONAL INDIAN RESERVATION

DRAINAGE

- INTERMITTENT STREAM
- NARROW STREAM
- MARSH OR SWAMP LAND
- POND OR LAKE

PUBLIC SERVICE FACILITIES

- PIPE LINE, GAS
- PIPE LINE, OIL
- TRANSMISSION LINE (33 KV OR OVER)
- POWER PLANT

EDUCATIONAL AND CORRECTIONAL INSTITUTIONS

- SCHOOL HOUSE
- CONSOLIDATED OR LARGE SCHOOL

-N-

0 1 2 3
MILES

0 1 2 3
KILOMETERS

PROJECTED LOCATIONS OF MAXIMUM GROUND-LEVEL FOGGING

UNIT 3 COOLING TOWER AND UNIT 4 WET/DRY COOLING TOWER

FIGURE V-33

Minnesota Perspective

The Minnesota anthropogenic emissions of particulates, NO_x, and SO_2 for 1972 are presented in Table V-29. Note that in Minnesota the principal source of particulates and SO_2 is fuel combustion in stationary sources, while the principal source of NO_x is transportation related activities.

TABLE V-29
ESTIMATED MINNESOTA ANTHROPOGENIC EMISSIONS
OF PARTICULATES, NO_x, AND SO_2, 1972 (59)

Pollutant Source	Particulates thousands		NO_x thousands		SO_2 thousands	
	tpy	mtpy	tpy	mtpy	tpy	mtpy
Fuel combustion in stationary sources	145.6	132.1	137.6	124.8	393.6	357.1
Industrial processes	130.0	117.9	4.3	3.9	26.4	23.9
Transportation	12.7	11.5	199.5	181.0	9.5	8.6
Solid waste disposal	5.3	4.8	2.0	1.8	2.1	1.9
Miscellaneous	0.0[a]	0.0[a]	0.0[a]	0.0[a]	0.0[a]	0.0[a]
Total[b]	293.5	266.3	343.7	311.8	431.7	391.6

[a] Negligible.
[b] Columns will not always total due to rounding of numbers.

Table V-30 presents the annual emission rates of particulates, NO_x, and SO_2 for the Duluth Air Quality Control Region (AQCR), which consists of Itasca, Aitkin, Carlton, Cook, Koochiching, Lake, and St. Louis Counties. Data on ambient concentrations of particulates, NO_x, SO_2, trace elements, and sulfates in northern Minnesota are presented in Tables IV-48 through IV-53.

TABLE V-30
ESTIMATED ANTHROPOGENIC EMISSIONS OF PARTICULATES, NO_x, AND SO_2
IN DULUTH AIR QUALITY CONTROL REGION, 1972 (7)

Pollutant Source	Particulates thousands		NO_x thousands		SO_2 thousands	
	tpy	mtpy	tpy	mtpy	tpy	mtpy
Fuel combustion in stationary sources	43.6	39.6	36.6	33.2	108.2	98.2
Industrial processes	52.6	47.7	1.0	0.9	10.8	9.8
Transportation	1.5	1.3	13.3	12.1	0.6	0.5
Solid waste disposal	1.5	1.3	0.5	0.5	0.6	0.5
Miscellaneous	0.0[a]	0.0[a]	0.0[a]	0.0[a]	0.0[a]	0.0[a]
Total[b]	99.2	90.0	51.2	46.4	120.3	109.1

[a] Negligible.
[b] Columns will not always total due to rounding of numbers.

SO_2 and NO_x emissions of coal-fired steam electric generating stations may contribute to the acidity of precipitation (see discussion below). There is very little available information on the pH of precipitation in Minnesota. Studies by Krupa, et. al. during 1974, found the pH of individual rainfalls in Minneapolis St. Paul to range from 4.0 to 5.65 (60). In Michigan, the seasonal weighted average and median pH of rainfalls collected at over 60 monitoring stations from September 1972 to December 1974 were 5.0 and 6.3, respectively (61). Annual median pH during this period varied from 8.45 at a monitor located 1.5 km from a concrete tile plant to 4.65 at a monitor located east of a heavily industrialized area. The authors of this study concluded that the pH was dependent on the amount of rainfall and on the natural and man-made conditions of each locality.

The annual arithmetic mean pH of 396 rain and snow samples collected at 6 locations in Iowa during the period September 1971 through December 1973 was approximately 6.2 (62). The lowest rainfall pH recorded during this study was about 4.0, and 2 monitor locations recorded an annual arithmetic mean pH of 6.5. The low pH values did not correlate with $SO_4^=$ concentrations (62).

Coal-fired steam electric generating stations emit a substantial portion of the total Minnesota emissions of particulates, NO_x, and SO_2. Approximately 6.4 million tons (5.8 million mt) of coal were burned in coal-fired steam electric generating stations in 1971 (63). This was 77% of the total coal consumed by all users in Minnesota in that year. Coal consumption by electric utilities has already increased substantially in Minnesota since 1971, and will continue to increase in the future (63) (64) (65). The increasing development of electrical energy facilities is currently the most important environmental issue in Minnesota (66). Consequently, it is important to briefly consider the air quality implications of this growth, of which MP&L's proposed Unit 4 at the Clay Boswell Station is a part.

Table V-31 presents the estimated annual emission rates of particulates, NO_x, SO_2, and trace elements by the modified units 1, 2, and 3 and proposed Unit 4 at the Clay Boswell Station. Note that the modified Units 1, 2, and 3 emissions accounted, respectively, for 7%, 32%, and 26% of the total emissions of particulates, NO_x, and SO_2 in the Duluth AQCR in 1972 however, the emissions in the AQCR may have decreased since 1972, and the emissions of modified Units 1, 2, and 3 are less than the emissions of pre-modified Units 1, 2, and 3 (Table IV-57 .

The gross electricity generating capacity, including coal, nuclear, hydroelectric, gas and jet turbine, and diesel facilities was approximately 7,100 MW in Minnesota in 1976 (65). Current estimates of the net growth in electrical generation capacity needed in Minnesota between 1976 and the year 2000 range from 9,000 MW (66) to 39,700 MW (67). A net growth in coal-fired generating capacity in Minnesota between 1976 and 2000 of 18,000 MW is reasonable for the projection of future annual emissions of coal-fired steam electric generating stations in Minnesota (Clay Boswell Unit 4 and Northern States Power's Sherco Units 2, 3, and 4 are included in the 18,000 MW) (cf. 65).

TABLE V-31
ESTIMATED ANNUAL POLLUTANT EMISSIONS
CLAY BOSWELL STEAM ELECTRIC STATION[a]

Pollutant	Modified Units 1, 2, and 3[b]		Proposed Unit 4[c]		Total	
	tpy	mtpy	tpy	mtpy	tpy	mtpy
Particulates	6,807	6,181	1,607	1,457	8,414	7,638
NO_x	16,350	14,830	11,250	10,210	27,600	25,040
SO_2[d]	31,000	28,120	19,290	17,500	50,290	45,620
Arsenic	1.20	1.09	0.75	0.68	1.95	1.77
Barium	74.23	67.34	44.53	40.40	118.76	107.74
Beryllium	0.12	0.11	0.06	0.05	0.18	0.16
Cadmium	0.12	0.11	0.06	0.05	0.18	0.16
Chromium	1.69	1.53	1.03	0.93	2.72	2.47
Cobalt	0.12	0.11	0.09	0.08	0.21	0.19
Copper	2.42	2.20	1.47	1.33	3.89	3.53
Fluorine	104.49	94.79	65.17	59.12	169.66	153.91
Gallium	3.83	3.47	2.35	2.13	6.18	5.61
Lead	9.78	8.87	6.00	5.44	15.78	14.32
Mercury	0.15	0.14	0.13	0.12	0.28	0.25
Manganese	9.17	8.32	5.63	5.11	14.80	13.43
Molybdenum	3.77	3.42	2.35	2.13	6.12	5.55
Nickel	0.95	0.86	0.59	0.54	1.54	1.40
Strontium	28.45	25.81	17.45	15.83	45.90	41.64
Titanium	137.76	124.97	84.49	76.65	222.25	201.62
Uranium	0.12	0.11	0.06	0.05	0.18	0.16
Vanadium	4.60	4.17	2.78	2.52	7.38	6.70
Zinc	6.47	5.87	4.07	3.69	10.54	9.56

[a] Estimated annual emissions for particulates, NO_x, and SO_2 are based on average hourly emission rates in Table II-46. Estimated annual emissions of trace elements are based on maximum emission rates in Table II-49.

[b] Annual capacity factor of 70.0% assumed for modified Units 1, 2, and 3 (Table II-1).

[c] Annual capacity factor of 71.4% assumed for proposed Unit 4 (Table II-33).

[d] SO_2 emission rates based on 38(%S) or 95% of the sulfur leaving the boiler.

The gross generating capacity of the proposed Unit 4 at the Clay Boswell Steam Electric Station is 554 MW (refer to Chapter II). Based on this, and the emission rates presented in Table V-31, the annual emissions resulting from the operation of coal-fired steam electric generating stations with a combined gross generating capacity of 18,000 MW are estimated to be as presented in Table V-32. The estimates in Table V-32 are based on the assumption that all of the new coal-fired steam electric generating stations will burn the same type of coal and have the same emission factors as the proposed Unit 4 at the Clay Boswell Station, and will be operated at an annual capacity factor of 71.4%. Variations in coal analyses and advances in steam electric generating technology could change these projections considerably.

TABLE V-32
ESTIMATED ANNUAL POLLUTANT EMISSIONS RESULTING FROM OPERATION OF COAL-FIRED STEAM ELECTRIC GENERATING STATIONS WITH A COMBINED GROSS GENERATING CAPACITY OF 18,000 MW[a]

Pollutant	Emissions	
	tpy	mtpy
Particulates	52,210	47,360
NO_x	365,500	331,600
SO_2	626,700	568,500
Arsenic	24.4	22.1
Barium	1,446.8	1,312.5
Beryllium	1.9	1.7
Cadmium	1.9	1.7
Chromium	33.5	30.4
Cobalt	2.9	2.6
Copper	47.8	43.4
Fluorine	2,117.4	1,920.9
Gallium	76.4	69.3
Lead	194.9	176.8
Mercury	4.2	3.8
Manganese	182.9	165.9
Molybdenum	76.4	69.3
Nickel	19.2	17.4
Strontium	567.0	514.4
Titanium	2,745.1	2,490.3
Uranium	1.9	1.7
Vanadium	90.3	81.9
Zinc	132.2	119.9

[a] Based on the emission rates of the 554 MW proposed Unit 4 in Table V-31.

Table V-32 indicates that the operation of an additional 18,000 MW of coal-fired generating capacity will increase the annual emissions of particulates, NO_x and SO_2 by 18%, 106% and 145% respectively over the 1972 Minnesota emissions. It is doubtful that the natural systems of Minnesota and adjacent regions could assimilate the increase without harm.

National and Global Perspectives

It is difficult to quantitatively relate the particulate, NO_x, SO_2, trace element and sulfate emissions of the Clay Boswell Steam Electric Generating Station to the national and global air pollution perspectives. The United Nations has identified all of these pollutants as being of "broad international significance" (67). Table V-33 lists some of the characteristics and globally significant aspects of the pollutants related to large steam electric generating stations.

TABLE V-33
SOME AIR POLLUTANTS OF BROAD INTERNATIONAL SIGNIFICANCE (67)

Pollutant	Principal Anthropogenic Sources	Distribution and Scale of Problems	Approximate Concentrations	Relavent Chemistry	Effects on Human Health	Environmental Effects	Comments
Particulates	Fuel combustion for heating and energy production, industrial processes, solid waste incineration, motor vehicles and other transport. Agriculture and forestry burning. Estimated global particulate emission, about 20 billion kg per year.	Air (local, regional, and global)	Annual averages in urban areas 40 to 400 μg per cu m.	Chemically a most diverse class of substances. Because their physical behaviour is related to particle size (surface and optical properties, motion), usually grouped together.	Synergistic effects with gaseous pollutants such as SO_2; possible toxic effects depend on chemical composition (e.g. lead, asbestos).	Reduction of direct sunlight and visibility; increased cloudiness and frequency of fogs; (these phenomena considerably affect amenity). Damage to materials, and soiling. Possible reduction of earth's temperature (long-range effect).	Natural sources: [dust storms and desert areas; volcanic eruptions, evaporation of sea spray (sea salt)]. Stratospheric particles are mainly of natural origin.
NO_x	Oxidation of atmospheric nitrogen at high temperature (internal combustion engines, furnaces, incinerators), industrial processes; forest fires. Estimated global emission from combustion sources including petroleum refining, about 53 billion kg per year.	Air (local and regional)	Usually less than 150 μg per cu m; in heavy traffic up to 1,600 μg per cu m. Marked diurnal patterns.	NO_x represents the sum of NO and NO_2. NO is the major oxide present in combustion emissions. Photochemical oxidation of NO_x in the presence of hydrocarbons produces irritants like peroxyacetylnitrate and ozone.	Little information available at ambient concentrations; possible increase in acute respiratory infection and bronchitis morbidity in new-born children.	Brown haze in city air. Levels which cause acute injury to plants are above those normally found in the atmosphere. Localized destruction of forests near large industrial sources. Damage to materials.	
SO_2	Energy and heat production from sulfur containing fuel. Industrial processes. Estimated global emission about 150 billion kg per year.	Air (water) (local and regional)	Annual arithmetic mean in polluted urban areas up to 260 to 390 μg per cu m.	Reducing type of air pollutant mainly formed by thermal oxidation of sulfur present in the fuel or sulfur-bearing ore. Atmospheric oxidation to SO_3 results in the formation of sulfuric acid mist and sulfates. Absorption and chemical reactions with suspended particles.	In combination with air borne particles (smoke) aggravates existing respiratory diseases and contributes to their development.	Chronic plant injury (79 μg per cu m, annual average); susceptible species affected at 790 μg per cu m for 8 hr; sulfuric acid mist produces leaf damage at 0.1 mg per cu m. Reduced visibility (sulfuric acid mist and sulfates). Deterioration of materials, increased corrosion rate (largely due to sulfuric acid). Acidification of lakes and soils.	Natural sources such as volcanic gases contribute about 20% of the total SO_2 in the atmosphere (global balance).
Hydrocarbons	Partial combustion of carbonaceous fuels (motor vehicles, stationary fuel combustion); industrial processes; solid waste disposal; solvents; forest fires.	Air (local and regional)	In highly polluted areas, maximum 1-hr values up to 5,400 μg per cu m (as carbon).	Unreacted and partially oxidized products from the original fuel and substances formed by bond-rupture and subsequent re-synthesis. Reactive compounds such as alkenes play an important part in formation of oxidizing type of pollution.	Most of the effects are caused by compounds derived from atmospheric reactions of hydrocarbons, their derivatives and other substances (e.g. NO_x). Some oxidation products are eye irritants (acrolein, aldehydes).	Some compounds, e.g. Ethylene, are very phytotoxic (sensitive plants are injured at 2.68 μg per cu m). Reduced visibility due to aerosol particles, particularly as a consequence of atmospheric reactions. May produce unpleasant odors and affect amenity.	This group comprises hydrocarbons which appear in the atmosphere in gas phase. Polycyclic aromatic hydrocarbons are not included.

TABLE V-33 (continued)
SOME AIR POLLUTANTS OF BROAD INTERNATIONAL SIGNIFICANCE (67)

Pollutant	Principal Anthropogenic Sources	Distribution and Scale of Problems	Approximate Concentrations	Relavent Chemistry	Effects on Human Health	Environmental Effects	Comments
Photochemical oxidants including ozone	Emissions from motor vehicles. Photochemical reactions of oxides of nitrogen and reactive hydrocarbons.	Air (local)	In highly polluted areas up to 294 µg per cu m (8-hr average); strong diurnal and seasonal variations.	Secondary air pollutants produced by photochemical reactions of oxides of nitrogen with hydrocarbons. Oxidizing type of air pollution. A complex mixture of gaseous pollutants and aerosols (O_3, peroxyacetylnitrates (PAN), free radicals, aldehydes, ketones, polymerised hydrocarbons, etc.).	Eye irritation. Possibly associated with asthmatic attacks. Impaired pulmonary function in diseased persons.	PAN injures sensitive plants such as tobacco, tomatos at levels 49.5 to 4,950 µg per cu m (1 to 8-hr exposure). Ozone considered one of the most damaging air pollutants for plants. Damage to materials, particularly rubber, textiles and metals. Pronounced reduction in visibility. Affect amenity.	Ozone is a natural and essential constituent of the upper atmosphere (4,000 to 6,000 µg per cu m).
Polycyclic aromatic hydrocarbons (PAH)	Combustion of organic materials. Exhausts from gasoline and diesel engines. Atmospheric soot, cigarette smoke. Wastes from gas-works, refineries, chemical industry.	Air, water, food (local and regional)	Information incomplete. Data below refer mainly to benzo (a) pyrene. Air: 0.01 to 100 µg per 1,000 cu m (large local and seasonal variations). Surface water: 0.03 to 0.1 µg per liter. Marine plankton: up to 400 µg per kg. Soil: 0 to 400 µg per kg. Smoked meat or fish: up to 50 µg per kg. Cigarette smoke: about 15 µg per 1000 cigarettes.	Include a variety of chemical compounds such as benzo (a) pyrene (BP), dibenzo (a, i) pyrene, dibenzo (a, h) acridine.	The evidence that occupational exposure to mixtures of PAH (coal tar, petroleum products) causes cancer in man is inconclusive. However, the role of individual chemical compounds is not clear. For other types of environmental exposure, evidence is suggestive but not conclusive.	Little information available.	
Carbon dioxide	Carbonaceous fuel combustion for energy production, heating and transport. Estimated global emission from combustion about 15 billion mtpy.	Air and water (global)	Normal atmosphere ∿576 mg per cu m. Rate of increase ∿1,080 µg per cu m per yr.	Biological processes provide a natural system for uptake and replenishment of CO_2. The mass of CO_2 in the ocean layer which is in exchange with the atmosphere is 5 to 8 times the mass of CO_2 in the atmosphere.	Only indirect through possible modification of global climate.	Possible increase in earth's surface temperature (long-range effect).	Normal constituent of the atmosphere essential for plant life.
Cadmium	Mining and metallurgy (lead, copper and zinc smelters). Chemical industry (alkaline accumulators, alloys, paints and plastics). Scrap metal treatment, electroplating. Superphosphate fertilizers. Cadmium-containing pesticides.	Air, soil, water (local), food.	Air: urban areas (yearly mean) ∿0.02 µg per cu m, non-urban ∿0.003 µg per cu m, industrial up to 0.6 µg per cu m. Fresh water: up to 10 µg per liter. Sea water: ∿0.02 µg per liter. Soil: 1 to 50 mg per kg in polluted rice fields (Japan). Food: generally below 0.05 mg per kg (milk 0.1 to 0.4 mg per kg, oysters up to 8 mg per kg, rice 0.1 to 1 mg per kg).	Known to accumulate in certain marine animals. Little known about environmental transformations.	Main intake from food. Possible association with the "itai-itai" disease in Japan (damage of kidney and skeletal system). Possible etiological factor in cardio-vascular disease.	Lethal for fish at less than 1 µg per liter. Little known about other ecological effects.	Compounds teratogenic in some experimental animals. No data available for man.

TABLE V-33 (continued)
SOME AIR POLLUTANTS OF BROAD INTERNATIONAL SIGNIFICANCE (67)

Pollutant	Principal Anthropogenic Sources	Distribution and Scale of Problems	Approximate Concentrations	Relavent Chemistry	Effects on Human Health	Environmental Effects	Comments
Fluorides	Industrial processes (production of aluminium, steel, phosphate fertilizers, fluorinated hydrocarbons, brick-making). Combustion of coal. Industrial liquid wastes and agricultural run-off.	Air (local), water, soil, food	Average concentrations reported for a number of cities (USA) varied from about 0.8 to 16 μg per cu m. Natural waters: very variable, range 0 to 20 mg per liter. Food: very variable range 0.1 to 20 mg per kg.	Fluoride ion is an inhibitor for a number of enzymes.	Beneficial in small concentrations, e.g. 1 mg per liter in drinking water decreases incidence of dental decay. At larger levels (daily intake 2 to 8 mg) mottling of teeth; at still higher levels possible skeletal damage.	Fluorosis in grazing animals. Toxicity to fish varies widely depending on species. Injury to vegetation at concentrations of 1.6 μg per cu m in air. Corrosion of metals, attack a wide range of building materials.	
Lead	Anti-knock ingredients of motor fuels. Lead smelting. Chemical industry. Pesticides. Burning of fossil-fuels. Lead paints, glazes and enamels.	Air, water and food (local, regional and global)	Air: 1.3 μg per cu m in polluted urban areas. In heavy traffic 14 to 25 μg per cu m. Fresh water: up to 0.14 mg per liter. Sea water: 0.01 to 0.3 μg per liter. Food: generally 0.08 to 0.3 mg per kg.	Airborne lead appears as aerosol, also associated with carbon particles. Lead alkyls are volatile and fat soluble. Build-up in oysters and other edible shellfish. Little is known about environmental transformations.	Main source of intake is food. Affects enzymes and heme synthesis; can affect nervous system. Accumulates in bone and kidney with potential long term effects. No recorded poisoning from eating aquatic food products.	Ecological effects not well understood. Stored in marine sediments.	Lead poisoning in children from repeated ingestion of lead-containing paint chips from walls in old houses has been observed. Suggested acceptable daily intake for lead is 0.005 mg per kg. Tumourigenic to experimental animals, but not to man.
Mercury	Chlor-alkali plants. Mercurial catalysts. Pulp and paper industry (slimicides). Seed treatment. Burning of fossil fuels. Mining and refining processes. Medical and research laboratories.	Food, fresh water and marine environment, soil, air (local, regional and global)	Air: ∿0.001 to 0.050 μg per cu m. Fresh waters: ∿0.01 to 0.1 μg per liter. Sea water: ∿0.1 μg per liter. Food: variable up to 0.05 mg per kg; however, some fish from polluted areas may contain up to 1 mg per kg and more.	Microbial conversion of inorganic mercury and some mercury-containing organic compounds to methyl mercury. Build-up in food chains particularly in fresh water and marine organisms.	Cumulative poison affecting nervous system (particularly methyl mercury). Epidemic outbreak of methyl mercury poisoning following ingestion of polluted shellfish and fish with fatal cases and congenital (fetal) disease (Minimata Disease in Japan).	Deaths in birds eating dressed seed (Sweden). Possible reproductive failures and population declines in predatory birds. Effects on aquatic vertebrates, including fish, and on phytoplankton poorly understood.	Mercury in the ocean is largely of natural origin. Man's activities seem to have contributed only .001 to .01 of the total amount. Compounds teratogenic in some experimental animals.

Particulates. Approximately 325 million tons (295 million mt) of particulates were emitted into the global atmosphere by anthropogenic sources in 1972 (59). This was equivelant to 13% of the particulates emitted in that year by natural sources such as wind erosion of land and sea, volcanoes, and forest fires (Table V-34). Fuel combustion in stationary sources contributed approximately 38% of the total United States anthropogenic emissions of particulates in 1972 (Table V-35) (excluding forest fires, which contributed approximately 6.7 million tons (6.1 million mt) (70). Stationary facilities using coal as fuel emitted approximately 6.9 million tons (6.3 million mt) of particulates in the United States in 1972. This constituted approximately 35% of the anthropogenic U.S. particulate emissions in that year. Typical ambient concentrataions of particulates range from 58 to 180 μg per cu m, annual geometric mean, in heavily polluted urban areas (70). Ambient concentrations in rural locations range from less than 10 to about 40 μg per cu m, annual geometric mean (refer to Figure IV-57).

The physical and chemical character of ambient particulates depends on the source. For example suspended particulates from fugitive dust sources in rural areas generally are more inert or biologically inactive compared to particulate from industrial sources (refer to Air Quality section of Chapter IV). Table V-36 compares the percentage composition of selected chemical compounds in particulates from urban and non-urban locations in the United States. A portion of the total particulates suspended in the atmosphere are "secondary" particulates. These particles are formed by chemical and physical reactions in the atmosphere involving gases and particles of either anthropogenic or natural origin (Table V-37). The secondary particulates are principally composed of sulfates, hydrocarbons, and nitrates.

The relative environmental impacts of particulates depends on their chemical and physical characteristics. Suspended particulates of natural origin can be presumed to be in balance with other natural processes. The effects of anthropogenic particulate emissions, however, range from local contamination of soils to possible global climatic changes. Acute environmental impacts are usually local and related to major point sources such as lime kilns and metal smelters. Particulates may increase the reflectance of the atmosphere and thus change the albedo of the earth (72). This man-caused global cooling process is as yet unproven and may be offset by anthropogenic carbon dioxide emissions or natural mechanisms.

The health effects of particulates also depend on their chemical and physical properties. Polycyclic organic compounds are highly toxic and are emitted in the aerosol form by most combustion processes. Benzo(a)pyrene, the principal compound in this group, is carcinogenic and is emitted by coal-fired steam electric generating stations at the rate of 20 to 4000 μg per million BTU (79 to 1,585 μg per million kg-cal) input (71). Other toxic constituents of particulates include sulfates and sulfites, nitrates and nitrites, and various trace elements. All of these compounds exert their health effects through the respiratory system. Acute reactions include the inducement of ashtma, bronchitis, and other inflammations of the respiratory tract. Chronic responses include asthma, bronchitiis, emphysema, and possibly lung cancer as well as systemic disorders caused by absorbed trace elements. Acute responses are generally felt in children, the elderly, and those predisposed to chronic respiratory disorders, and occur with increasing frequency at ambient concentrations of about 200 μg per cu m, 24-hr average, or more (73). Chronic responses probably occur at lower concentrations, but the dose-response relations of chronic responses are as yet largely unknown (59). The health effects of suspended particulates are significantly exacerbated by synergistic reactions with sulfur dioxide and other pollutants.

Particle size is the principal determinant of the efficacy of deposition and retention of particulates by the respiratory system. Most particles larger than 10 microns are filtered out in the nasal region. Maximum lung deposition occurs with particles of 1 to 2 microns in diameter (74).

Nitrogen Oxides. Approximately 500 million tons (450 million mt) of NO_x were emitted by natural sources into the global atmosphere in 1972 (Table V-34). Most naturally occurring NO_x is in the nitrous oxide form (N_2O), and is thought to be principally produced by bacterial action on nitrogenous compounds in soil (75). N_2O is a relatively inert gas. Global anthropogenic emissions of NO_x amounted to approximately 53 million tons (48 million mt) in 1972 (Table V-34). Approximately 51% of this came from coal combustion in stationary sources. United States anthropogenic sources emitted approximately 24.6 million tons (22.3 million mt) of NO_x in 1972 (Table V-35). Of this, approximately 16% was emitted by coal-fired steam electric generating stations. Approximately 27% of the United States total was emitted by gasoline combustion in transportation sources. Ambient concentrations of nitric oxide (NO) commonly range from 40 to 125 μg per cu m, annual arithmetic mean, in urban areas and average about 2 μg per cu m in rural areas (75). Ambient concentrations of nitrogen dioxide (NO_2) range from 54 to 100 μg per cu m, annual arithmetic mean, in urban areas and average about 8 μg per cu m in rural areas (75). The average residence time of NO_2 in the atmosphere is about 3 days (75).

Nitrogen emissions from stationary fuel combustion sources, such as the Clay Boswell Station, are primarily in the nitric oxide form. Nitrogen dioxide is readily converted in the atmosphere to nitrogen dioxide, which may in turn be converted to ozone and other photochemical oxidants (refer to the Air Quality Section of Chapter IV).

NO_x is only moderately phytotoxic. The principal environmental effects of NO_x result from conversion to the highly phytotoxic photochemical oxidants, from discoloration and increased haziness of the atmosphere, and from increased acidity and nitrogen content of precipitation. The atmospheric discoloration and haziness resulting from NO_x emissions are primarily urban phenomena and are due to the brown coloration of NO_2. Nitrogen enrichment of precipitation by ammonia and other nitrogen compounds resulting from NO_x emissions can accelerate lake eutrophication and cause other significant environmental effects (76). NO_x emissions may also be converted to acids in precipitation, which can cause increased leaching of nutrients from soils, increased corrosion of materials, increased acidity of soils and water bodies, and other subtle environmental changes (69). NO_x emissions additionally may act as a benefical fertilizer of errestrial communities.

TABLE V-34
ESTIMATED GLOBAL EMISSION RATES OF PARTICULATES
NO_x, AND SO_2, 1972 (59) (68) (69)

Pollutant and Source	Million tpy	Million mtpy
Particulates		
Natural, total	2,500	2,270
Anthropogenic, total	325	295
NO_x (as NO_2)		
Natural, total	500	450
Anthropogenic, total[a]	53	48
Coal combustion		
industrial processes	13.7	
electricity generation	12.2	11.1
domestic and commercial	1.0	0.9
Petroleum		
residual oil combustion	9.2	8.3
gasoline combustion	7.5	6.8
fuel oil combustion	3.6	3.3
kerosene combustion	1.3	1.2
refinery production	0.7	0.6
Natural gas combustion		
industrial processes	1.1	1.0
power generation	0.6	0.5
domestic and commercial	0.4	0.4
Other		
refuse incineration	0.5	0.5
wood combustion	0.3	0.3
forest fires	0.5	0.5
SO_2 (as SO_2)[b]		
Natural, total[a]	335.1	304
biogenic, land	127.9	116
biogenic, marine[c]	105.8	96
sea spray[c]	97.0	88
volcanoes	2.2	2
Anthropogenic, total[a]	143.3	130
fossil fuel combustion	112.4	102
non-fuel combustion	30.9	28

a Columns may not always total due to rounding of numbers.

b Most natural sulfur emissions are in the hydrogen sulfide form (H_2S), but have been converted here to SO_2 for convenience.

c Most marine sulfur emissions return directly to the sea.

TABLE V-35
ESTIMATED UNITED STATES ANTHROPOGENIC EMISSIONS
OF PARTICULATES, NO_x, AND SO_2, 1972 (59)(68)(70)

Pollutant Source	Particulates		NO_x		SO_2	
	Million tpy	Million mtpy	Million tpy	Million mtpy	Million tpy	Million mtpy
Fuel combustion in stationary sources, total[a]	7.5	6.8	12.3	11.2	24.5	22.2
Coal, total[a]	6.9[b]	6.3[b]	5.2[b]	4.7[b]	20.4[b]	18.5[b]
Oil, total[a]	0.3[b]	0.3[b]	1.4[b]	1.3[b]	4.1[b]	3.7[b]
Natural and process gas, total[a]	0.2[b]	0.2[b]	5.7[b]	5.2[b]	0.0[c]	0.0[c]
Wood	0.2[b]	0.2[b]	na[d]	na	0.0[c]	0.0[c]
Electricity generation, total[a]	na	na	5.9	5.4	17.3	15.7
coal	na	na	4.0	3.6	na	na
oil	na	na	0.9	0.8	na	na
natural gas	na	na	1.1	1.0	na	na
Industrial fuel combustion, total[a]	na	na	5.4	4.9	4.9	4.5
coal	na	na	0.8	0.7	na	na
oil	na	na	0.4	0.4	na	na
natural and process gas	na	na	4.2	3.8	na	na
Commercial, institutional, and residential, Total[a]	na	na	0.9	0.8	2.3	2.1
commercial and institutional	na	na	0.7	0.6	na	na
residential	na	na	0.3	0.3	na	na
Industrial Processes	9.6	8.7	2.9	2.6	6.8	6.2
Transportation, total[a]	0.8	0.7	8.7	7.9	0.6	0.5
Gasoline, total[a]	na	na	6.6	6.0	na	na
Diesel, total[a]	na	na	1.9	1.7	na	na
Other fuels, total	na	na	0.2	0.2	na	na
Motor vehicles, total[a]	0.5[b]	0.5[b]	na	na	0.2	0.2
gasoline	0.3[b]	0.3[b]	na	na	na	na
diesel	0.2[b]	0.2[b]	na	na	na	na
Railroads	0.1[b]	0.1[b]	na	na	na	na
Vessels	0.1[b]	0.1[b]	na	na	na	na
Non-highway motor vehicles	0.1[b]	0.1[b]	na	na	na	na
Other transportation	0.0[c]	0.0[c]	0.0[c]	0.0[c]	0.4[b]	0.4[b]
Solid waste disposal	1.0	0.9	0.2	0.2	0.1[b]	0.1[b]
Miscellaneous, total[a]	0.9	0.8	0.2	0.2	0.6	0.5
Agricultural burning	0.8	0.7	na	na	na	na
Coal refuse burning	0.1	0.1	na	na	na	na
Structural fires	0.0[c]	0.0[c]	na	na	na	na
Total[a]	19.8	18.0	24.6	22.3	32.6	29.6

[a] Columns may not always total due to rounding of numbers.
[b] Interpolated from 1968 emission rates.
[c] Negligible.
[d] na means not available.

TABLE V-36
SELECTED PARTICULATE CONSTITUENTS AS PERCENTAGES
OF TOTAL PARTICULATES IN UNITED STATES - 1966 AND 1967 (70)

Compound	Urban[a] %	Non-Urban Proximate[b] %	Non-Urban Intermediate[c] %	Non-Urban Remote[d] %
Benzene soluble organics	6.6	5.6	5.4	5.1
Ammonium ion	0.9	2.7	0.7	0.7
Nitrate ion	2.4	3.1	2.1	2.2
Sulfate ion	9.9	22.2	13.1	11.8
Copper	0.15	0.36	0.19	0.28
Iron	1.38	1.24	0.67	0.71
Manganese	0.07	0.06	0.03	0.02
Nickel	0.02	0.02	0.01	0.01
Lead	1.07	0.47	0.24	0.10
Total particulate concentration				
μg per cu m, annual geometric mean	102	45	40	21

[a] Average of 217 monitoring locations.
[b] Average of 5 monitoring locations. Near urban areas.
[c] Average of 15 monitoring locations.
[d] Average of 10 monitoring locations. Far from urban areas.

TABLE V-37
PROCESSES AFFECTING EVOLUTION AND CONCENTRATION
OF PARTICULATES IN THE LOWER ATMOSPHERE (71)

Growth or change in particles by homogeneous or heterogeneous chemical reactions of gases on the surface of particles.

Change in particles by attachment and adsorption of trace gases and vapors to aerosol particles.

Net change by collision between particles undergoing Brownian motion or differential gravitational settling.

Net change by collision between particles in the presence of turbulence in the suspending gas.

Gain or loss in concentration by diffusion or convection from neighboring air volumes.

Loss by gravitational settling.

Removal at the earth's surface on obstacles by impaction, interception, Brownian motion, and turbulent diffusion.

Loss or modification by rainout in clouds.

Loss by washout under clouds.

The health hazards of NO_x are not completely known. Acute responses include impairment of pulmonary defense mechanisms against microbial infection, and vascular congestion and edema in the lungs (77). Prolonged exposure to lower dosages (e.g. 1,000 μg per cu m) may cause ciliary loss in the airways, alveolar cell disruption, and obstruction of respiratory bronchioles (77). Epidemiological studies have tentatively linked NO_x, in combination with other pollutants, to increased incidences of respiratory diseases including lung cancer (77).

Sulfur Dioxide. Approximately 335 million tons (304 million mt) of sulfur (expressed as sulfur dioxide) were emitted globally by natural sources in 1972 (Table V-34). The global anthropogenic total in that year was 143.3 million tons (130 million mt), of which approximately 78% resulted from fossil-fuel combustion. In the United States, anthropogenic sources emitted approximately 32.6 million tons (29.6 million mt) of SO_2 in 1972 (Table V-35). Of this, 63% resulted from coal combustion in stationary sources. Annual arithmetic mean SO_2 concentrations range from 10 to 50 μg per cu m in urban areas (68).

Sulfur is an important macronutrient which is essential for plant growth. SO_2 is an important phytotoxin (refer to Terrestiral Vegetation and Soils section of Chapter V). Sulfuric acid, sulfates, and other secondary reaction products of atmospheric SO_2 are moderately phytotoxic. The principal environmental effects of these secondary compounds are the increased acidity of precipitation, and resultant changes in soil and surface water chemistry (refer to the Terrestrial Vegetation and Soils section of Chapter V, and to the report of the summer field study).

Increased acidity of precipitation has been noted as a serious regional environmental problem only during the last 20 years. The principal geographical areas of concern have been northern Europe and northeast United States. Pure water in equilibrium with carbon dioxide in the atmosphere is about pH 5.7 (78). Alkaline particulates of natural or anthropogenic origin raise the pH of precipitation above 5.7, and acid forming compounds of natural or anthropogenic origin lower the pH below 5.7. Rainfalls in Sweden have exhibited a pH of 2.8 (79), and rainfalls in northeast United States have exhibited a pH as low as 2.1 (80).

Acidic precipitation can be caused by a variety of compounds which donate hydrogen ions. In Minneapolis and St. Paul rainfalls of pH 4.0 to 5.65, the increase in acidity was found to be caused by a combination of volatile and non-volatile weak acids (e.g. RCOOH) and strong acids (e.g. H_2SO_4, HNO_3, HCl) (60). In northern Europe, the pH of highly acidic rain is most closely associated with sulfuric acid (69). The trend of increasing acidity of precipitation in Sweden can be correlated with increased anthropogenic SO_2 emissions over the past 20 years (81).

In New England, annual arithmetic mean pH during the period 1970 through 1971 were found to be 4.03 at the Hubbard Brook Experimental Forest, New Hampshire; 3.98 at Ithaca, New York; 3.91 at Aurora, New York; and 4.02 at Geneva, New York (80). The principal cation in the acidic precipitation in New

England is H^+(80). Of the anions in the precipitation during 1970 and 1971 at Ithaca and Hubbard Brook, respectively, $SO_4^=$ constituted 59% and 62%, NO_3^- constituted 21% and 23%, and C constituted 20%, and 14% (80). These three anions principally result from emissions of coal-fired steam electric generating stations and other industrial sources.

Thus, acidic precipitation is a complicated phenomenon which can be caused by a wide variety of compounds emitted by human activities. Most reports indicate that SO_2 is a principal precursor of acids in precipitation, but not all scientists agree that it dominates (e.g., 82). Measurement systems and procedures are only now becoming sufficiently sophisticated to detect the relative importance of strong and weak acids in precipitation (e.g., 83).

As with environmental effects, the human health effects of atmospheric sulfur depend on its chemical and physical form. Below concentrations of 65,5000 μg per cu m, SO_2 affects only the upper respiratory tracts (59). However, if sulfur is in the aerosol form (sulfate, H_2SO_4, etc), it can be drawn deeper into the respiratory tract and become an irritant of the lower bronchiolar system and lungs. Thus, aerosols containing secondary reaction products of SO_2 cause health effects 3 to 4 times more severe than does pure SO_2 (59). Other particulate matter can also worsen the health effects of SO_2 (refer to the Air Quality section of Chapter IV).

Trace Elements. There is very little available information on the national emission rates of trace elements. Table V-38 summarizes some of this data, as well as presenting a broad summary of the principal sources, transport modes, and effects of some of these toxic elements (also refer to Table V-33). All of these trace elements are emitted by coal-fired steam electric generating stations.

Trace elements generally are present in very low ambient concentrations (less than a few μg per cu m). Acute environmental damage and health effects are primarily associated with large metal smelters and metal processing facilities. Little is known about the effects of chronic exposure to these elements, as may occur with lead emitted by automobiles (refer to the Terrestrial Vegetation and Soils section of Chapter V, and the report of the summer 1977 field study). Since most airborne trace elements are present as aerosols, they can effectively become deposited in the lung. This can cause or worsen respiratory diseases, including lung cancer (e.g. by beryllium), and may lead to systemic poisoning (many of the trace elements cause severe neurological disorders). Most of the trace elements are retained by tissues and are concentrated further by each trophic level. Trace elements toxicity in plants and animals is also characterized by synergistic reactions between 2 or more compounds, and by displacement of essential micronutrients in enzymes and subcellular systems (90).

Sulfates. Sulfates are primarily secondary reaction products of SO_2 (refer to Air Quality section of Chapter IV and acid rain discussion above). The conversion rate of SO_2 to sulfates is highly variable and dependent on a number of factors (see Tables IV-64 and IV-65). Ambient sulfate concentrations range from 2 to 24 μg per cu m, annual arithmetic mean (See Figure IV-67).

Sulfates cause little direct damage to vegetation. Excess deposition rates can cause elevated concentrations of sulfur in the soil, but seldom to levels toxic to plants or soil organisms. The principal environmental concern with sulfates is increased acidification of soils (i.e., by H_2SO_4), which increases the mobilization and loss to leaching of essential soil nutrients.

The health effects of sulfates generally are related to respiratory disorders and are exacerbated by the presence of other particulates.

TABLE V-38

PRINCIPAL SOURCES, TRANSPORT MODES, AND EFFECTS OF SOME TRACE ELEMENTS (72)(84)(85)(86)(87)(88)(89)

Trace Element	Toxicity: Acute	Toxicity: Chronic	Biological Concentration	Commercial Production	Loss to Environment	Sources of Environmental Contamination	Typical Urban Ambient Concentrations µg per cu m Annual Arithmetic Mean	Comments
Arsenic (oxide forms)	Very high to low, depending on form and route of exposure; rarely seen	Possible carcinogen, and teratogenic cummulative poison	Yes, in aquatic environment	50,000 tpy (world) 45,000 mtpy	na[a]	Weathering; mining and smelting; coal combustion, pesticides; detergents	na	
Barium	At high levels, variable	Not a cummulative poison	na			Industrial	na	Toxicity levels and time of exposure extensively studied
Beryllium	Short term poison at high concentrations, especially toxic by inhalation	Long term systemic poison at low concentrations; carcinogenic in experimental animals	na	5,000 tpy (world) 4,500 mtpy	na	Industrial; combustion of coal. Rocket fuels	na	
Cadmium	Very toxic at high concentrations; to animals and aquatic life. Toxic by all routes of exposures	Possible carcinogenic cummulative poisons; Associated with hypertension, cardiovascular disease, kidney damage	Yes, in aquatic environment and plants from soil	18,700 tpy (world) 17,000 mtpy 5,400 tpy (U.S.) 4,900 mtpy	1,980 tpy (U.S.) 1,800 mtpy	Weathering; mining and smelting, especially zinc; iron and steel industry; coal combustion; urban runoff; phosphate fertilizers	na	Chronic cadmium poisoning resulting in illness and death has occurred in Japan, where cadmium mobilized by mining contaminated daily diet. Margin of safety-measured levels of cadmium in renal cortex compared to threshhold for renal dysfunction is low: 4 to 12.5
Chromium	Hexavalent form most harmful; skin and respitory tract irritant	Carcinogenic; workers engaged in manufacture of chromium chemicals have incidence of lung cancer, no evidence of risk in nonoccupational exposure	Yes? Almost no data on ecologic cycling of chromium in environment	6,800 tpy (world) 6,200 mtpy	na	No chromium now mined in U.S. Emissions from industrial processes, including electroplating, tanning, dyes; coal combustion	0.02 to 0.10	

TABLE V-38 (continued)

PRINCIPAL SOURCES, TRANSPORT MODES, AND EFFECTS OF SOME TRACE ELEMENTS (72)(84)(85)(86)(87)(88)(89)

Trace Element	Toxicity		Biological Concentration	Commercial Production	Loss to Environment	Sources of Environmental Contamination	Typical Urban Ambient Concentrations µg per cu m Annual Arithmetic Mean	Comments
	Acute	Chronic						
Copper (various salts)	Toxic at high concentrations, varies with salt form	Studies required; some evidence suggestive of possible toxic effects	Yes	7 million tpy (world) 6.4 million mtpy	na	Metal processing and working; Industrial processes	na	
Fluorides	Variable, some plants very susceptible to damage; toxicity to animals varies with form	Affects skeleton, teeth	Whether plants concentrate or cumulate fluoride from air is uncertain	5 million tpy (world) 4.5 million mtpy	na	Volcanoes; phosphate fertilizer manufacture; aluminum reduction plants; brick, glass, cement manufacturing; fluoridation of drinking water	0.05 to 1.89	
Lead	Toxic to man, animals, fish and other aquatic life; depends on form of lead	Cumulative poison, affects central nervous system, can be toxic if tolerance levels are exceeded	Yes, by animals	3.6 million tpy (world) 3.3 million mtpy	na	Weathering; mining and smelting; combustion of leaded gasoline, paints	0.80 to 3.10	Lead poisoning among children from eating lead paint serious urban problems; hazard from combustion of gasoline uncertain
Manganese	Slight	Inhalation can lead to chronic poisoning or pneumonia	na	22 million tpy (world) ore 20.0 million mtpy	na	Industrial	0.01 to 0.08	
Mercury	Methyl mercury and mercury fumes very toxic; other forms of variable toxicity	Methyl mercury very toxic, cumulative poison; affects central nervous system	Yes; by natual processes converts to methyl mercury, the most concentratable form	10,000 tpy (world) 9,100 mtpy	Man's activities are estimated to increase mobilization of mercury in environment 18 times natural processes	Weathering, volcanoes; mining and smelting; industrial; pharmaceuticals; coal combustion; sewage sludge; urban runoff, fungicides	na	Environmental pollution leading to contamination of fish and shellfish caused illness and death in Japan; contamination of fish in U.S. has caused closure of waters to commercial fishing

TABLE V-38 (continued)
PRINCIPAL SOURCES, TRANSPORT MODES, AND EFFECTS OF SOME TRACE ELEMENTS (72)(84)(85)(86)(87)(88)(89)

Trace Element	Toxicity		Biological Concentration	Commercial Production	Loss to Environment	Sources of Environmental Contamination	Typical Urban Ambient Concentrations µg per cu m Annual Arithmetic Mean	Comments
	Acute	Chronic						
Nickel	Variable	Probable carcinogen when inhaled, high incidence of sinus cancer among nickel workers	na	700,000 tpy (world) 640,000 mtpy	na	Mining and smelting, industrial, fossil fuel combustion	0.01 to 0.19	
Selenium	Soluble compounds are highly toxic	Possible carcinogen; may also be an anti-carcinogenic agent	Yes; natural levels in soil may be concentrated by plants to levels toxic to grazing animals	1,300 tpy (world) 1,200 mtpy	na	Natural; mining and smelting; industrial process; coal combustion	na	Interacts with other metals, increasing or decreasing toxicity
Silver	In high doses; depends on compound	Silver is not readily excreted, chronic exposure can lead to toxic levels	Yes, in aquatic life, mushrooms, some vegetables	290,000 troy ounces 9,000 kg per year	na	Industrial	na	
Vanadium	Toxic by inhalation at relatively low levels; irritates lungs, skin	Chronic general poisoning possible. Carcinogenicity speculative	Possibly	20,000 tpy (world) 18,000 mtpy	na	Industrial, particularly in association with iron and steel industry; combustion of fossil fuels	0.17 to 1.30	Not believed to be a problem at ambient levels
Zinc	High concentrations harmful, rarely lethal to animals; toxic to plants at low levels; variable, depends on compound involved	Probably no chronic effects from low levels of exposure	Yes	5.5 million (world) tpy 5.0 million mtpy	na	Mining and smelting; industrial; auto use; urban runoff	na	

[a] na means information not available.

NOISE

Noise Impacts of Proposed Action

Existing background levels must be assessed and used to forecast expected noise levels from a new or modified source such as MP&L's proposed Unit 4 at the Clay Boswell Station. To quantify existing background levels, an on-site survey was conducted during October 8 and 9, 1975 (91). A sampling site in the community of Cohasset was judged to typify the most sensitive receptor due to Cohasset's population density and proximity to the Clay Boswell Station. Nighttime residual octave band sound levels (equivalent to 37 dB(A)) were selected as a base for the acoustic design criteria. In addition to the A-weighted levels listed in Table V-39, measurements were taken for the 10 octave band center frequencies. These measurements provide an approximate assessment of existing background ambient levels and allow a more refined forecast of expected levels. The sound pressure levels of each octave band (plus the A-weighted residual) are listed below:

Frequency Band (Hz)	31.5	63	125	250	500	1K	2K	4K	8K	16K	A-weighted sound level (dB)
Sound Pressure Level (dB)	54	46	42	36	35	33	27	26	23	25	37

Construction Noise Impacts

Construction Noise Sources and Corresponding Levels. Construction of MP&L's proposed Unit 4 at the Clay Boswell Station started in May 1976 and is expected to continue through February 1980. It will be conducted in the following discrete stages:

- Site clearing and grading,
- Excavations,
- Foundations and concrete pours,
- Structural steel and siding erection, and
- Equipment installation.

Different areas of construction are often carried out simultaneously, such as work on erection of siding and equipment installation. Table V-40 depicts major noise sources expected during construction of Unit 4, and their corresponding average sound levels.

At the Clay Boswell Station, construction normally will be on a single shift, 8 hr per day, 40 hr per week, Monday through Friday. However, extended workdays will be required during large concrete pours and pile driving operations. It is expected that large concrete pours will require four concrete

TABLE V-39
AMBIENT SOUND LEVEL OBSERVATIONS - CLAY BOSWELL STEAM ELECTRIC STATION (92)

Measurement Location	Measurement Time	L_{10} dB(A)	L_{50} dB(A)	L_{90} dB(A)	Residual dB(A)
October 8, 1975 Daytime Hours (7 a.m. to 10 p.m.)					
Location No. 1 western property line WSW corner near T.H. 6	12:40 p.m.	53	47	41	43
Location No. 2 western property line near T.H. 6	1:45 p.m.	51	49	45	49
Location No. 3 inside property line near County Road 258	2:10 p.m.	47	45	43	44
Location No. 5 in Cohasset about 500 ft (152.4m) east of property line	2:50 p.m.	49	47	43	-
Location No. 6 in Cohasset at the edge of the Mississippi River	3:20 p.m.	51	49	45	46
October 9, 1975 Nighttime Hours (10 p.m. to 7 a.m.)					
Location No. 4 inside property line west of County Road 258	6:35 a.m.	49	37	35	36
Location No. 5 Cohasset about 500 ft (152.4m) east of property line	5:10 a.m.	43	41	39	37
In Cohasset about 1½ mi (2.4 km) east of Station	5:50 a.m.	41	39	37	41
Location No. 7 on U.S. Highway 2 at northern property line	6:10 a.m.				41[a]

[a] Sound levels increased intermittently up to 61dB(A) due to nearby traffic.

mixers, one concrete pump, and two cranes, which are expected to operate intermittently. Construction will be required for the proposed Unit 4 ash and SO_2 sludge pond. Tables V-41 and V-42 present the utilization schedules indicating the type, quantity, and span of operation of the various equipment used during construction of the Unit 4 disposal pond and electric generating facilities, respectively.

At the end of construction and prior to trial operation of Unit 4, there will be noise associated with steam piping blowout, a temporary procedure designed to clean the debris left in the steam pipework. It is possible that noise impacts resulting from this operation may cause violations of Minnesota noise regulation, NPC2 (93). MP&L has proposed to use silencers on the steam piping to reduce this impact.

TABLE V-40
MAJOR NOISE SOURCES DURING FACILITIES CONSTRUCTION
UNIT 4 - CLAY BOSWELL STEAM ELECTRIC STATION (94)

Equipment	Average Sound Level dB(A)	Distance from Equipment	
		ft	m
Truck cranes	83	50	15.2
Mobile cranes (cherry pickers)	83	50	15.2
Backhoes	85	50	15.2
Graders	85	50	15.2
Air compressors	81	50	15.2
Pickup trucks	58	50	15.2
Trucks	91	50	15.2
Bulldozers	80	50	15.2
Front end loaders	79	50	15.2
Scrapers	88	50	15.2
Impact wrenches	85	50	15.2
Crawler cranes	83	50	15.2
Diesel 2 drum hoist[a]	77	50	15.2
Concrete mixer	85	50	15.2
Concrete pump	82	50	15.2
Gas driven welding machine	63	50	15.2
Pile driver	104 (dB Peak Impact)	50	15.2
Steam blowout	129	50	15.2

[a] The sound level of this equipment has been estimated according to similar size equipment.

TABLE V-41
DISPOSAL POND CONSTRUCTION EQUIPMENT SCHEDULE
APRIL 1978 TO OCTOBER 1979[a]
UNIT 4 - CLAY BOSWELL STEAM ELECTRIC STATION

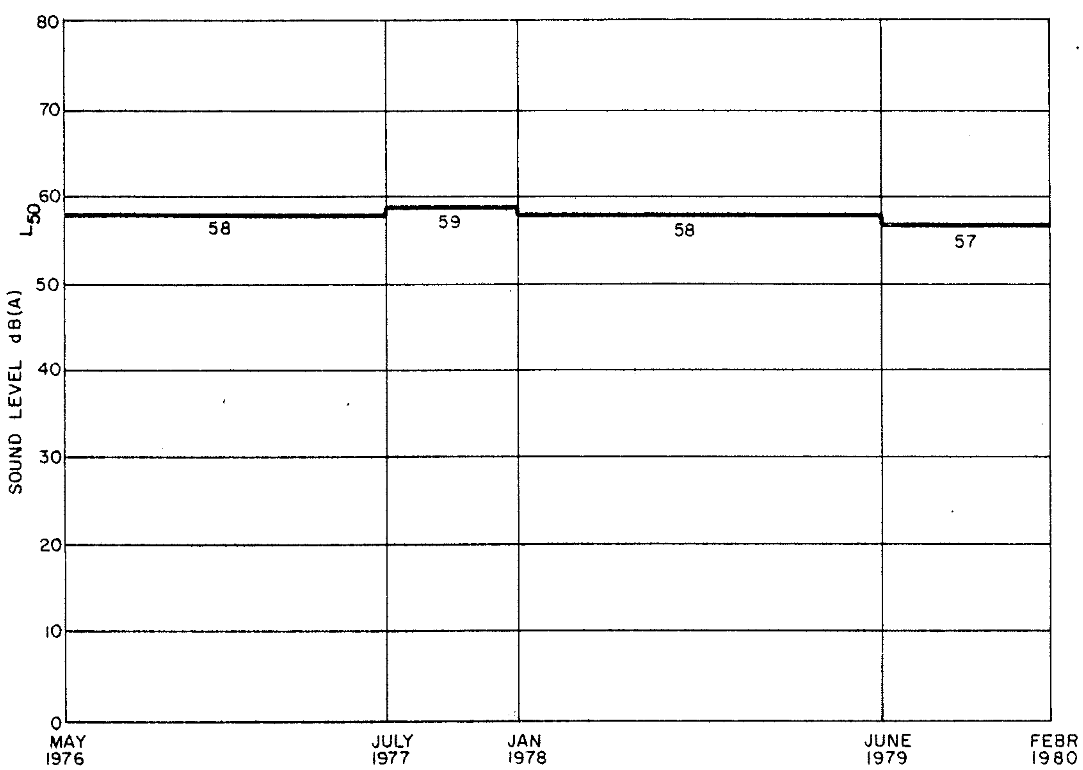
Equipment	
8	Bulldozers
10	24 cu yd scrapers
4	Pickup trucks
2	Flat bed trucks
2	Graders

[a] No disposal pond construction work is contemplated from December through March.

The construction communication network will consist of a high level paging system, telephone stations, and "one-way" and "two-way" radio systems. Communications during construction will be conducted mainly through the radio and the telephone systems. MP&L proposes to use the loudspeaker only in case of emergencies.

Expected Construction Noise Impact. Sound level estimates for individual pieces of equipment (Table V-40) and the equipment utilization schedules (Tables V-41 and V-42) were used to develop the impacts of construction sound at the Clay Boswell Station. Although Table V-40 indicates a particular equipment model, MP&L might use similar size equipment manufactured by other companies.

The noise level associated with each time period was computed by estimating the sound level produced by individual pieces of equipment at a distance of 50 ft (15.2 m). These levels, added logarithmically and projected using hemispherical spreading and molecular absorption, are shown in Figures V-34 and V-35. Two acoustic centers were selected for the propagation model: one near the generating building and a second one in the center of the new disposal pond.



CONSTRUCTION SOUND LEVELS AT A DISTANCE OF ABOUT 4400 FEET FROM FACILITY CONSTRUCTION CENTER- PROPOSED UNIT 4 CLAY BOSWELL STEAM ELECTRIC STATION

SOURCE: ADAPTED FROM MP&L, CLAY BOSWELL UNIT 4, "ENVIRONMENTAL SOUND IMPACT", 1977, EXHIBIT 2

FIGURE V-34

TABLE V-42
FACILITIES CONSTRUCTION EQUIPMENT SCHEDULE
UNIT 4 - CLAY BOSWELL STEAM ELECTRIC STATION (96)

May 1976 to December 1976

3 - 24 cu yd dirt scrapers
2 - Caterpillar D-8 dozers
1 - Manitowoc 4000 crawler crane
1 - 65 ton crawler crane
2 - 65 ton truck cranes
2 - 14 ton cherry pickers
3 - 250 cfm air compressors
1 - Pile driving rig, consisting of 3900 Manitowoc crane and a 19,500 ft lb double acting pile hammer
1 - Front end loader - Cat #977
1 - 3/4 yd Koehring backhoe
4 - Gas driven welding machines
2 - 2-1/2 ton trucks
6 - 3/4 ton pickups
4 - 8 cu yd concrete mixers
1 - Concrete pump

January 1977 to June 1977

2 - Manitowoc 4100 crawler cranes
1 - Manitowoc 4000 crawler crane
1 - 65 ton crawler crane
2 - 65 ton truck cranes
4 - 14 ton Grove cherry pickers
2 - 250 cfm air compressors
1 - 750 cfm air compressor
2 - 2-1/2 ton trucks
2 - Truck tractors
1 - 3/4 yd front end loader - Cat #977
1 - 3/4 yd backhoe
1 - Pile driving rig, consisting of 3900 Manitowoc crane and a 19,500 ft lb double acting pile hammer
6 - 3/4 ton pickups
6 - Chicago Pneumatic 612 impact wrenches

June 1977 to December 1977

2 - Manitowoc 4100 crawler cranes
2 - Manitowoc 4000 crawler cranes
1 - 65 ton crawler crane
2 - 65 ton truck cranes
6 - 14 ton Grove cherry pickers
2 - 250 cfm air compressors
1 - 750 cfm air compressor
2 - 2-1/2 ton trucks
1 - Diesel 2-drum hoist
2 - Truck tractors
1 - 3/4 front end loader - Cat #977
1 - 3/4 yd backhoe
8 - 3/4 ton pickups
8 - Chicago Pneumatic 612 impact wrenches

January 1978 to December 1978

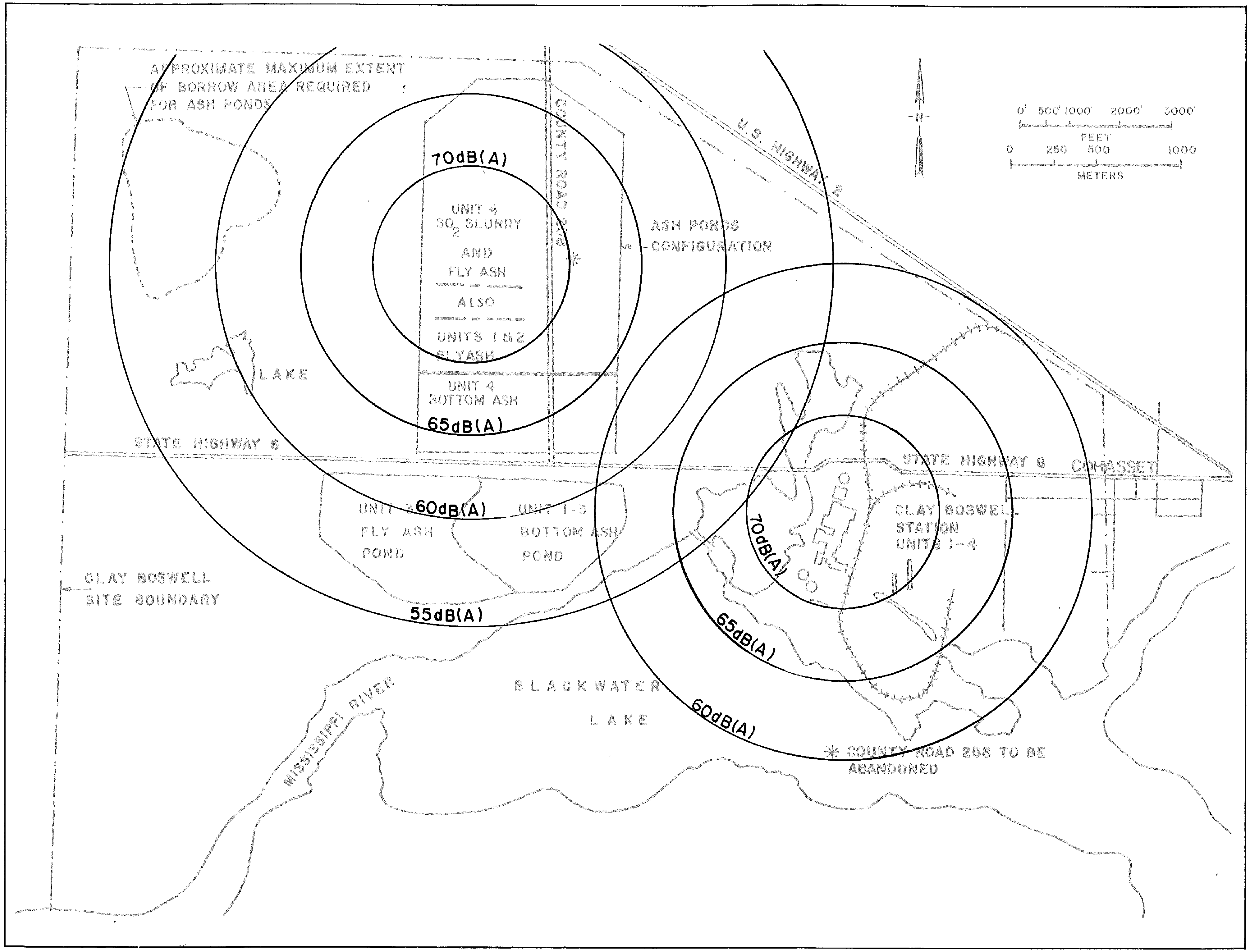
2 - Manitowoc 4100 crawler cranes
3 - Manitowoc 4000 crawler cranes
1 - 65 ton crawler crane
2 - 65 ton truck cranes
8 - 14 ton Grove cherry pickers
2 - 250 cfm air compressors
2 - 750 cfm air compressors
2 - 2-1/2 ton trucks
1 - Diesel 2-drum hoist
2 - Truck tractors
1 - 3/4 yd front end loader - Cat #977
1 - 3/4 yd backhoe
8 - 3/4 ton pickups

January 1979 to June 1979

2 - Manitowoc 4100 crawler cranes
3 - Manitowoc 4000 crawler cranes
1 - 65 ton crawler crane
2 - 65 ton truck cranes
8 - 14 ton Grove cherry pickers
2 - 600 cfm air compressors
2 - 2-1/2 ton trucks
2 - Truck tractors
1 - 3/4 yd front end loader - Cat #977
8 - 3/4 ton pickups

June 1979 to February 1980

3 - Manitowoc 4000 crawler cranes
1 - 65 ton crawler crane
2 - 65 ton truck cranes
8 - 14 ton Grove cherry pickers
1 - 750 cfm air compressor
1 - Truck tractor
2 - 2-1/2 ton trucks
8 - 3/4 ton pickups



**FACILITY CONSTRUCTION SOUND CONTOURS-
PROPOSED UNIT 4
CLAY BOSWELL STEAM ELECTRIC STATION**

SOURCE: ADAPTED FROM MP&L, CLAY BOSWELL UNIT 4, "ENVIRONMENTAL SOUND IMPACT", 1977, EXHIBIT 3

FIGURE V-35

As can be seen from Figure V-34, the estimated sound level produced by Clay Boswell Station construction activities at the MP&L property line at the community of Cohasset (about 4,400 ft (1,341.1 m) east of the Station) varies between 57dB(A) (L_{50}) and 59dB(A) (L_{50}) during the construction period (May 1976 to February 1980). At the northeast property line which runs parallel to U.S. Route 2, the maximum estimated sound level produced by construction of the Station is about 60dB(A) (L_{50}). At the northern property line, the estimated sound level produced by the new disposal pond construction is about 63dB(A) (L_{50}) as shown on Figure V-35.

The maximum (instantaneous) impact sound level produced by the pile driving operations at the community of Cohasset property line (about 4,400 ft) (1,341.1 m) is expected to be 63dB(A).

It should be noted that Minnesota noise standards do not identify the limiting levels of impulsive noise such as pile driving operations. The Minnesota noise standards adopted September 17, 1974 restrict the noise level entering a NAC-1 area (which includes household units) to a daytime L_{50} maximum of 60dB(A) and a L_{10} maximum of 65dB(A) (93), and a nighttime L_{50} maximum of 50dB(A) and an L_{10} maximum of 55dB(A). In a very general sense, the L_{50} is a statistical value that is somewhat representative of near-average noise level, and the L_{10} is a statistical value that is somewhat representative of near-peak noise level. The construction propagation model provides a conservative estimate of the L_{50} level and, therefore, the L_{50} maximum of 60dB(A) is applicable. Based on this limiting value, NPC2 will be violated at MP&L's northern property line where an estimated 63dB(A) (L_{50}) is expected to occur during both work days and the possible extended nighttime work periods due to ash and SO_2 scrubber sludge pond construction. The impact may be exacerbated due to existing high noise levels produced by the traffic on nearby U.S. Route 2 (up to 61dB(A) or higher).

As mentioned previously, extended workdays beyond the regular 8 hr shift will be required during large concrete pours, and the maximum sound levels produced by the equipment used for this operation is estimated to be 49dB(A) (L_{50}) from a distance of 4,400 ft (1,341.1 m). This level is lower than the nighttime standard of 50dB(A) (L_{50}) established in the Minnesota noise regulations.

Operation Noise Impacts

Major Noise Sources and Corresponding Levels

Factors taken into consideration to establish an engineering acoustic design criterion for MP&L's proposed Unit 4 at the Clay Boswell Station were:

- Minnesota Noise Regulations, and
- Existing ambient noise levels near the Clay Boswell Station.

Having taken these into consideration, it was estimated that Unit 4 will produce a maximum continous L_{50} sound level of 40 to 45dB(A) at the community of Cohasset property line (about 4,400 ft east of the Station center). Thus, the total sound level at the community of Cohasset property line is not expected to exceed a value of 50dB(A), including the existing ambient (L_{50}) level and the maximum sound level produced by MP&L's proposed Unit 4.

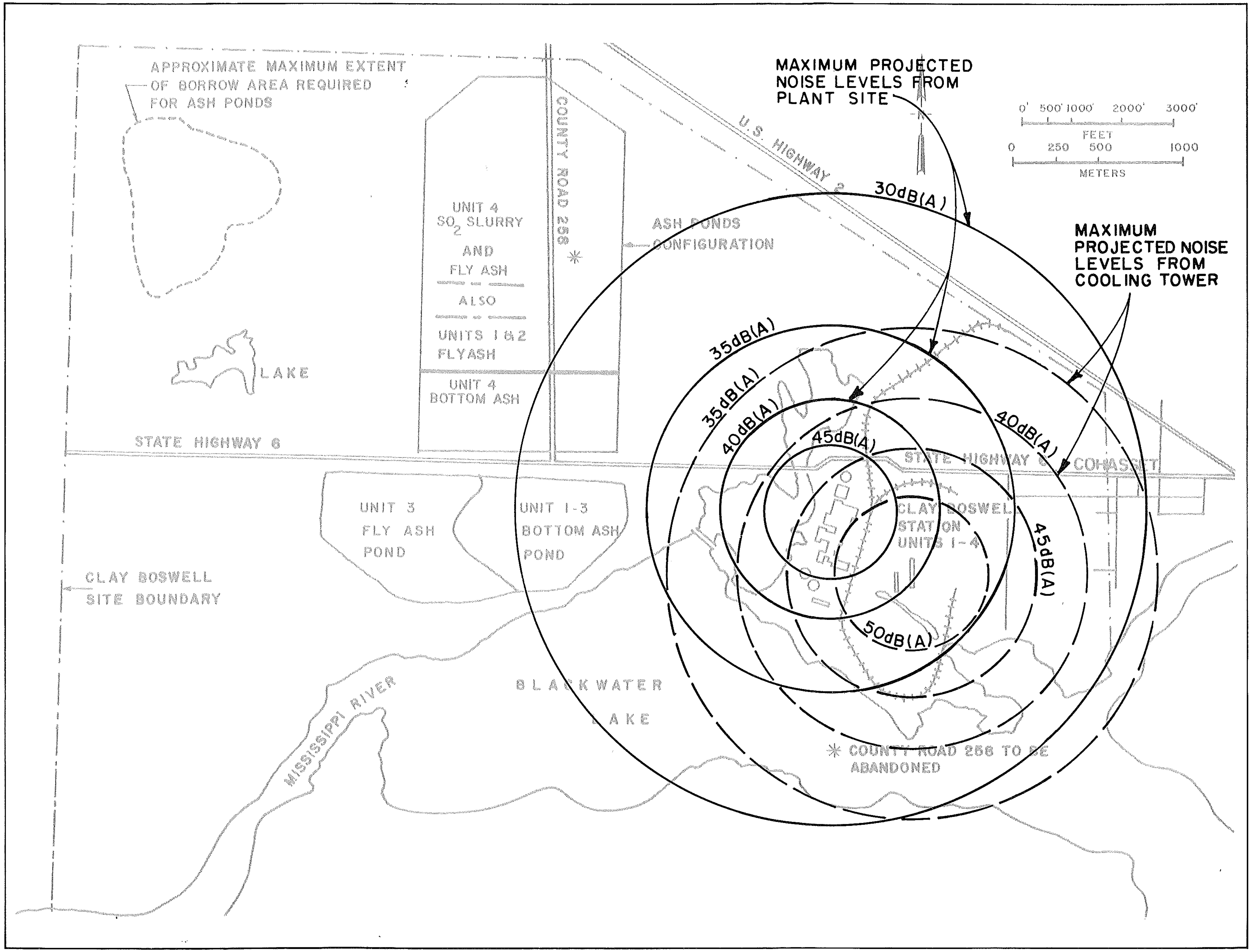
The major noise sources present during operation of a generating facility such as the Clay Boswell Station are listed in Table V-43. This table identifies type of equipment, representative sound level, equipment location, and the frequency of operation.

TABLE V-43 (97)
MAJOR NOISE SOURCES DURING FACILITIES OPERATION - UNSILENCED
UNIT 4 - CLAY BOSWELL STEAM ELECTRIC STATION

Equipment	Representative Sound Level dB(A)	Distance From Equipment ft	Distance From Equipment m	Type of Operation[a]	Equipment Location
Turbine generator	92	3	0.91	C	Indoor
Pulverizer	90	3	0.91	C	Indoor
Induced draft fan	128	5 from open outlet	1.5	C	Indoor
Forced draft fan	106	5 from inlet	1.5	C	Indoor
Primary air fan	113	5 from inlet	1.5	C	Indoor
Boiler feed pump	105	3	0.91	C	Indoor
Boiler feed pump turbine	97	3	0.91	C	Indoor
Circulating water pump	82	3	0.91	C	Indoor
Main transformer	83	5	1.5	C	Outdoor
Auxiliary transformer	78	3	0.91	C	Outdoor
Emergency diesel generator	105	3	0.91	I	Indoor
Cooling tower	78	50	15.2	C	Outdoor
Power control valve discharge pipe	129	50	15.2	I	Outdoor
Public address system	122	4	1.2	I	Indoor/outdoor

[a] C means continuous, I means intermittent.

Because MP&L's proposed Unit 4 is an indoor design, it is inherently quieter than a similar generating facility of the outdoor type. MP&L proposes to attenuate certain pieces of the Station equipment to aid in reducing overall noise levels. It is proposed that noise levels emitted from items such as the emergency diesel generator, power control valves, forced draft and primary air fans, and electrical transformer can be controlled by silencers or product design.



FACILITY OPERATION SOUND CONTOURS-PROPOSED UNIT 4
CLAY BOSWELL STEAM ELECTRIC STATION

SOURCE: ADAPTED FROM MP&L, CLAY BOSWELL UNIT 4, "ENVIRONMENTAL SOUND IMPACT", 1977, EXHIBIT 4

FIGURE V-36

Eight major sound systems selected as being representative of Clay Boswell Unit 4 Station continuous operation are listed below:

- Two forced draft fans,
- Three induced draft fans,
- Power Station building,
- Two auxiliary transformers,
- Two main transformers,
- Two primary air fans,
- One cooling tower, and
- Circulating water station.

The noise emissions from these major systems were assumed to be attentuated (where applicable), combined logarithmically, and projected in 5dB(A) intervals using hemispherical spreading and molecular absorption to produce the estimated contours shown in Figure V-36. Because the proposed cooling tower will be located about 1,400 ft (426.7 m) from the generator building, 2 acoustic centers were selected for the plant operation mode: one for the cooling tower and a second for the rest of the facility near the electric generating building.

Expected Normal Operation Noise Impacts

The maximum continuous sound level produced by MP&L's proposed Unit 4 at the community of Cohasset property line (about 4,400 ft (1,341.1 m) east of the Station) will be 40 to 45dB(A) (L_{50}). Noise area classification 1 (NAC1) which includes household units, has a daytime (L_{50}) limit of 60dB(A) and a nighttime (L_{50}) limit of 50dB(A). Thus, the estimated sound levels produced by Unit 4 and experienced by the community of Cohasset will be lower than the standards mentioned previously. It is expected that the total sound level at the MP&L property line at the community of Cohasset will not exceed a value of 50dB(A) when considering the combined effect of the ambient level and the maximum L_{50} sound level produced by MP&L's proposed Unit 4.

Intermittent sound sources, such as the power control valve and the emergency diesel generator, will produce maximum (instantaneous) sound levels of 45dB(A) and 50dB(A), respectively, at a distance of 4,400 ft (1,341.1 m) due to the acoustical treatment specified previously. There will be either one or two power control valves per unit, however, the 45dB(A) value applies to 2 valves operating simultaneously.

Maintenance activities at Clay Boswell Station, such as replacement of machinery parts, will generate some noise, but probably will not have a significant impact on noise sensitive land uses. It should be noted that the noise measurements did not include coal train unloading operations. This causes some uncertainty in determining maximum ambient noise levels. Compliance with Minnesota noise regulations cannot be determined since the test procedures utilized were not consistent with those approved by the MPCA, and since coal train operations were not included.

Noise Impacts of Alternatives

Waste Wood as Supplemental Fuel

If waste wood is processed and utilized as supplemental fuel, increases in noise levels are likely to result from operation of a wood processing facility (assuming the processing facility is at the Clay Boswell Station, and a wood hog is used for processing).

It is assumed that the wood processing facility will be located to the north of Unit 4 because of the logistics of conveying the waste wood to the furnace. Therefore, the distance of the wood processing facility from MP&L's eastern property boundary (most sensitive receptor) will be equal to or greater than the distance of the Unit 4 cooling tower and coal handling equipment from the eastern property boundary. This arrangement should help attenuate noise levels from the processing equipment.

Noise levels cannot be specifically quantified for the wood processing facility, since design details are not available. Before implementation of the alternative of waste wood burning, probable noise levels should determined based on design details. If noise levels are excessive, they could be reduced by acoustical treatment.

Coal Beneficiation

Coal beneficiation of the sub-bituminous coal from the Big Sky Mine will not have any additional noise impacts in the vicinity of the Clay Boswell Station when compared with MP&L's proposed action.

Dry Cooling Towers

Utilization of dry cooling towers will increase noise levels at the Clay Boswell Station site as a result of increased fan requirements. Also, if a direct condensing dry cooling tower is used, there will be considerable noise associated with the steam movement from the turbine to and through the dry cooling tower.

While noise levels will increase with dry cooling towers, their contribution probably will not be distinguishable from overall noise levels at the eastern property line, which is considered to be the most sensitive area for noise impact. This is because molecular absorption reduces high-frequency noise over long distances, leaving the mid and lower frequencies, which could be characterized as a "hum".

Noise level increases cannot be quantified, since specific details on dry cooling tower design are not available. If dry cooling towers were to be installed, projected noise levels should be evaluated based on the dry cooling tower design parameters.

Wet/Dry Cooling Towers

Utilization of wet/dry cooling towers may increase slightly noise levels at the Clay Boswell Station as a result of increased fan requirements. The increase will depend on the amount of dry cooling included in the wet/dry cooling tower design, which will dictate fan requirements.

While there may be slight increases in noise, the contribution of the cooling towers probably will not be distinguishable at the property lines. This is because molecular absorption reduces high-frequency noise over long distances, leaving the mid and lower frequencies, which could be characterized as a "hum".

Noise level increases cannot be specifically quantified, since details on wet/dry cooling tower design are not available. However, assuming a small dry portion (e.g. 20%), the sound levels at the property line are not expected to differ significantly from those identified for the proposed action wet cooling towers.

Disposal of Solid Waste in an Abandoned Mine

If an exhausted iron ore mine was used for the disposal of fly ash and SO_2 scrubber sludge, there will be some noise impacts caused by the railroad trains transporting the solid waste materials to the abandoned mine. The noise impacts will have the greatest possible impact near the city of Grand Rapids where the trains pass right through residential areas.

TERRESTRIAL VEGETATION AND SOILS

Terrestrial Vegetation and Soils Impacts of Proposed Action

Construction Impacts

The principal construction impact on terrestrial vegetation and soils associated with the proposed action will be the excavation and construction of the new ash and SO_2 slurry ponds and borrow area (Figure II-12). At most, approximately 506.6 acres (204.5 hectares) will be excavated for the proposed fly ash and SO_2 slurry ponds (Table V-44). The borrow area will cover 90.2 acres (36.5 hectares). The proposed Unit 4 will cover about 21.7 acres (8.8 hectares). New construction for the proposed action will destroy approximately 308.4 acres (124.8 hectares) of cropland, and 175.7 acres (71.1 hectares) of hardwood forest on the Clay Boswell Station site. Smaller acreages of other community types will also be excavated. A total of approximately 617.3 acres (249.8 hectares) will be subjected to excavation and construction by the proposed action. In addition, other areas will be altered by the proposed rerouting of Minnesota T.H. 6 north from its intersection with County Road 251 to U.S. 2. The acreages needed for this construction are not known.

TABLE V-44
AREAS OF SITE WHICH WOULD BE ALTERED BY CONSTRUCTION OF PROPOSED ACTION
CLAY BOSWELL STEAM ELECTRIC STATION (98)

	Area Altered							
	Ash and SO_2 Slurry Ponds		Borrow Area		Proposed Unit 4		Total	
Community Type	acre	hectare	acre	hectare	acre	hectare	acre	hectare
Cropland	307.9	124.6	0.5	0.2	0	0	308.4	124.8
Upland and swamp hardwood forest	129.2	52.3	43.9	17.8	2.5	1.0	175.7	71.1
Pasture	13.1	5.3	44.7	18.1	0	0	57.8	23.4
Fens and sedge/grass meadow	18.0	7.3	0	0	19.3	7.8	37.3	15.1
Conifer swamp	12.8	5.2	0	0	0	0	12.8	5.2
Alder thicket	0.7	0.3	0	0	0	0	0.7	0.3
Residential	14.8	6.0	0	0	0	0	14.8	6.0
Roads	8.6	3.5	0	0	0	0	8.6	3.5
Open water	0	0	1.0	0.4	0	0	1.0	0.4
Total	506.6	204.5	90.2	36.5	21.8	8.8	617.3	249.8

The floral composition of the areas which will require excavation for the proposed action is not known. Some of the construction areas are potential habitats for some of the rare and endangered plant species listed in Table IV-76. The construction areas will be searched for rare and endangered plant species during the summer 1977 terrestrial ecology field study.

The proposed ash and SO_2 slurry ponds and the borrow area could possibly be revegetated after their use is ended. The natural communities now present on these sites could not be duplicated.

Operational Impacts

The only significant impact on terrestrial vegetation and soils caused by operation of Unit 4 at the Clay Boswell Steam Electric Station will be caused by atmospheric stack emissions. Salt deposition caused by drift from the proposed Unit 4 rectangular, mechanical draft wet cooling tower will not significantly affect the terrestrial vegetation, or alter the soils, particularly in areas beyond MP&L's property line (refer to Air Quality Section of Chapter V).

Predicting the probable impact resulting from the operation of Unit 4 depends to a large extent on detailed and specific information on the present environmental setting of the Clay Boswell Station. This information is not available (refer to Terrestrial Vegetation and Soils section of Chapter IV). Detailed and specific information on the environmental setting will be provided by the report of the supplemental terrestrial vegetation and wildlife field studies being conducted in summer 1977. This study will also collect information on the past impacts on terrestrial vegetation and soils caused by the Clay Boswell Station. These impacts have been substantial, but will be lessened in the future by modifications of the air quality control systems of Units 1, 2, and 3 (refer to Terrestrial Vegetation and Soils section and Air Quality section of Chapter IV). The report of the summer 1977 field study will also provide an extensive review of the literature on the effects of air pollution on vegetation and soils. This review will supplement the following general and brief discussion.

The response of plants to air pollutants is highly variable and affected by a number of factors. In general, plants are most suseptible to air pollutants when respiration, metabolic, and photosynthesis rates are highest. Thus, temperatures above approximately 40°F (4.4°C) are conducive to air pollution injury. Light conditions which favor high rates of photosynthesis, and thus open stomata, also favor air pollution injury. Note, however, that some plant species carry on respiration activities, and hence maintain open stomates, during the night. Humidity is one of the most critical influencing factors because stomata generally close during periods of low humidity; i.e., plants are suseptible to air pollution injury when the humidity is relatively high. With sulfur dioxide, 70% relative humidity appears to be a critical value (99). Soil moisture, soil fertility, and other edaphic conditions also are important influencing factors. In general, edaphic factors which promote optimum plant growth rates also make plants most susceptible to air pollution injury (100). Other influencing environmental factors include the time of the day when the fumigation occurs, and the presence of physical and biological stresses.

Plant response to air pollution also depends on the type of plant. Response to each pollutant varies widely at all taxonomic levels, including species, variety, and clonal levels, and even between individuals of apparently identical subpopulations. The response also depends on the developmental stage which the plant is in at the time of fumigation (i.e., whether the plant is flowering, dormant, etc.).

Particulates. Particulate emissions associated with large coal-fired steam electric generating stations seldom cause permanent, growth reducing damage to vegetation. The worst case ambient particulate concentrations caused by emissions of the proposed Unit 4 is projected to be 3.8 μg per cu m, 24-hr maximum, and 0.2 μg per cu m, annual geometric mean (Table V-18). The concentrations resulting from modified Units 1, 2, and 3 and proposed Unit 4, plus background, are projected to be 124.3 g per cu m, 24-hr maximum, and 18 μg per cu m, annual arithmetic mean (Table V-18). Approximately 86% of the 24-hr particulate concentration and 98% of the annual particulate concentration are due to background sources.

Most of the background particulates are from fugitive dust sources (e.g. roads, agricultural fields, etc.) and are generally biologically inert (100). Phytotoxic particulates usually result from the emissions of cement manufacturies and other sources of highly alkaline substances. Very high anthropogenic particulate emission rates may cause coating of leaves, needles, or other plant parts. This can lead to partial blockage of stomates and inhibit plant respiration. The coatings may also result in absorption of toxic trace elements. The high particulate emission rates of the pre-modified Units 1, 2, and 3 have caused a very heavy particulate coating on plant surfaces in the vicinity of the Clay Boswell Station, but the effects of this coating have not yet been studied. The particulate emission rates of the modified Units 1, 2, and 3 and proposed Unit 4 will be substantially less than those of pre-modified Units 1, 2, and 3 and probably will not injure vegetation in the vicinity of the Clay Boswell Station. The impacts of trace elements associated with the particulates are discussed below.

Nitrogen Oxides. Nitrogen dioxide is the most phytotoxic of the nitrogen oxides, but it is much less phytotoxic than, for example, ozone or sulfur dioxide. In the absence of other pollutants, NO_x concentrations at or below the level established by the Ambient Air Quality Standards (AAQS) (100 μg per cu m annual arithmetic mean, MPCA and EPA primary and secondary AAQS), probably cause only small reductions in plant growth and reproduction rates (101). The ambient concentration projected to be caused by emissions of modified Units 1, 2, and 3 and proposed Unit 4, together with background levels, is 15.7 μg per cu m, annual arithmetic mean (Table V-18). This is approximately 16% of the AAQS. No projections have been made for short term (i.e. 4 hr or less) NO_x concentrations, which are most critical in determining plant injury. Table V-45 summarizes some of the reported responses of plants to nitrogen dioxide. Most of the exposures reported in this table were done under laboratory or greenhouse conditions, which in general predispose plants to air pollution injury. Thus, the results are worst case reactions which may overestimate the expected responses under field conditions. Also note that the phytotoxic effects of NO_x are enhanced by synergistic reactions with, for example, sulfur dioxide (102).

Secondary impacts of NO_x emissions of the Clay Boswell Station include the formation of ozone and the contribution to acidic precipitation. Ozone causes more than half of the economic loss due to air pollution plant damage in the United States (103). Ozone is formed primarily from NO_2 and hydrocarbons, but projections have not been done for ozone concentration resulting from the emissions of the Clay Boswell Station. The production rate will probably be low, NO_x can also be converted to various acids in precipitation, which could increase the leaching of soil nutrients and minerals (refer to Air Quality section of Chapter V). NO_x emissions may also be converted to nitrate compounds which could cause desirable or undesirable stimulation of plant growth in terrestrial and aquatic ecosystems. The NO_x emissions of the Clay Boswell Station will probably not significantly increase the acidity of precipitation or have a significant fertilizer effect.

TABLE V-45
SUMMARY OF EFFECTS OF NITROGEN DIOXIDE ON VEGETATION (102)

Effect	Ambient Concentration µg per cu m	Length of Exposure
Decrease in dry weight and leaf area of tomatoes, darker green color and downward curvature of leaves	282 to 489	10 to 22 days
Increased leaf drop and reduced yield of fruit in navel oranges	470	8.5 months
Decrease in dry weight and increased chlorophyll per unit wt of pinto beans	564	10 to 19 days
Leaf chlorosis and leaf drop in navel oranges	940	35 days
Leaf injury to Bel #3 tobacco	188[a]	
Growth depression	1,880	14 days
Necrotic leaf spots on cotton, beans and endive	1,880	48 hr
No leaf injury on cotton, beans and endive	1,880	12 hr
Severe leaf necrosis on tobacco	4,324	8.6 hr
Necrotic spots on cotton and beans but complete leaf necrosis on endive	6,580	21 hr
Leaf lesions on beans	5,640 to 7,520	8.0 hr
Leaf lesions on beans, peas and alfalfa	11,280	4 to 8 hr
Leaf discoloration and waxy appearance on leaves of 10 common weeds: mustard very sensitive, pigweed resistant	37,600 to 94,000	4.0 hr
Some leaf damage to alfalfa, beets, rye, and lettuce	56,400	1.0 hr
Marginal and intercostal leaf necrosis, plus shoot dieback on 14 ornamentals, 6 citrus species	18,800 to 470,000	0.2 to 8.0 hr

[a] Plus 262 µg per cu m of SO_2.

Sulfur Dioxide, Sulfates, and Sulfuric Acid. Sulfur dioxide emissions from the Clay Boswell Station will have greater impacts on the terrestrial vegetation and soils in the vicinity of the Clay Boswell Station than will the other pollutants because SO_2 is highly phytotoxic and can significantly alter the chemistry of precipitation and soils.

As with most other pollutants, short term relatively high concentrations of SO_2 cause more plant injury than do long term, lower concentrations. The emissions of modified Units 1, 2, and 3 and the proposed Unit 4 at the Clay Boswell Station, together with background sources, are projected to cause a worst case 3-hr maximum ambient SO_2 concentration of 1,128 µg per cu m (Table V-18). This concentration will cause significant damage to plant leaves and needles and may cause significant growth rate and reproduction losses in sensitive plant species in the Clay Boswell Station area. Note, however, that because of the various air quality regulations, MP&L will not be allowed to operate the Clay Boswell Station in a manner which would cause the 3-hr maximum ambient SO_2 concentration to exceed 655 µg per cu m (refer to Chapter I).

Plant species can be grouped into sensitive, intermediate, and resistant categories based on their susceptibility to injury by SO_2. Table V-46 summarizes some of the plant groups and SO_2 dosages associated with these categories, based on observations made near some coal-fired steam electric generating stations in the southeastern United States. Note that this list, as with most air pollution-vegetation data, provides information on threshold dosages needed to produce visible injury symptoms. These dosages may not cause growth rate or yield reductions because the plants may recover from the injury. Conversely, SO_2 may cause growth and yield reduction at dosages below those needed to cause visible injury. Most studies indicate that sub-visible injury from SO_2 does not occur (104), but this has yet to be convincingly demonstrated. Table V-47 presents some information on white pine growth reductions caused by relatively low SO_2 dosages near a large metal smelter complex at Sudbury, Ontario, Canada.

TABLE V- 46
SULFUR DIOXIDE CONCENTRATIONS CAUSING THRESHOLD INJURY TO VARIOUS SENSITIVITY GROUPINGS OF VEGETATION[a] (104)

	Susceptibility Category		
Exposure Period	Sensitive µg per cu m SO_2	Intermediate µg per cu m SO_2	Resistant µg per cu m SO_2
Peak	2,620 to 3,930	3,920 to 5,240	>5,240
1-hr maximum	1,310 to 2,620	3,620 to 5,240	>5,240
3-hr maximum	786 to 1,572	1,572 to 2,096	>2,096
	Ragweeds	Maples	White oaks
	Legumes	Locusts	Potato
	Blackberries	Sweetgum	Upland cotton
	Southern pines	Cherry	Corn
	Red and black oaks	Elms	Dogwoods
	White ash	Tuliptree	Peach
	Sumacs	Many crop and garden species	

[a] Based on observations over a 20-yr period of visible injury occuring on over 120 species growing in the vicinities of coal-fired steam electric generating stations in the southeastern United States.

TABLE V-47
CHANGES IN NET TREE VOLUME OF EASTERN WHITE PINE *(PINUS STROBUS)* CAUSED BY SO_2 POLLUTION NEAR A SMELTER COMPLEX IN SUDBURY, ONTARIO, CANADA (105)

Dosage % Above 655 μg per cu m[a]	Dosage % Above 1,310 μg per cu m[a]	Dosage % Above 2,620 μg per cu m[a]	Average Concentration[b] μg per cu m	Net Average Gain or Loss in Total Tree Volume[c]
5.92	2.36	0.38	118	Tree volume reduced 1.3% over 10-year period.
0.98	0.11	0.01	45	Tree volume reduced 0.6% over 10-year period
0.33	0.01	0.00	21	Tree volume increased 1.6% over 10-year period[d]

[a] Concentration frequencies based on the percentage of 0.5 hr average concentrations above the respective SO_2 values over the 10-year period (1954 through 1963).

[b] Average concentrations for 6-month growing season (April 1 through October 31) over a 10-year period. Values are from 3 stations radiating from a group of 3 major SO_2 sources.

[c] White pine sampling areas were located several miles from the air monitoring sites, but were within the same concentration isopleths.

[d] Increases in tree volume were measured at white pine sampling areas located near the SO_2 monitoring station farthest from the 3 sources.

Table V-48 summarizes several interpretations of the SO_2 dosages which cause threshold visible injury to plants grouped into the 3 susceptibility categories. Table V-49 lists, by susceptibility categories, some native and introduced plants which may occur in the vicinity of the Clay Boswell Station. Tables V-48 and V-49 refer to threshold visible injury, which may not result in permanent growth or yield reductions. Prolonged exposure to the concentrations indicated, or repeated short term exposures to higher concentrations will probably cause growth or yield reductions. The short term peak concentrations may be of only a few minutes duration, and may occur without violating the 3-hour SO_2 AAQS. In general, however, the AAQS are adequate to preclude significant damage to vegetation caused by SO_2 acting along (99) (104). When mixed with other pollutants commonly present in the air, the mixture may be phytotoxic at lower concentrations. For example, Table V-50 demonstrates that this synergistic effect may occur with SO_2 and NO_x concentrations which are less than the AAQS.

TABLE V-48

ESTIMATED THRESHOLD SO_2 CONCENTRATIONS WHICH PRODUCE VISIBLE INJURY TO VEGETATION

Exposure Period (hr)	Sensitive µg per cu m			Intermediate µg per cu m			Resistant µg per cu m		
	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
0.5	2,620 to 3,930[d]	2,620 to 10,480	na[e]	3,920 to 5,240[d]	9,170 to 31,440	na	>5,240[d]	≥26,200	na
1.0	1,310 to 2,620	1,310 to 7,860	1,824	2,620 to 5,240	6,550 to 26,200	na	>5,240	≥20,960	na
2.0	na	655 to 5,240	1,048	na	3,930 to 19,650	na	na	≥15,720	na
3.0	786 to 1,572	400 to 3,750[f]	785[f]	1,572 to 2,096	2,250 to 15,500[g]	na	>2,096	na	na
4.0	na	262 to 2,620	681	na	1,310 to 13,100	na	na	≥10,480	na
8.0	na	131 to 1,310	472	na	524 to 6,550	na	na	≥ 5,240	na

[a] Reference number 104 located at end of Chapter V.

[b] Reference number 105 located at end of Chapter V.

[c] Reference number 106 located at end of Chapter V.

[d] 5-min peak concentration.

[e] na means not available.

[f] Interpolated (107).

[g] Interpolated (108).

TABLE V-49
PLANTS LISTED IN THREE SUSCEPTIBILITY GROUPS BY SENSITIVITY TO SO_2 (105)(109)

Sensitive	
Alfalfa *(Medicago sativa)*	Larch, western *(Larix occidentalis)*
Apple *(Malus* sp.)	Leek *(Allium porrum)*
Apricot *(Prunus* sp.)	Mallow *(Malva* sp.)
Ash, red (green) *(Fraxinus pennsylvanica)*	Maple, Manitoba *(Acer negundo interius)*
Aspen, large-toothed *(Populus grandidentata)*	Marigold *(Tageres* sp.)
Aspen, trembling *(Populus tremuloides)*	Mountain ash *(Sorbus aucuparia)*
Aster *(Aster* sp.)	Mustard, black *(Brassica* sp.)
Bachelor's buttons *(Centaurea cyanus)*	Mustard, hedge *(Sisymbrium* sp.)
Barley *(Hordeum vulgare)*	Nasturtium *(Nasturtium* sp.)
Bean *(Phaseolus vulgaris)*	Nightshade *(Solanum* sp.)
Bean, lima *(Phaseolus lunatus)*	Ninebark, Pacific *(Physocarpus capitatus)*
Beech *(Fagus silvatica)*	Oats *(Avena staiva)*
Beet *(Beta vulgaris)*	Onion *(Allium cepa)*
Begonia *(Begonia* sp.)	Orchardgrass *(Dactylis giomerata)*
Bentgrass *(Agrostis palustris)*	Parsley *(Petroselinum crispum)*
Birch, gray *(Betula populifolia)*	Parsnip *(Pastinaca* sp.)
Birch, western paper *(Betula papyrifera commutata)*	Pea *(Pisum sativum)*
Birch, paper *(Betula papyrifera)*	Peach *(Prunus* sp.)
Birch, yellow [*Betula alleghanensis (lutea)*]	Pear *(Pyrus* sp.)
Blueberry, lowbush *(Vaccinium angustifolium)*	Petunia *(Petunia* sp.)
Bluegrass *(Poa annua)*	Pigweed *(Amaranthus retroflexus)*
Bouncing bet *(Saponaria officinalis)*	Pine, eastern white *(Pinus strobus)*
Broccoli *(Brassica oleracea* var. *botrytis)*	Pine, jack *(Pinus banksiana)*
Bromegrass *(Bromus* sp.)	Pine, red *(Pinus resinosa)*
Brussels sprouts *(Brassica oleracea* var. *gemmifera)*	Plantain *(Plantago* sp.)
Buckwheat *(Fagopyrum* sp.)	Poplar, Lombardy [*Populus nigra* (hybrid)]
Cabbage *(Brassica oleracea* var. *capitata)*	Prickly lettuce *(Lactuca scariola)*
Carrot *(Daucus carota)*	Prune *(Prunus* sp.)
Catalpa *(Catalpa* sp.)	Pumpkin *(Cucurbita pepo)*
Celery *(Apium graveolens)*	Radish *(Raphanus staivus)*
Cherry, bitter *(Prunus emarginata)*	Ragweed *(Ambrosia* sp.)
Chinese elm *(Ulmus parvifolia)*	Rhubarb *(Rheum rhaponticum)*
Cockelbur *(Xanthium* sp.)	Rubber *(Hevea brasiliensis)*
Coleus *(Coleus blumei)*	Rye *(Secale cereale)*
Cosmos *(Bidens* sp.)	Ryegrass *(Lolium)*
Cotton *(Gossypium hirsutum)*	Serviceberry, low [*Amelanchier spicata (stolonifera)*]
Cucumber *(Cucumis staivus)*	Smartweed *(Polygonum* sp.)
Dandelion *(Taraxacum officinale)*	Sorrel *(Rumex* sp.)
Eggplant *(Solanum melongena)*	Soybean *(Glycine Max)*
Elm *(Ulmus* sp.)	Spinach *(Spinacia oleracea)*
Endive *(Cichorium endivia)*	Squash *(Cucurbita maxima)*
Fescue, red *(Festuca rubra)*	Sumac, staghorn *(Rhus typhina)*
Four o'clock *(Mirabilis jalapa)*	Sweet clover *(Meliotus* sp.)
Gladiolus *(Gladiolus)*	Sweet pea *(Lathyrus odoratus)*
Gooseberry *(Ribes* sp.)	Sweet potato *(Ipomea batata)*
Hazel, beaked [*Corylus cornuta (rostrata)*]	Sweet william *(Dianthus baratus)*
Hazel, California *(Corylus cornuta californica)*	Swiss chard *(Beta vulgaris* var. *cicla)*
Hollyhock *(Althaea* sp.)	Tobacco *(Nicotiana tabacum)*
Hydrangea *(Hydrangea* sp.)	Turnip *(Brassica rapa)*
Iris *(Iris* sp.)	Vetch *(Vicia* sp.)
Junegrass *(Poa pratensis)*	Wheat *(Triticum aestivum)*
Kale *(Brassica oleracea* var. *acephala)*	Wild grape *(Vitis labrusca)*
Lamb's quarters *(Chenopodium album)*	Willow, black *(Salix nigra)*
Larch *(Larix* sp.)	Zinnia *(Zinnia* sp.)

TABLE V-49 (continued)

PLANTS LISTED IN THREE SUSCEPTIBILITY GROUPS BY SENSITIVITY TO SO_2 (105)(109)

Intermediate

Alder, mountain *(Alnus tenuifolia)*
Basswood *(Tilia americana)*
Begonia *(Begonia* sp.)
Boxelder *(Acer negundo)*
California hazel *(Corylus californica)*
Canna *(Canna* sp.)
Castor bean *(Ricinus communis)*
Chrysanthemum *(Chrysanthemum)*
Columbia Snowberry *(Symphoricarpos rivularis)*
Cottonwood *(Populus deltoides)*
Cucumber *(Cucumis sativa)*
Dogwood, red osier *(Cornus stolonifera)*
Elm, American *(Ulmus americana)*
Fir *(Abies* sp.)
Fir, balsam *(Baies balsamea)*
Ginkgo *(Ginkgo* sp.)
Gladiolus *(Gladiolus* sp.)
Grape, wild *(Vitis riparia)*
Hazel, witch *(Hammelis virginiana)*
Hemlock, western *(Tsuga heterophylla)*
Hibiscus *(Hibiscus* sp.)
Honeysuckle *(Lonicera* sp.)
Honeysuckle, tatarian *(Lonicera tatarica)*
Horse-radish *(Armoracia misticana)*
Kentucky bluegrass *(Poa pratensis)*
Lilac, common *(Syringa vulgaris)*
Maple *(Acer* sp.)
Maple, red *(Acer rubrum*
Milkweed *(Asclepias* sp.)
Mock-orange *(Philadelphus* sp.)
Mock-orange, coronarius *(Philadelphus coronarius)*
Mock-orange, Lewis *(Philadelphus lewisii)*
Mountain-ash, European *(Sorbus aucuparia)*
Mountain-laurel *(Ceanothus sanguineus)*
Norway Maple *(Acer platanoides)*
Oak, white *(Quercus alba)*
Onion *(Allium cepa)*
Plum *(Prunus* sp.)
Poplar *(Populus* sp.)
Poplar, balsam *(Populus balsamifera)*
Potato, Irish *(Solanum tuberosum)*
Purslane *(Portulaca* sp.)
Rose *(Rosa* sp.)
Salt grass *(Spartina* sp.)
Salvia *(Salvia* sp.)
Shepherd's purse *(Capsella bursa-pastora)*
Snapdragon *(Antirrhinum* sp.)
Snowball *(Viburnum* sp.)
Spruce, white *(Picea glauca)*
Sumac *(Rhus* sp.)
Sweet cherry *(Prunus avium)*
Tobacco *(Nicotiana tabacum)*
Virginia creeper *(Parthenocissus quinquefoloa)*
Wisteria *(Wisteria* sp.)

Resistant

Arborvitae *(Thuja* sp.)
Arborvitae (white cedar) *(Thuja occidentalis)*
Cantaloupe *(Cucumis melo)*
Ceanothus, redstem *(Ceanothus sanguineus)*
Cedar, western red *(Thuja plicata)*
Celery *(Apium graveolens)*
Citrus *(Citrus* sp.)
Corn *(Zea mays)*
Dianthus *(Dianthus* sp.)
Fir, white *(Abies concolor)*
Forsythia *(Forsythia viridissima)*
Gardenia *(Gardenia* sp.)
Ginkgo *(Gingko biloba)*
Hawthorn, black *(Crataegus douglasii)*
Juniper, common *(Juniperus communis)*
Juniper, western *(Juniperus occidentalis)*
Kinnikinnick *(Arctostaphylos uva-ursi)*
Lily *(Lilium speciosum)*
Maple, Norway *(Acer plantanoides)*
Maple, silver *(Acer saccharinum)*
Maple, sugar *(Acer saccharum)*
Oak *(Quercus* sp.)
Oak, live *(Quercus virginiana)*
Oak, pin *(Quercus palustris)*
Oak, white *(Quercus alba)*
Orchid *(Cattleya* sp.)
Orchid *(Cymbidium* sp.)
Orchid *(Oncidium* sp.)
Poison-ivy *(Rhus radicans)*
Privet *(Ligustrum* sp.)
Rhododendron *(Rhododendron* sp.)
Spruce, blue *(Picea pungens)*
Sumac, smooth *(Rhus glabra)*

TABLE V-50
PERCENT INJURY - UPPER LEAF SURFACE OF PLANTS EXPOSED FOR 4 HOURS TO MIXTURES OF SO_2 AND NO_x (110)

Pollutant Mixture		Percent Leaf Injury [a]						
SO_2 Concentration μg per cu m	NO_2 Concentration μg per cu m	Pinto Bean	Oats	Radish	Soybean	Tobacco	Tomato	Number of Observations
131	94	2	1	1	2	1	0	7
262	94	0	0	0	0	0	0	4
524	94	1	0	0	6	2	0	3
655	94	1	3	0	7	1	1	4
131	188	0	0	1	1	9	0	3
262	188	11	27	27	35	11	1	3
262	282	24	12	24	20	18	17	4
655	282	4	0	4	1	6	0	3
524	376	16	10	6	9	4	0	2
131	470	0	0	13	2	16	0	2

[a] Average percentage leaf injury to the 3 most severely injured plants, except for pinto bean, which was based on injury to the two most severely injured plants.

Lichens, bryophytes, and other non-vascular plants are often more susceptible to injury by SO_2 than are vascular plants. This is indicated by Table V-51. Some lichen analyses will be done during the summer 1977 field studies.

TABLE V-51
AVERAGE SO_2 CONCENTRATIONS CAUSING A DECREASE IN NUMBER OF EPIPHYTIC LICHEN AND BRYOPHYTE SPECIES (104)

SO_2 Concentration μg per cu m	Averaging Period	Research Area
39	Annual	Stockholm, Sweden
52	Winter (October to April)	Newcastle, England
39 to 79	Annual	Belfast, Ireland
13 to 26	Summer (May to October)	Sudbury, Ontario Canada

The SO_2 emissions of the Clay Boswell Station may cause significant secondary impacts on terrestrial vegetation and soils by acidifying precipitation (refer to the Air Quality section of Chapter V) (111). Increased rainfall acidity may leach nutrients from plant foliage (112). The amount of this type of leaching which will result from the SO_2 (and NO_x) emissions of the Clay Boswell Station will probably be slight. Similarly, there probably will be little foliage damage caused by the direct effects of sulfuric acid formed by the SO_2 emissions of the Clay Boswell Station.

The impact of acidic precipitation resulting from the emissions of the Clay Boswell Station on the soils in the vicinity of the Clay Boswell Station depends to a large extent on the pH, base saturation, type of parent material, and other characteristics of the soil in the area. This type of information is not available at this time. More soils data will be collected this summer and analyzed in the report of the summer 1977 terrestrial ecology field study (refer to Terrestrial Vegetation and Soils section of Chapter IV).

Trace Elements. The trace element emissions of the modified Units 1, 2, and 3 and proposed Unit 4 will probably not be deposited at rates sufficient to directly damage foliage (see Table V-21). The long-term soil deposition and accumulation of trace elements potentially can reach levels which reduce the productivity of plants, alter the nutritional value of plants to humans and wildlife, and lead to harmful concentrations of toxic compounds in plants. These impacts have occurred around large metal smelters and similar sources and occasionally have occurred near large coal-fired steam electric stations. The possibility of these trace element impacts occurring in the vicinity of the Clay Boswell Station depend almost entirely on the chemical and physical characteristics of the soil in the vicinity. The soil impacts of the Clay Boswell Station trace element emissions will be analyzed during the summer 1977 terrestrial vegetation and soils field study.

Terrestrial Vegetation Impacts of Alternatives

Waste Wood as Supplemental Fuel

No significant changes in impacts on terrestrial vegetation and soils are expected if waste wood were to be used as supplemental fuel.

Coal Beneficiation

The only reasonable alternative which would significantly reduce the terrestrial vegetation and soils impacts of the emissions from Unit 4 at the Clay Boswell Station is the use of beneficiated coal. Since this coal would be used in all 4 Units, the impact of the combined operation of Units 1, 2, 3, and 4 would be reduced substantially compared to the impacts resulting from the use of design performance coal.

Table V-28 indicates that the 3-hr maximum SO_2 concentration would be reduced from 1,113 μg per cu m by the change in coal. A 3-hr maximum SO_2 concentration of 223 μg per cu m would not be phytotoxic to nearly all plants (Tables V-48, V-49, and V-50). Similarly, the use of beneficiated coal would substantially reduce the potential for the formation of acidic precipitation.

The use of beneficiated coal may reduce trace element deposition resulting from the Clay Boswell Station emissions. The amount of this reduction is not known.

Dry and Wet/Dry Cooling Towers

The alternative of using either wet/dry or dry cooling towers is not expected to significantly change the impacts on terrestrial vegetation or soils around the Clay Boswell Station.

Disposal of Solid Waste in an Abandoned Mine

The only reasonable alternative which would substantially reduce the destruction of plant communities on the Clay Boswell Station site is the use of an abandoned mine for solid waste disposal (refer to Chapter III). This alternative would eliminate the need for the proposed ash and SO_2 sludge pond and part of the borrow area.

TERRESTRIAL WILDLIFE
Terrestrial Wildlife Impacts of the Proposed Action

Construction Impacts

The principal construction impacts on terrestrial wildlife will be caused by the excavation and construction of the proposed borrow area and ash and SO_2 slurry ponds (see Figure II-12). Approximately 597 acres (241 hectares) will be altered by this activity (Table V-44). Approximately 22 acres (9 hectares) will be altered by excavation and construction of the proposed Unit 4. Croplands and hardwood forests are the principal community types on the areas which will be affected. Table V-44 lists the proportions of these and the other communities which will be disrupted.

Table IV-77 through IV-79 present information on the wildlife which currently use the areas which will be destroyed. The birds, large mammals, and some medium sized mammals can move from these areas into adjacent areas if suitable habitat is available. Most of the small mammals, amphibians, and reptiles currently in the areas to be excavated will be destroyed. The habitats currently provided by these areas will also be destroyed. None of these habitats are particulatly unique in the vicinity of the Clay Boswell Station. Some new habitat types will be created (e.g., open water in the ash and SO_2 slurry ponds), and will be available for the life of the Clay Boswell Station. Some of the areas can be revegetated when activity ceases in those areas, but it will not be possible to duplicate those natural communities which now exist on the sites of the proposed excavation and construction.

Noise and other disturbances related to construction activity will affect the wildlife near the Clay Boswell Station (refer to Noise section of Chapter V). It is not possible to quanitify this impact, but it probably will be minor and localized.

Impacts of Operation

Impacts of Water Consumption and Waste Water Effluents. If the consumptive water use of Units 1, 2, 3, and 4 is of a magnitude which will cause Blackwater Lake, the Mississippi River, or other lakes, rivers or reservoirs to be drawn down to levels below their present levels, some shoreline wildlife habitat may be lost or altered. The newly exposed shoreline may revegetate, however, thus reducing long-term impacts.

If the proposed Unit 4 complies with the applicable water quality and effluent standards, there probably will be no significant impact on terrestrial wildlife.

Impacts of Air Emissions. Air emissions from Unit 4 at the Clay Boswell Station may, under some conditions, adversely affect wildlife. If the pollutant concentrations comply with the Ambient Air Quality Standards (AAQS), then effects on terrestrial wildlife probably will not be significantly harmful. However, there are several unknowns, because the impacts are influenced by such factors as species, age, nutritional and health status, season of the year, and length of exposure to the pollutant (113).

Because of the number of variables and the relative lack of information on the toxic effects of pollutants on wild animals, it is very difficult to predict the impacts of emissions from the Clay Boswell Station on the wildlife of the area. Most quantative studies have been conducted either in the laboratory, or on domestic animals. Furthermore, little information has been gathered on the effects of low pollutant concentrations during periods of long exposure.

Pollutants can be diluted or concentrated in the natural environment. The process by which a chemical becomes more concentrated in an organism than in the air is known as bioaccumulation. In some cases, as organisms are eaten by predators at higher trophic levels, concentrations of chemicals in the body may progressively increase by a process known as biomagnification (114).

Nearly all of the research done with the effects of air pollution on animals has dealt with dosages which will very seldom be encountered in the ambient air. Consequently, much of the following discussion is provided only to indicate the toxicity symptoms and pathological modes of action. Little research has been done with pollutants at concentrations which will be encountered in the vicinity of the Clay Boswell Station. That which has been done suggests that the pollutant emissions of the Clay Boswell Station, when in compliance with the air quality standards, will have only subtle and probably minor impacts on terrestrial wildlife.

Pollutants can either be inhaled or ingested by animals. Generally, ingestion is more significant (115) (116), although there are exceptions. Two wildlife food sources which may become contaminated due to emissions from the Clay Boswell Station are vegetation and insects. Some species of plants are apparently capable of accumulating very large quantities of chemicals without adverse effects (117). These compounds may accumulate to levels toxic to herbivores.

A significant impact on wildlife in the area may be vegetation damage caused by the pollutants emitted by the Clay Boswell Station. Such changes may affect wildlife species composition and diversity by changing the vegetative composition of the habitat.

Insects are another major wildlife food source which may be affected by pollutants emitted by the Clay Boswell Station. Trace elements often are accumulated by insects and thus transferred to predator species (e.g., 118). This biomagnification may result in relatively high concentrations of these toxic compounds in predator species.

Some <u>nitrogen oxides</u> are highly toxic to wildlife. NO_2 is acutely toxic to many domestic animal species at concentrations above 47,000 μg per cu m (119).

Of a group of rabbits continuously exposed to 15,000 to 23,000 μg per cu m of nitrogen dioxide for 3 months, 59 to 60% of the rabbits died (119). Post mortem studies showed pulmonary congestion, edema, bronchiolitis, and destructive changes in alveolar walls. The most consistent and marked abnormality was a significant increase in the nonelastic resistance of the lungs, with marked hyperinflation and arterial oxygen desaturation (119). These physiological changes were reversed when the exposure was ended.

Chronic exposure of rats to 840 to 5,700 µg per cu m of nitrogen dioxide for 6 months caused changes in their conditional reflex activity (120).

Studies with rats, guinea pigs, Swiss albino mice, inbred mice, hamsters, rabbits, dogs, and monkeys indicate that the effects of nitrogen dioxide exposure are restricted primarily to the respiratory tract (121). The effects of nitrogen dioxide range from odor perception, nasal irritation, and difficulty in breathing, to acute respiratory irritation, edma, and death (113).

It is more likely that the NO_2 emissions of the Clay Boswell Statio will affect animals indirectly through effects on their food resources.

Limited research indicates that sulfur dioxide concentrations at or below the AAQS do not produce obviously harmful effects on wildlife. For example, in a 90 day test, 10 cows were fed rations containing either uncontaminated alfalfa, or alfalfa contaminated with SO_2 emissions from an industrial facility. Results obtained on milk production, body-weight changes, apparent digestibility of the alfalfa, palatability, and pH of urine indicated no significant change in cows fed alfalfa with more than 25% of the leaflets damaged by SO_2.

When swine under 7 days of age were exposed to SO_2 concentrations of 13,000, 26,000 52,000, and 105,000 µg per cu m for an 8 hr period, there was eye irritation and salivation at the 13,000 µg per cu m concentration; eye irritation, nasal secretion, salivation, and altered respiration at the higher levels; and hemorrhage and emphysema within 24 hr at the 105,000 µg per cu m concentration (113). At 158 day post exposure, 2 out of 2 swine exposed to 105,000 µg per cu m and one out of 2 exposed to 52,000 µg per cu m showed pulmonary fibrosis attributable to SO_2. Exposure of rabbits to 400 µg per cu m of SO_2 6 hr per day for 4 successive days resulted in a drop in blood vitamin C levels by 50% in most of the rabbits (113).

The exposure of white rats to similar SO_2 concentrations for approximately 4 hr per day for 1, 114, 144 or 165 days resulted in a decrease in the activity of enzymes such as cholineserase, spleen dehydrase, and carbohydrase, and in the vitamin C content of several organs (113).

Wildlife may be killed after only a brief exposure to high concentrations of sulfuric acid mist (122). The pathological effects of H_2SO_4 mist inhalation are degenerative changes of the respiratory tract, pulmonary hyperemia, edema, emphysema, and in some instances focal pulmonary hemorrhages (122). It is more likely that sulfates and sulfuric acid will affect animals indirectly through changes in vegetation or insect populations.

Damage to domestic and wild animals has been observed in areas polluted by fluorides. Animals may be exposed to fluorine in the air, in their forage, and in their water supply. High fluorine concentrations in the soil may contaminate vegetation through rain splash or windblown dust (123). Most of the damage to domestic animals is caused by the ingestion of vegetation contaminated by fluroine rather than by inhalation of fluorine. Fluorine is an accumulative poison under conditions of continuous exposure to sub-acute (chronic) doses (113).

The difference in susceptibility to fluorosis (fluorine intoxication) among various species of domestic animals is substantial. The ranking from the most to the least susceptible is cattle, sheep, horses, swine, rabbits, and poultry (113). Ruminants are particularly susceptible to fluorosis because of their slow digestive process. Therefore, white-tailed deer may be one of the more susceptible wildlife species in the vicinity of the Clay Boswell Station.

Acute fluorine poisoning is rare among farm animals because they will voluntarily refuse to consume heavily contaminated forage (113). Chronic symptoms are more common. Although Minnesota is not considered to be an area where fluorosis is prevalent, it could occur near places in Minnesota where fluorine-containing coal is used as a fuel (124). The sources most responsible for toxicity problems in livestock are the aluminum, steel, and phosphate industries (123).

Cattle appear to be the most susceptible of livestock to fluorosis. The chronic symptoms of fluorosis in cattle include dental skeletal changes, accumulation of fluorides in the skeleton, lameness, emaciation appetite impairment, diminished milk yields, and sometimes reduced reproductive efficiency (113) (123). Dental changes are among the first and most improtant symptoms of chronic fluorosis. Chronic fluorine ingestion interferes with the calcium metabolism of developing teeth, and results in the incomplete formation of the enamel or dentine layer of teeth (113). Fluorine has an affinity for calcium and interferes with normal calcification processes. Ingestion of fluoride over a long term may result in the development of exostotic lesions, and, in some cases, a general thickening of the bones (periosteal hyperostosis) (123). Fluorosis can be suspected if cattle bones contain more than 4,000 ppm of fluorine, or 2 to 10 times more than that of normal animals (113).

A level of 5, 8, 14, and 98 ppm fluorine in pasture vegetation produced no dental changes, slight dental lesions in 25% of the cattle, dental fluorsis in 100%, and bond and joint lesions within a month, respectively (113). Dairy cattle fed a diet of 3 to 5 ppm fluorine for 5½ yr stored less than 1,000 ppm fluorine in the bone. Sheep show many of the same clinical symptoms of fluorosis as cattle. Symptoms observed in sheep but not in cattle include conjunctivitis, and dermatitis with loss of wool. Honey bees may be killed by fluorides from industrial emissions. Most of the symptoms are of an acute form of fluorine intoxication (muscular paralysis and high mortality). Evidence of fluorosis in horses exists, with symptoms including lameness, pain, exostoses, emaciation, and bone fractures (113). Roughage containing at least 30 ppm fluorine on a dry weight basis produced fluorosis in horses. Levels of 30, 60, and 100 g of NaF per 100 lb of diet for a 144 day period impaired growth and feed conversion in swine. The effects include increased shaft diameter of bone, induced exostoses, decreased breaking strength of the femurs, and softened teeth. The tolerance limits for swine are conflicting, with reports from 8 to 10 ppm of body weight per day, to 70 to 100 ppm, to 100 to 200 ppm of poorly soluble fluorine compounds. Approximately 70 ppm of fluorine on a body weight basis was necessary to inhibit growth of poultry chicks after the first week of life (123). The fluorine tolerance limits for poultry are approximately 35 to 70 ppm of body weight per day (113).

Fossil fuels contain small amounts of many elements which may be released by combustion. <u>Trace elements</u> accumulate in tissues and are potentially toxic at quite low levels. At low levels, some trace elements are essential to life. The essential micronutrients include cobalt, copper, iron, manganese, molybdenum, vanadium, and zinc. However, arsenic, beryllium, cadmium, lead and mercury are toxic at similarly low levels (117).

Many trace elements can be accumulated through the food web to concentrations far greater than the initial ambient levels.

Arsenic occurs in varying amounts as an element in coal and other ores, behaving primarily as a non-metallic agent. The toxicity of arsenic varies greatly depending on its form, concentration and mode of exposure. It is a cumulative poison, and possibly carcinogenic (117). All organisms are capable of tolerating most natural arsenic concentrations, but most are sensitive to toxic effects at relatively low levels.

The physiological symptoms of arsenic toxicosis for cattle include inflamed eyes and mucous membranes of the upper air passages, diarrhea, thirst, emaciation, excessive salivation, uncoordination, and rough coats. The pathological symptoms include inflamation of the stomach and intestines, anemia and destruction of the red blood cells, fatty degeneration of the stomach and kidneys, muscular atrophy, congestion, hemorrhage, and proliferation of connective tissue cells or organs (113). In horses, chronic symptoms include diarrhea, colic, weakness, muscular aches and twitches, hard skin, and paraplegia. Death occurred in many cases.

Arsenic poisoning of bees has been found in industrial areas. Much of the arsenic responsible was emitted as a fine powder from chimneys of industrial plants during combustion of large quantities of low quality coal.

All arsenic containing compounds are quite toxic, and tolerance levels for most animals are low. Sheep have been poisoned by as little as 0.25 to 0.50 g of arsenic daily, although cattle may withstand doses of 1.3 to 1.9 g daily (113).

Beryllium is a trace element released in the combustion of coal. There has not been much work done on the effects of this element, but that research which has been done has centered on the effects of inhalation of beryllium fumes.

The chronic symptoms of beryllium toxicosis include weight changes, histologic pulmonary damage, anemia, changes in arterial oxygen tension, and changes in nitrogen metabolism (113). Prolonged exposure to mists of beryllium compounds may induce chronic pneumonitis, epithelial proliferation, and primary pulmonary cancer (125).

Cadmium is highly toxic, cumulative, and concentrated by organisms (126)(127). Its toxicity is increased by the presence of other chemicals including copper, selenium, and zinc, all of which are present in coal in low concentrations. Levels of cadmium in moss in trees have increased 3 to 4 times since 1940 (117). Exposure to cadmium aerosols at various concentrations disturbs the conditioned reflex activity in rats without manifestations of changes in their general condition or behavior (117).

Lead is a highly toxic impurity in coal (113). Since lead is a cumulative poison, continuous ingestion of small amounts will have an effect on the organisms.

Investigations have suggested that lead compounds taken up through inhalation are more easily absorbed into the blood, and therefore more dangerous, than lead taken in through ingestion (124). However, in the field it is often impossible to distinguish between the effects of inhalation and ingestion of contaminated vegetation.

All domestic animals with lead poisoning are found to exhibit various degrees of disruption of the central nervous system, gastrointestinal tract, muscular system, and hematopoietic system (128). Chronic symptoms of cattle exposed to lead include altered metabolism, emaciation, cachexia, enteritis, muscular twitches, nervous disorders, colic, swollen joints, diarrhea, bellowing, stupor, lethargy, paralysis of the larynx muscles, difficulty in breathing, and convulsions (128). It appears that most of the lead is stored in bone tissue, where it is physiologically inert (129).

Both sheep and goats, though sensitive to lead toxicity, seem to be more resistant than other animals. Sheep appear capable of excreting most of the lead ingested. While acute poisoning is still very much a possibility with high dosages, there is little evidence of chronic poisoning in sheep (113). However, lead intoxication at one mg per kg body weight per day will induce abortion in sheep (113). Toxic doses of lead for ruminants are 50 to 100 g; for horses 500 to 700 g; 20 to 25 g for sheep and goats; and 10 to 20 g for pigs and dogs (113).

Manganese is present in significant quantities in coal, and is one of the least toxic trace elements to birds and mammals (130). In rabbits, manganese accumulates in the blood and the cerebrum (113). Hens can tolerate 1,000 ppm without ill effects, while 4,800 ppm is toxic to young chicks. The growth rate of rats is unaffected by dietary intake with manganese concentrations as high as 3,000 ppm. For swine, 500 ppm depresses the appetite and retards growth (130). Calves may develop decreased feed intake and lower body weight gains when their diet contains manganese at 2,400 ppm (130).

Burning of fossil fuels such as coal contributes significant amounts of mercury to the environment (131). Coals in the U.S. contain mercury concentrations of a few parts per billion to several parts per million and, when burned, may contribute significant amounts of mercury to the environment (131). Organic mercury compounds tend to be about 4 times more toxic than inorganic forms.

Several studies show that while mercury can be widely distributed in the body, it tends to concentrate in the kidneys and liver and, to a lesser extent, in the brain (132). It has been suggested that acute mercury toxicoses result primarily in renal dysfunction, while chronic effects, sometimes taking years of exposure to become noticeable, are often traceable to effects on the central nervous system (133). Mercury often accumulates on leaves and other parts of plants (133).

While small quantities of molybdenum are essential to life, larger doses can have a detrimental effect on animals (117). Industrial molybdenosis is not a prevalent in the U.S. as it is in foreign countries. Molybdenosis symptoms in cattle include diarrhea, emaciation, reduced milk yields, low copper levels, high molybdenum levels in blood, dry skin, change or depigmentation of hide color, and death (113)(134). Horses are apparently more resistant to poisoning from molybdenum than are cattle.

Selenium is present in very small quantities in coal. It appears to be both beneficial and harmful within a very narrow range of concentrations (117). In the western United States, sheep, cattle, and horses have been killed by feeding on plants which had accumulated selenium (117).

Nickel is a relatively nontoxic metal (135) which is present in coal in small amounts. Little work has been done on the effects of ingestion of nickel under natural situations. Some tolerance limits are known. Dogs tolerate 1 to 3 g per kg by oral administration without any obvious effects, and dogs and cats both tolerate daily doses of 4 to 12 mg per kg for 200 days with no ill effects (135). Rodents are not particularly affected by orally administered nickel salts. Toxic effects have been observed in calves when given nickel carbonate in the diet during an 8 week period. At 62.5 ppm, a normal body weight gain was observed; at 250 ppm both food intake and growth were slightly reduced; and at 1,000 ppm, food intake and growth were reduced substantially (135).

Inhalation of zinc by cattle has been known to cause pulmonary emphysema, increased body temperature, increased pulse, and increased respiration in cattle (113).

The clinical symptoms of vanadium poisoning before death include weakness, gradual loss of appetite, lethargy, prostration, and drier hair in cattle. The main pathological changes associated with this toxicosis are liver and lung congestion, petchia covering the kidney and heart muscle, mycotic lesions in the rumen, and hemorrhage in the intestines (113). In chickens, 25 ppm vanadium in a purified and 200 ppm in a preactical diet brought about high mortality, while levels of 13 to 35 ppm were required to depress growth (113).

Terrestrial Wildlife Impacts of Alternatives

Waste Wood as Supplemental Fuel

This alternative will not significantly affect the impacts of Clay Boswell Station Unit 4 on terrestrial wildlife.

Beneficiated Coal

This alternative may reduce the trace element emission rates of Unit 4. This would reduce any potential impacts of trace elements on terrestrial wildlife.

Dry or Wet/Dry Cooling Towers

These alternatives would not significantly affect the terrestrial wildlife impacts of Unit 4.

Disposal of Solid Waste in an Abandoned Mine

This alternative would eliminate the need for the ash and SO_2 slurry pond and part of the borrow area. Thus, the wildlife habitat currently provided by these sites would be preserved.

SOCIO-ECONOMIC

Socio-Economic Impacts of Proposed Action

Introduction

The primary socio-economic impacts of the Clay Boswell Station will be those associated with increased construction and operational work forces and their families. These impacts will include both an increased demand and expenditures for services in the affected areas in addition to increased revenues.

Two kinds of employment will be created by the construction and operation of the Clay Boswell Station. First, a construction force will be required for a period of approximately 46 months to construct proposed Unit 4 and associated facilities. At its peak, the construction force will number 1,200 workers. These construction workers are regarded as temporary residents who will move on to other work when Unit 4 is completed. Operation of Clay Boswell Unit 4 will require 170 new permanent operational employees, presumably for the lifetime of the facility, which MP&L estimates to be 35 years.

The analysis of socio-economic impacts is based on several criteria and assumptions regarding the residential location patterns of new employees at the Clay Boswell Station.

Criteria. No criteria for assessing socio-economic impacts or impacts of an action on land use and recreation are to be found in state or Federal regulations and standards. Therefore, appropriate criteria were developed. The criteria used to determine significant socio-economic impacts are as follows.

Housing

- A significant impact will occur if the demand for temporary housing is 5% or more than the existing number of units.
- A significant impact will occur if the demand for permanent housing is 5% or more than the existing housing units.

Schools

- A significant impact will occur if school enrollments increase beyond the design capacity of the physical facilities.
- A significant impact will occur if the property taxes which support the school district change 5% or more.

Public Services

- A significant impact will occur if the ratio of police, fire, or health service personnel to population drops by more than 10%, or below the State average.

Public Expenditures and Revenues

- o A significant impact will occur if per capita governmental expenditures due to the proposed action exceed revenues by more than 5% for any one year.

- o A significant impact will occur if revenues increase over 10% of total present governmental revenues during or after construction.

Employment

- o A significant impact will occur if unemployment is projected to drop by 0.5% in the County due to the proposed action.

Business Activity

- o A significant impact will occur if dollar business volume increases by more than 5% over base level dollar volume within the County or any incorporated area due to the proposed action.

Assumptions. The most current data were utilized for estimating impacts. When available, projected 1980 data were used. The following assumptions regarding employment, increased population, and residential location are utilized throughout the impact analysis.

The most critical factor influencing the type and magnitude of socio-economic impacts is construction employment or the number of construction workers who will move to the affected area. Determining how many workers will commute or the number who will relocate to the area is difficult due to lack of data and the number of variables that influence this decision. Factors which will influence the decision of where a construction worker will live include the following.

- o Permanent residential location. Many skilled laborers now working in Duluth and on the Mesabi Iron Range are from other areas of the State--the Minneapolis and St. Paul areas in particular (136), North and South Dakota, Wisconsin, and many other states. Iron Workers Local 563 in Duluth reported that of the 1,000 people employed on the Mesabi Iron Range, 400 were nonlocal. While some of the 600 "local" workers may shift jobs to work on the construction of MP&L's proposed Unit 4, and may want to commute, others may want to move to the area for the construction period.

- o The availability and cost of housing. Town clerks in many of the cities in southern Itasca County indicated that very few homes are available for sale or rent in many of the cities in southern Itasca County (137). Similarly, few vacant lots with public sewer or water exist within these communities. If no homes are available to rent or buy, construction workers will have little choice but to commute, which may mean some workers would turn down jobs.

- o Single or families. In some cases a decision to relocate may rest on the marital status of the worker.

Very little data exists on these 3 factors. The best data is on housing, and potential apartment construction in Grand Rapids may cause the housing data to change.

Very little data exists on commuting habits of construction workers on the Mesabi Iron Range. Information from a number of local unions indicates that there are many workers who commute to homes in the Twin Cities, Wisconsin, and North and South Dakota on weekends. While these people have found lodging in the various cities on the Mesabi Iron Range, the locations may be inconvenient for work at the Clay Boswell Station. Some workers from other states have relocated in the area and may stay where they are now living.

Given these variables, it appeared appropriate to investigate impacts for a range of construction workers commuting to or living in the affected area. Therefore, 2 sets of conditions were assumed. They are illustrated in Figures V-37 and V-38. The use of 2 parameters will give decision-makers a range of impacts to assess.

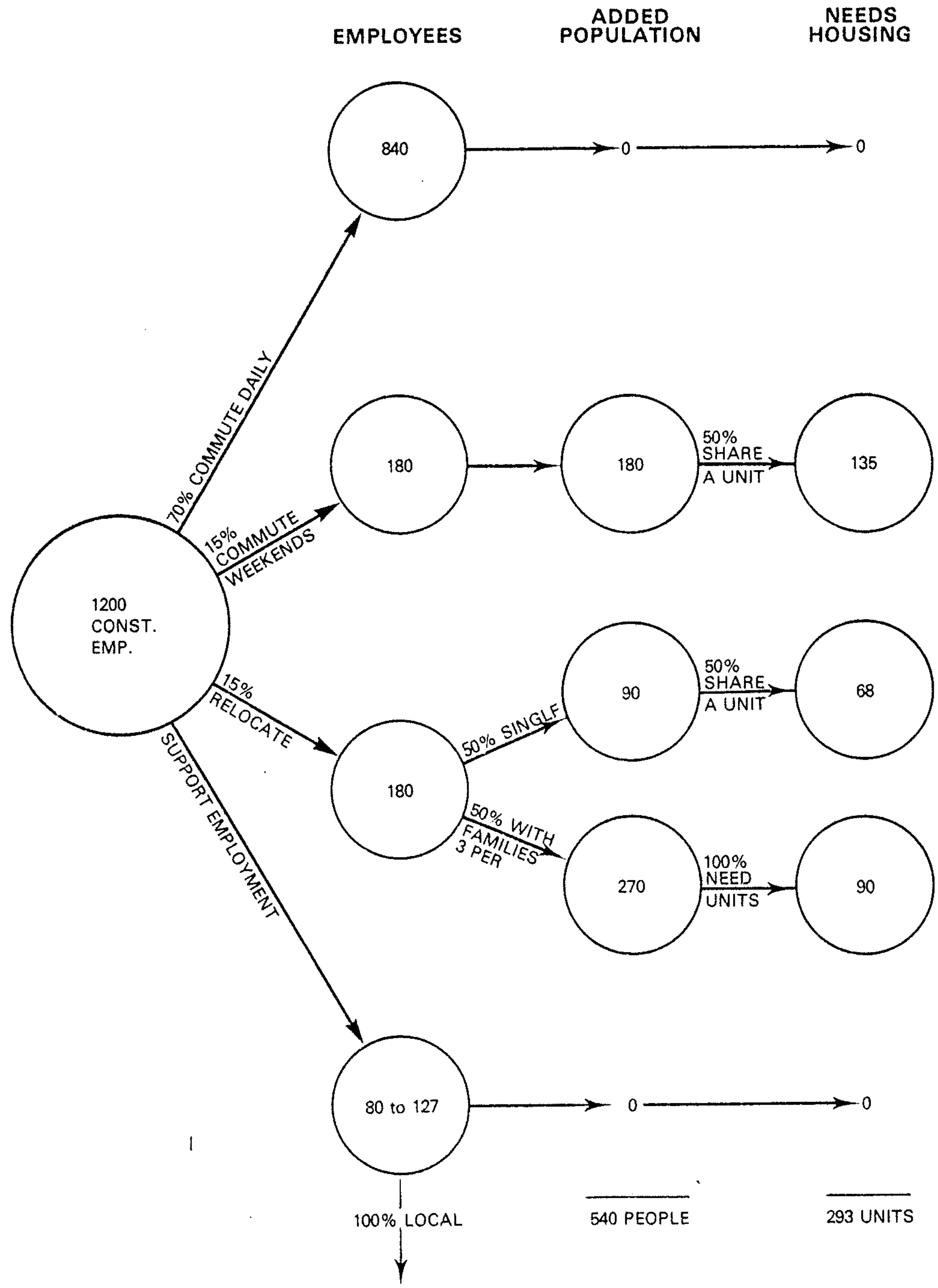
Under Case A, it was assumed that 70% of the peak construction labor force will commute daily to the Clay Boswell Station; 15% will commute on weekends; and 15% will relocate within the area. Additional service-related personnel are assumed to come from the existing local population due to the current high unemployment rate, the minimal skills required, and the temporary nature of these jobs. Population increases and housing demands for Case A are shown in Figure V-37.

Under Case B, it was assumed that 50% of construction labor will commute daily, 25% will commute on weekends, and 25% will relocate. As in Case A, the additional service-related personnel are assumed to come completely from local residents. Population increases and housing demands for Case B are shown in Figure V-38.

Permanent employment at the Clay Boswell Station is based on MP&L's estimated need for 170 additional employees (138). The assumptions made with regard to population and housing demand are illustrated in Figure V-39. In most cases, impacts related to operational employment fall within or below the range of impacts created by construction employment. The impacts of the larger group of construction employees will be more severe than the impact of the smaller group of operational employees. Where no impact was projected for the construction labor force, it was assumed that no impact from the operational labor force would occur. In these cases, permanent employment is not treated separately in the impact analysis.

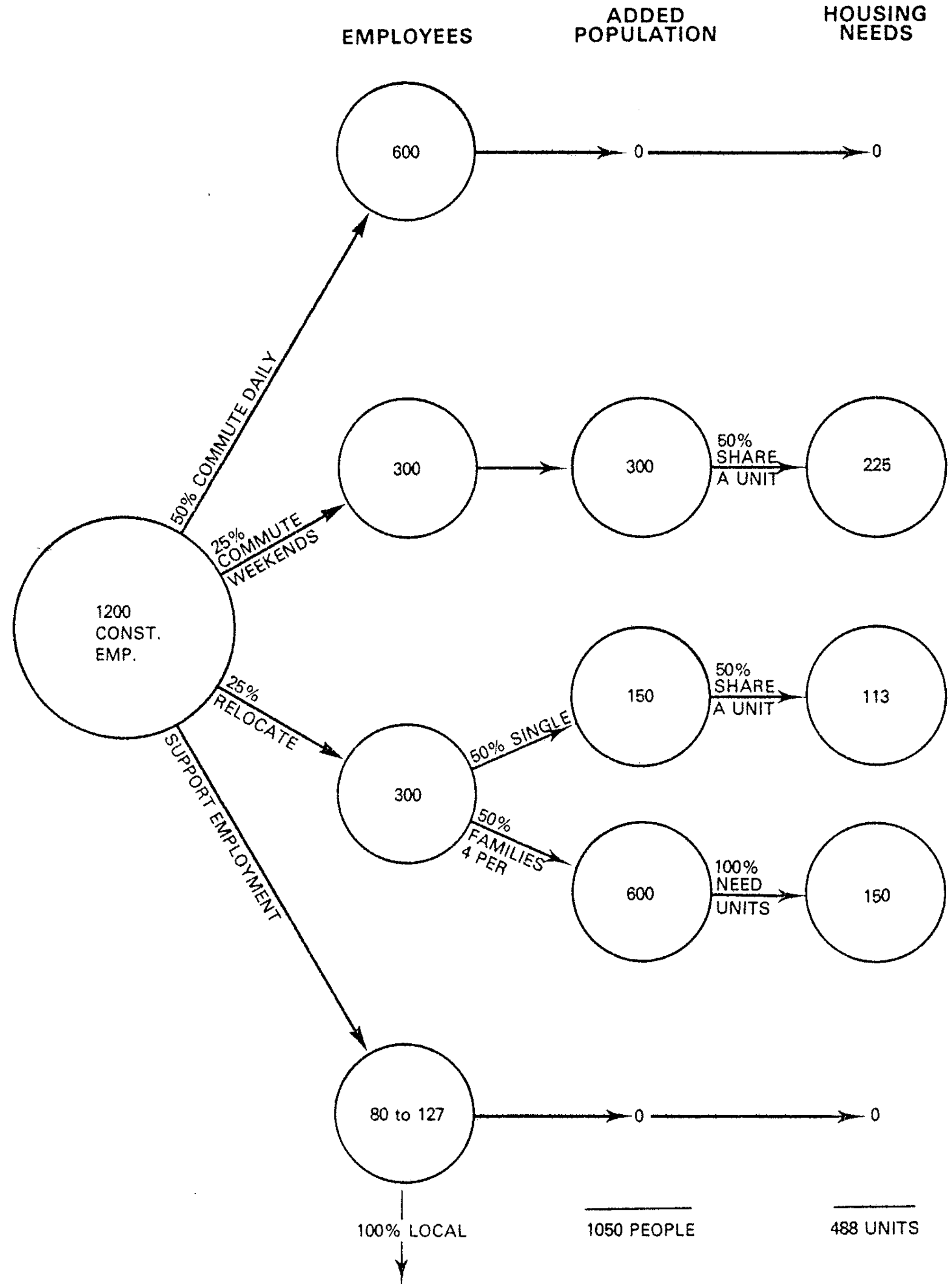
Residential Location. Assumptions also had to be made concerning the cities in which construction and permanent laborers would decide to locate residentially. The first assumption was that workers would prefer to live within a short driving time to the Clay Boswell Station. Cities within a triangle from Deer River to Keewatin to Warba were considered to be prime potential locations for employee residences.

It was assumed that relocating construction employees will be distributed amoung the incorporated communities within the Deer River, Keewatin, and Warba triangle in the same proportion as the existing population is distributed in



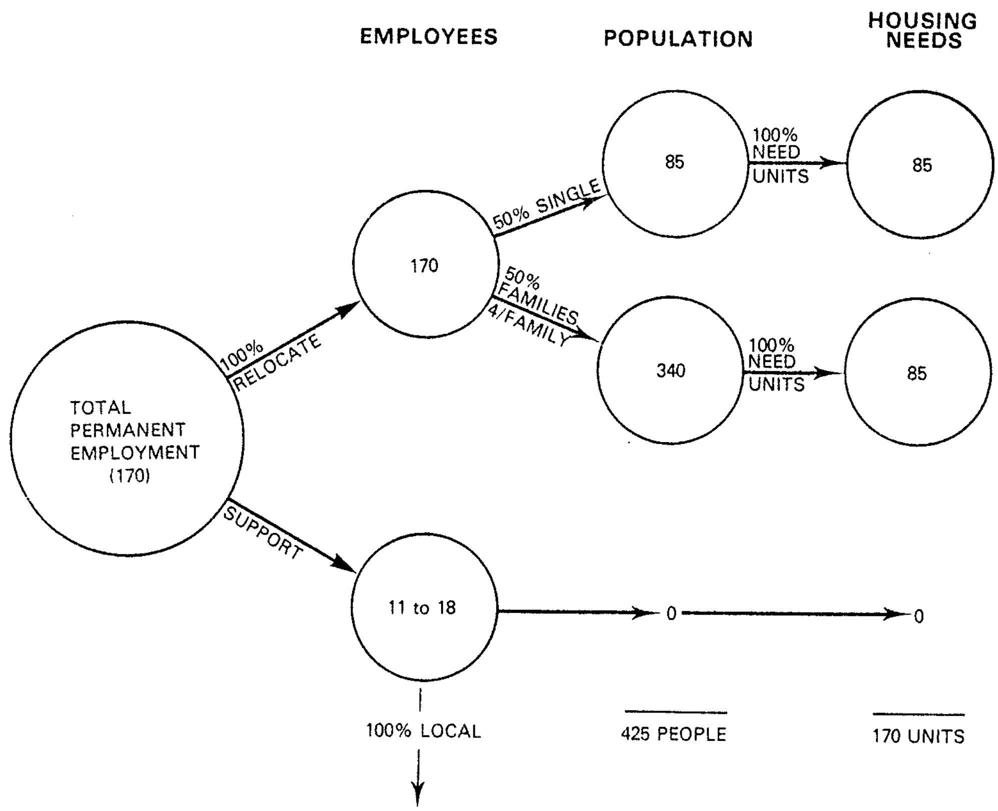
ESTIMATED DISTRIBUTION OF TEMPORARY CONSTRUCTION WORKERS - CASE A

FIGURE V-37



ESTIMATED DISTRIBUTION OF TEMPORARY CONSTRUCTION WORKERS - CASE B

FIGURE V-38



ESTIMATED DISTRIBUTION OF PERMANENT OPERATIONAL EMPLOYEES

FIGURE V-39

these communities. Projected distribution of population due to new MP&L employment is presented in Table V-52.

TABLE V- 52
PROJECTED DISTRIBUTION OF NEW POPULATION DUE TO NEW MP&L EMPLOYMENT

City	Population number	Population percent	Temporary Case A[a]	Temporary Case B[b]	Permanent[c]
Bovey	858	5.6	30	59	26
Calumet	460	3.0	16	31	-
Cohasset[d]	536	3.5	19	37	61
Coleraine	1,086	7.0	38	73	26
Deer River	815	5.3	29	57	53
Grand Rapids	7,247	47.0	254	493	250
Keewatin	1,382	9.0	47	94	-
La Prairie	413	2.7	15	28	-
Marble	682	4.4	24	46	4
Nashwauk	1,341	8.7	47	91	-
Taconite	352	2.3	11	24	-
Warba	148	1.0	5	10	4
Zemple	71	0.5	3	5	-
Total	15,744	100.0	539	1,048	424

[a] Low estimate of family size and employee relocation.
[b] High estimate of family size and employee relocation.
[c] Assumes 50% single and 50% families of 4 distributed as existing employee residences.
[d] Now included in Bass Brook Township.

It was assumed that relocating permanent employees will be distributed in essentially the same fashion as existing MP&L employees.

Projected Impacts on Housing Demand

Criteria. The 2 criteria used to measure impacts of MP&L's proposed Unit 4 on housing demand in the area are as follows.

- A significant impact will occur if the demand for temporary housing is 5% or more than the existing number of units.

- A significant impact will occur if the demand for permanent housing is 5% or more than the number of existing housing units.

Assumptions. The following assumptions were utilized for estimating potential demand for housing in the area.

- 1970 population was used as the data base for projecting increased housing demand.

- Both the Case A and the Case B estimates of commuting patterns and relocation estimates for temporary employment were utilized as illustrated in Figures V-37 and V-38. In both cases, it was assumed that population would distribute within nearby incorporated communities on the same percentage basis as existing population is distributed within those communities.

- Need for permanent housing units was based on MP&L's estimate of 170 new permanent employees at the Clay Boswell Station (Figure V-39 . Distribution of the new population was assumed to be the same as distribution among current employees at the Clay Boswell Station. It was assumed that each new permanent employee would require a housing unit.

- The 1975 family size of 3.05 persons per household was used to estimate the number of existing housing units.

Temporary Housing Demand. The temporary housing demand which will result from construction of the proposed Unit 4 is presented in Table V-53. Housing demand will range from 290 units for Case A to 483 units for Case B depending upon the number of commuting employees. The majority of these units will be located in the Grand Rapids area (137 to 227 units) with the remaining units distributed as shown in Table V-54. Case A would result in all incorporated communities except Cooley and Zemple experiencing an increase in temporary housing demand of approximately 6%. In Case B, all incorporated communities except Cooley will have a projected increase of 9 to 10%. Percent increase in housing unit demand for temporary employees is shown in Table V-54. Based on this projection it can be assumed that there will be a significant impact in housing demand as a result of temporary employment in all incorporated communities within the area except Cooley.

Permanent Housing Demand. Estimated permanent housing demand in the area as a result of the operation of MP&L's proposed Unit 4 is indicated in Table V-55. Approximatey 170 units (one per employee) will be required by new permanent Clay Boswell Station employees. Assuming the distribution shown in Table V-55 occurs, significant impacts in permanent housing demands will occur in the community of Cohasset (now part of Bass Brook Township) and Deer River. In all other incorporated communities permanent housing demand will increase less than 5%. In the community of Cohasset, demand will increase approximately 14%, and in Deer River permanent housing demand will increase approximately 8%.

Projected Impacts on Schools

Criteria. Two criteria were utilized to measure the impacts on schools from increased enrollment resulting from projected new employment at the Clay Boswell Station.

- A significant impact will occur if schools or school systems enrollment increases beyond the design capacity of the physical facilities.

- A significant impact will occur if the property taxes which support the school district change by 5% or more.

TABLE V -53
DISTRIBUTION OF TEMPORARY HOUSING DEMAND BASED ON 1970 POPULATION DISTRIBUTION

City	1970 Population[a]	Percent of Impact Area	Case A[b]		Case B[b]	
			Population Added	Units Needed	Population Added	Units Needed
Bovey	858	5.6	30	16	59	27
Calumet	460	3.0	16	9	31	15
Cohasset[c]	536	3.5	19	10	37	17
Coleraine	1,086	7.0	38	20	73	34
Cooley	33	-	-	-	-	-
Deer River	815	5.3	29	15	57	26
Grand Rapids	7,247	47.0	254	137	493	227
La Prairie	413	2.7	15	8	28	13
Keewatin	1,382	9.0	47	26	94	43
Marble	682	4.4	24	13	46	21
Nashwauk	1,341	8.7	47	25	91	42
Warba	148	1.0	5	3	10	5
Taconite	352	2.3	12	7	24	11
Zemple	71	0.5	3	1	1	2
Total	15,424	100.0	539 (540)	290 (293)	1,048 (1,050)	483 (488)

[a] ___, "Population Projections," (unpublished memorandum), 1973, ARDC.

[b] Assuming 1975 Household Size of 3.05 and distribution according to existing population distribution in incorporated areas.

[c] Now included in Bass Brook Township.

TABLE V - 54
PERCENT INCREASE IN HOUSING UNIT DEMAND FOR TEMPORARY EMPLOYEES

City	1970 Population[a]	Units Using 1975 Family Size (3.05)	Case A		Case B	
			Units Needed	Percent Increase	Units Needed	Percent Increase
Bovey	858	281	16	5.6	27	9.6
Calumet	460	151	9	6.0	15	9.9
Cohasset[b]	536	176	10	5.7	17	9.6
Coleraine	1,086	356	20	5.6	34	9.5
Cooley	33	11	-	-	-	-
Deer River	815	267	15	5.6	26	9.7
Grand Rapids	7,247	2,376	137	5.8	227	9.5
Keewatin	1,382	453	26	5.7	43	9.5
La Prairie	413	135	8	5.9	13	9.6
Marble	682	224	13	5.6	21	9.4
Nashwauk	1,341	440	25	5.7	42	9.5
Warba	148	48	3	6.2	5	10.4
Taconite	352	115	7	6.1	11	9.5
Zemple	71	23	1	4.3	2	8.7
Total	15,424		290		483	

[a] ___, "Population Projections," (unpublished memorandum), 1973, ARDC.

[b] Now included in Bass Brook Township.

TABLE V-55
ESTIMATED HOUSING DEMAND FOR PERMANENT EMPLOYEES BASED ON EXISTING MP&L EMPLOYEE DISTRIBUTION

City	1970 Population[a]	Households Assuming 3.05 Per Unit	Present MP&L Employees Living in City	Percent of Total MP&L Employees	Units Required (170)[b]	Percent of Existing Units
Bovey	858	281	6	6.2	10	3.6
Cohasset[c]	536	176	14	14.4	24	13.6
Coleraine	1,086	356	6	6.2	10	2.8
Deer River	815	267	12	12.4	21	7.9
Grand Rapids	7,247	2,376	57	58.8	100	4.2
Marble	682	224	1	1.0	2	0.9
Warba	148	48	1	1.0	2	4.2
Total			97[d]	100.0	169	

[a] ___, "Population Projections," (unpublished memorandum), 1975, ARDC.
[b] It is assumed each permanent employee will require a housing unit.
[c] Now included in Bass Brook Township.
[d] There are 102 current permanent employees, but the remaining people live outside the impact area.

Assumptions. The following assumptions were utilized in this analysis in addition to the basic employment and population distribution assumptions previously described.

- Four school districts in Itasca County will be affected by changes in MP&L employment during the construction and operation period of MP&L's proposed Unit 4. These school districts are 316 (Coleraine), 317 (Deer River), 318 (Grand Rapids), and 319 (Nashwauk-Keewatin).

- 1974-75 enrollment data supplied the base data.

- New population was distributed into age groups according to the population age distribution in Itasca County in the 1970 census. In this census, 14% of Itasca County population was of elementary school age and 16% was of secondary school age. These percentages were applied to projected population increases for each of the school districts to estimate increased enrollment.

- School capacity is based on estimates provided by each school district (139).

- The 1975 mill rate was used to project increases in school taxes. It was assumed that this mill rate will not change.

New Student Population. The projected number of new elementary and secondary school students for Case A, Case B, and permanent employment are presented in Table V-56. Increases in enrollment are anticipated during the temporary construction period for all 4 school districts. Increases in enrollment are not projected for District 319 during the operational period of MP&L's proposed Unit 4.

TABLE V-56
ESTIMATED INCREASES IN SCHOOL ENROLLMENT

School District	Case A Population Increase	Case A Elementary Students	Case A Secondary Students	1970 School Age Population Percent Elementary	1970 School Age Population Percent Secondary
316 (Coleraine)	120	17	19	14	16
317 (Deer River)	32	4	5	14	16
318 (Grand Rapids)	293	41	47	14	16
319 (Nashwauk-Keewatin)	94	13	15	14	16

School District	Case B Population Increase	Case B Elementary Students	Case B Secondary Students	Permanent Population	Permanent Elementary	Permanent Secondary
316 (Coleraine)	233	33	37	56	8	9
317 (Deer River)	62	9	10	53	7	8
318 (Grand Rapids)	568	80	91	315	44	50
319 (Nashwauk-Keewatin)	185	26	30	0	-	-

Projected elementary school enrollment is shown in Table V-57. All school districts except Deer River (District 317) are expected to continue to have a surplus capacity. The Deer River School District currently is operating at full capacity (139). Therefore, elementary schools in the Deer River School District are expected to exceed capacity by 6 to 11 students. It should be noted, however, that the Minnesota State Demographer is projecting a relatively rapid decline in elementary school enrollment throughout the State. This projection coupled with the projected overall decline in population in Itasca County suggests that there will not be a significant impact on elementary school enrollment in any of the school districts in Itasca County including District 317.

Projected student enrollment for secondary schools in the 4 school districts in Itasca County is indicated in Table V-58. Neither School District 316 (Coleraine) nor District 319 (Nashwauk-Keewatin) is expected to exceed current capacity as a result of temporary or permanent employment at the Clay Boswell Station. Both Districts 317 and 318 are expected to exceed current capacity. As in the case of elementary schools, a decline in secondary school enrollment is projected for the State and Itasca County. This projected enrollment decline, coupled with the relatively small number of students exceeding current school capacity, suggests that a significant impact will not

TABLE V-57
PROJECTED IMPACTS ON ELEMENTARY SCHOOL ENROLLMENT

School District	1974 to 1975 Enrollment[a]	School Capacity[b]	Case A		Case B		Permanent	
			Estimated Students[c]	Estimated Impact	Estimated Students[c]	Estimated Impact	Estimated Students[c]	Estimated Impact
316 (Coleraine)	932	1,200	949	+251	965	+235	940	+260
317 (Deer River)	552	550	556	-6	561	-11	559	-9
318 (Grand Rapids)	2,250	2,575	2,291	+284	2,330	+245	2,294	+281
319 (Nashwauk-Keewatin)	453	650	466	+184	479	+171	-	-

a ___, "Update Special Report," Volume 10, No. 2, Spring, 1976, Minnesota Department of Education.
b Individual communications with school districts, May, 1977.
c 1974-75 enrollment plus new students from Table V-56.

TABLE V-58
PROJECTED IMPACTS ON SECONDARY SCHOOL ENROLLMENT

School District	1974 to 1975 Enrollment[a]	School Capacity	Case A		Case B		Permanent	
			Estimated Students[c]	Estimated Impact	Estimated Students[c]	Estimated Impact	Estimated Students[c]	Estimated Impact
316 (Coleraine)	1,086	1,400	1,105	+295	1,123	+277	1,095	+305
317 (Deer River)	656	650	661	-11	666	-16	664	-14
318 (Grand Rapids)	2,821	2,800	2,868	-68	2,912	-112	2,871	-71
319 (Nashwauk-Keewatin)	604	650	619	+31	634	+16	-	-

a ___, "Update Special Report," Volume 10, No. 2, Spring, 1976, Minnesota Department of Education.
b Individual communications with school districts, May, 1977.
c 1974-75 enrollment plus new students from Table V-56.

occur in the Deer River School District. In the Grand Rapids School District (District 318), school enrollment is expected to exceed current school capacity by 68 to 112 students. Assuming an average maximum capacity of 25 students per classroom, 3 to 5 additional classrooms may be required to accommodate these students. Permanent employment estimates fall toward the lower end of this range with an estimated excess over current capacity of 71 students (Table V-58). A significant impact is, therefore, projected for secondary schools in District 318.

Property Taxes Supporting School District 318. There is a potential of reducing State aid and individual property taxes in Grand Rapids School District 318 due to the increased valuation added by the proposed Clay Boswell Station's Unit 4. Based on property taxes paid in 1975 by MP&L for the existing Clay Boswell Steam Electric Station, it has been projected that the proposed action will increase property taxes paid by MP&L in School District 318 by approximately $587,000 as shown in Table V-59. This will be an increase of approximately 41% over school district taxes currently paid by MP&L, and will be

TABLE V- 59
ESTIMATED IMPACT ON PROPERTY TAXES
IN SCHOOL DISTRICT 318 - GRAND RAPIDS

	MP&L Taxes[b]	Total School District Taxes
Property taxes in 1975	$1,421,675	$3,583,000
Projected taxes[a]	$2,008,968	$4,170,293
Percent change	+41	+16
Additional taxes from proposed plant	$ 587,293	$ 587,293

[a] Assuming 1975 School Mill Rate of 48.88.

[b] ___, "Environmental Report, Clay Boswell Steam Electric Station Unit No. 4," Minnesota Power & Light Company, New York, N.Y., 1976, Exhibit IV-B-59.

an increase of approximately 16% over 1975 school taxes collected in the Grand Rapids School District. Therefore, the projected increase in property taxes is considered to have a significant impact in School District 318.

Projected Impact on Public Services

Criteria. The impacts of MP&L's proposed Unit 4 on public services will be based on the level of service as measured by the ratio between public service employees and residents in addition to comparing level of service to the State average. It is assumed that there is some flexibility in all systems and that public services can accommodate up to a 10% increase in residents. If the local ratio falls below the State average due to additional population, the impact will be considered significant. If the present ratio is below the State average, the impact will be considered significant. If the present ratio is below the State average, the impact will be considered significant if the ratio of service personnel to population drops by more than 10%.

Assumptions. To estimate potential impacts on public service demands in the area, the following assumptions were made.

- 1980 projected population by minor civil division, prepared by the Arrowhead Regional Development Commission (ARDC), was used as base data for analyzing police and health services.
- Police service areas were assumed to be the incorporated community in which the department is located. Sheriff personnel were added to determine countywide estimates.
- Fire service areas and population served were estimated by the Fire Information Center (140). Since 1980 population projections were not available for these areas, 1970 population was used as the base data.

TABLE V-60
PROJECTED IMPACTS ON FULL-TIME POLICE SERVICES

City	Projected Population[a] Case A	Case B	Full-Time Certified Police Per 1,000 Population Existing	Case A	Case B	Percent Change Case A	Case B
Bovey	760	789	2.3	2.5	2.5	+8.7	+8.7
Calumet	406	421	2.2	2.5	2.4	+13.6	+9.1
Cohasset[b]	549	567	-	-	-	-	-
Coleraine	1,098	1,133	0.9	0.9	0.9	-	-
Deer River	829	857	2.4	2.3	2.3	-4.2	-4.2
Grand Rapids	8,694	8,993	1.5	1.3	1.2	-13.3	-20.0
Keewatin	1,287	1,334	2.2	2.3	2.2	+4.5	-
La Prairie	515	528	-	-	-	-	-
Marble	694	716	2.9	2.9	2.8	-	-3.4
Nashwauk	1,127	1,171	3.0	3.5	3.4	+16.7	+13.3
Warba	145	150	-	-	-	-	-
Taconite	362	374	-	-	-	-	-
Zemple	73	75	-	-	-	-	-
Itasca County	35,259	35,862	0.9	0.9	0.9	-	-

[a] 1980 population projections (ARDC) plus estimated population increases.

[b] Now included in Bass Brook Township.

Police Services. Data regarding the number of full-time certified police officers in the affected communities and Itasca County were obtained from the ARDC for communities over 1,000 population and by direct communications with those communities under 1,000 population (141) (142). The existing police staff per 1,000 population in these cities is presented in Table V-60. The projected new population resulting from construction of the proposed Unit 4 at the Clay Boswell Station was added to the 1980 ARDC projected population to estimate total peak year population for Case A, Case B, and the full-time certified police per 1,000 population was calculated for each case (Table V-60).

While the statewide average police personnel per 1,000 population is 1.7, police services in the affected communities range from 0 (no existing police service other than County Sheriff) to 3.5 per 1,000 population. Police personnel in the County as a whole is currently below the State average. In no community with current police services above the State average will police services drop below the State average of 1.7 full-time policemen per 1,000 population. However, in the City of Grand Rapids police service per 1,000 population is expected to decrease by 13.3% under the Case A assumption and 20% under the Case B assumption. Therefore, a significant impact on police services in the City of Grand Rapids is expected due to the proposed action.

Fire Services. Fire departments in Itasca County serve areas larger than the incorporated communities in which they are located. In addition, there are certain portions of Itasca County which are not currently served by local fire departments. It should be noted, however, that the Minnesota DNR provides extensive rural fire fighting services throughout the County and the Arrowhead Region. Figure IV-98 shows fire service areas in Itasca County. The population of each fire service area is presented in Table V-61.

The statewide average for local fire services is estimated to be 4.8 fire fighters per 1,000 population. As shown in Table V-61, only the City of Grand Rapids currently has fewer fire fighters than the State average. The number of fire department personnel is not projected to drop below the State average in any city where the ratio is currently above the State average. The projected decrease in per capita fire fighting capability in Grand Rapids ranges from 0 to 5.6%. This is less than the 10% figure used as an indicator of significant impact. Therefore, no significant impacts on local fire services are anticipated as a result of the proposed action.

TABLE V-61
PROJECTED IMPACT ON FIRE SERVICES

Fire Department	Population Served			Fire Fighters[a]	Fire Fighters Per 1,000 Population			Percent Change	
	Existing[a]	Case A	Case B		Existing	Case	Case B	Case A	Case B
Big Fork	2,740	2,740	2,740	22	8.1	8.1	8.1	-	-
Bovey	1,396	1,426	1,455	20	14.3	14.0	13.7	-2.18	-4.2
Calumet	1,177	1,193	1,208	20	17.0	16.8	16.6	-1.2	-2.4
Cohasset[b]	2,197	2,216	2,234	24	10.9	10.8	10.7	-0.9	-1.8
Coleraine	1,699	1,737	1,772	20	11.8	11.5	11.3	-2.5	-4.2
Deer River	3,084	3,116	3,146	25	8.1	8.0	7.9	-1.2	-2.5
Grand Rapids	13,976	14,245	14,497	25	1.8	1.8	1.7	-	-5.6
Keewatin	1,650	1,697	1,744	19	11.5	11.2	10.9	-2.6	-5.2
Marble	770	794	816	20	26.0	25.2	24.5	-3.1	-5.8
Nashwauk	2,800	2,847	2,891	20	7.1	7.0	6.9	-1.4	-2.8
Taconite	670	682	694	14	20.9	20.5	20.2	-1.9	-3.3
Warba	1,351	1,356	1,361	20	14.8	14.7	14.7	-0.7	-0.7
Itasca County	33,510	34,049	34,558	249	7.4	7.3	7.2	-1.4	-2.7

[a] Source: Communications with Fire Information Center, University of Minnesota, May, 1977.

[b] Now included in Bass Brook Township.

Health Services. Health services data were not available for individual communities. Therefore, this analysis was carried out only for Itasca County. The projected impacts on health services are presented in Table V-62.

The recommended guideline (143) for doctor's services is 1.25 doctors per 1,000 population. The statewide average is 1.6 while Itasca County has only 0.6 doctors per 1,000 population. This ratio does not change as a result of the proposed action. Therefore, no significant impact is projected.

The recommended guideline for hospital beds is 4.0 beds per 1,000 population. Both the State of Minnesota and Itasca County have services above this guideline--5.2 and 4.4 beds per 1,000 population, respectively as shown in Table V-62. This ratio does not change as a result of the proposed action. Therefore, no significant impact is projected.

TABLE V-62
IMPACT ON HEALTH SERVICES

	Existing	Projected Case A		Projected Case B	State Average[a]	Recommended Guidelines
Itasca County Population 1970	35,530	35,259		35,862	-	
Doctors per 1,000 population	0.6[a]	0.6		0.6	1.6	1.25[c]
Hospital beds per 1,000 population	4.4[b]	4.4		4.4	5.2	4.0 [a]
Percent change						
Doctors	-	+0.8	to	0.9	-	-
Hospital beds	-	+0.8	to	0.9	-	-
Percent variation from state average						
Doctors	38	38		38	-	-
Hospital beds	110	110		110	-	-

[a] Communications with Minnesota Department of Health, March, 1977.

[b] ___, "Public Programs and Minnesota's Development Region," 1973, State Planning Agency.

[c] McClure, Walter, Ph.D., Elwood, Paul, M.D., Stokes, Linda, J.D., "Alternatives for State Support of Health Research," a report to the Governor, 1977, Interstudy, St. Paul, Minnesota.

Projected Impacts on Unemployment

Criteria. The basic criterion used to measure the impact on unemployment in the affected area as a result of employment at the Clay Boswell Station is as follows.

- A significant impact will occur if unemployment is expected to drop by 0.5% in the County due to the proposed action.

The current employment situation, especially that related to construction, is very dynamic at the present time in northern Minnesota. Historically the area has had relatively high unemployment as a result of employment trends in the construction and mining industries. Therefore, these unemployment projections should not be viewed as absolutes because of the impact of variables such as mining and construction industry employment.

Assumptions. Since detailed data on unemployment by occupation were not available, the following assumptions had to be made.

- Base data on work force by occupation were taken from the 1970 Census for Itasca County.

- Unemployment figures by occupation were calculated using data from the active application files for the City of Grand Rapids in 1975 as compiled by the Minnesota Department of Employment Services (144). These applications are generally categorized by occupation and by experienced applicants and inexperienced applicants. It was assumed that unemployment throughout Itasca County would be distributed among occupations in approximately the same pattern as unemployment within the City of Grand Rapids. Both experienced and non-experienced applicants were included in the analysis.

TABLE V-63
ESTIMATED IMPACT OF CONSTRUCTION EMPLOYMENT ON UNEMPLOYMENT RATE BY OCCUPATIONAL CATEGORIES IN ITASCA COUNTY

Occupation	Existing Conditions: Employed in 1970[a]	Existing Conditions: Estimated Unemployed[b]	Existing Conditions: Total	Existing Conditions: Percent Unemployed	Projected Employment: New Employees	Projected Employment: Estimated Percent of Currently Unemployed	Projected Employment: Total Employed	Projected Employment: Estimated Unemployed	Projected Employment: Percent Unemployed	Percent Change in Unemployment Rate
Professional, Technical Manager	2,302	181	2,483	7.3	16 (33)	50	2,318	165	6.6	-9.6
Craftsmen and Foremen	1,922	438	2,360	18.6	219 (1,290)	50	2 141	219	9.3	-50.0
Operatives and Laborers	2,512	363	2,875	12.6	143	100	2,655	220	10.3	-18.3
Clerical and Sales	1,779	317	2,096	15.1	44 to 70	100	1,823 to 1,849	247 to 273	11.8 to 13.0	-13.9 to -21.8
Service	1,465	182	1,647	11.0	36 to 57	100	1,501 to 1,522	125 to 146	7.6 to 8.9	-19.1 to -31.0
Other	592	30	622	4.8	-	-	592	30	4.8	0
Total	10,572	1,511	12,083[a]	12.5[a]	458 to 505 (1,546 to 1,593)	-	11,030 to 11,077	1,006 to 1,053	8.3 to 8.7	- 30.4 to 33.6

[a] ___, "1970 Census of population, Socio-Economic Characteristics," Minnesota, 1970, U.S. Department of Commerce.

[b] Estimated distribution of unemployed by occupation based on occupational distribution of 1975 job applications in Grand Rapids from "An Analysis of the Active Application files for Ely, Grand Rapids, Hibbing, International Falls, Virginia," May, 1975, Minnesota Department of Employment Services.

TABLE V-64
ESTIMATED IMPACT OF OPERATIONAL EMPLOYMENT ON UNEMPLOYMENT RATE IN ITASCA COUNTY

Occupation	Existing Conditions: Unemployed[a]	Existing Conditions: Percent Unemployed	Total Work Force	Projected: New Employees	Projected: Estimated Percent of Unemployed	Projected: Unemployed	Projected: Percent Unemployed	Percent Change in Unemployment rate
Professional, Technical, Managers	181	7.3	2,483	10 (20)	50	171	6.9	-5.5
Craftsmen and Foremen	438	18.6	2,360	64 (128)	50	374	15.8	-15.1
Operatives and Laborers	363	12.6	2,875	22	100	341	11.9	-55.6
Clerical and Sales	317	15.1	2,096	0 to 44	100	273 to 317	13.0 to 15.1	-13.8 to 0
Service	182	11.0	1,647	0 to 36	100	146 to 182	8.9 to 11.0	-19.1 to 0
Other	30	4.8	622	-	100	30	4.8	0
Total	1,511	12.5[b]	12,083[b]	176 (250)	-	1,335 to 1,415	11.0 to 11.7	-6.4 to -12.0

[a] Estimated distribution of unemployed by occupation based on occupational distribution of 1975 job applications in Grand Rapids from "An Analysis of the Active Application Files for Ely, Grand Rapids, Hibbing, International Falls, Virginia," May 1975, Minnesota Department of Employment Services.

[b] U. S. Department of Commerce, Bureau of Census, 1970 Census of Population, Socio-Economic Characteristics, Minnesota, 1970.

- Since the occupational data categories available are very general and include individuals experienced in a wide variety of fields not necessarily applicable to the proposed employment at the Clay Boswell Station, it was generally assumed that: 1) in those categories requiring some technical expertise ("professional, technical, managers" and "craftsmen, foremen"), only half of those individuals available for employment in Itasca County will have the appropriate technical expertise for employment at the Clay Boswell Station, and 2) all other occupations require little or no training and will be completely filled by the local labor force if an adequate number of individuals are available for work.

Temporary Construction Employment. It was determined that between 458 and 505 individuals from the existing work force in Itasca County might be employed during the construction period for Unit 4 at the Clay Boswell Station as shown in Table V-63. Itasca County presently has an unemployment rate of 12.5%. Temporary construction employment would reduce unemployment by 30.4 to 33.6%, for an Itasca County unemployment rate of 8.3 to 8.7%. The occupational groups most dramatically affected by increased employment during the construction period will be craftsmen and foremen, where unemployment will be decreased by 50% for an unemployment rate of 9.3%. It should be noted, however, that unemployment throughout Itasca County in all occupational categories except "professional, technical, managers"; and "other" (primarily farm laborers) will still be above the national rate.

Permanent Operational Employment. Since total employment during the operational period of the proposed Unit 4 at the Clay Boswell Station will be significantly below that projected for the construction period, the impact of operation of Unit 4 on unemployment in Itasca County will be less.

It is anticipated that 176 to 250 operational and secondary service-related jobs will be created as a result of operation of MP&L's proposed Unit 4, as shown in Table V-64. It is estimated that this new permanent employment will decrease the unemployment rate in Itasca County by from 6.4 to 12.0%, for a net unemployment rate of 11 to 11.7%. Again, the occupational category most significantly affected by this increased employment would be the category of craftsmen and foremen.

Based on the preceding analysis, it can be assumed that increased temporary and permanent employment at the Clay Boswell Station will have a positive impact on the unemployment rate currently being experienced in Itasca County. It should be noted, however, that for both permanent and temporary employment, the unemployment rate in Itasca County will still remain above the national average.

Projected Impact on Business Activity

Criteria. Many businesses may be influenced by added expenditures by MP&L or its employees. The significance of such increased business activity will be determined by the dollar volume within the affected area. Estimates will be made for different types of expenditures made by employees who commute, those who live in the area during the week, and those who relocate either for the construction period or permanently. The criterion for measuring this impact is as follows.

- A significant impact will occur if dollar business volume increases by more than 5% over base level dollar volume within the County or any incorporated area due to the proposed action.

<u>Assumptions</u>. The impact of retail expenditures by residents is more apparent than the impact of retail expenditures by temporary construction population. Weekly commuters, daily commuters, and related support workers will each have different expenditure patterns focusing on different retail activities. Table V-65 presents an estimate of local retail expenditures by the various groups of workers. National personal consumption expenditures for 1973 are presented in Table V-66. Using the distribution shown in Table V-66, retail expenditures by households of construction personnel were estimated based on:

- Case A and B population estimates,
- Average annual wage,
- General tax liability, and
- Disposable income factors.

Based on an annual salary or wage of $12,800 (138), income for retail spending can be estimated as presented below.

$12,800	annual salary or wage
- 14.4%	Federal tax (138)
$10,957	
- 5.7%	State tax (138)
$10,322	
x 65.0%	spendable income factor (138)
$ 6,716	spendable income
x 90.0%	retail factor (138)
$ 6,044	annual retail expenditure

TABLE V-65
ASSUMED LOCAL RETAIL EXPENDITURES BY TYPE OF EMPLOYEES

Category of Expenditure	Residents	Weekly Commuters	Daily Commuters
Eating and drinking	x	x	x
Grocery and drug	x	x	-
Automotive	x	x	x
Gas and auto service	x	x	x
Hotel, motel, lodging ("housing")	-	x	-
Furniture and appliances	x	-	-
Hardware ("housing operations")	x	-	-
Apparel	x	-	-
Personal services	x	x	-
Other	x	x	x

TABLE V-66
DISTRIBUTION OF PERSONAL RETAIL EXPENDITURES (145)

Category	Percent of Personal Expenditures
Eating, drinking, grocery and drug	22.2
Automotive, gas, and auto service	13.6
Hotel, motel, lodging ("housing")	14.5
Furniture, appliances and hardware ("housing operations")	14.6
Apparel	10.1
Personal services	14.9
Other	10.1
Total	100.0

Depending on commuting and residency patterns, the proportion of spendable income which will be spent locally may vary, as shown in Table V-67.

TABLE V-67
ESTIMATED SHARE OF RETAIL EXPENDITURES BY EMPLOYEE GROUPS

	Eating, Drinking Grocery and Drug	Auto, Gas and Service	Housing	Housing Operations	Apparel and General Merchandise	Other	Percent of Total Retail Expenditures Occurring in Employment Area
Percent of national average expenditures	22.2	13.6	14.5	14.6	10.1	10.1	85.1[a]
Weekend commuter	17.7[b]	10.8[b]	7.2[c]	7.3[c]	-	3.0[d]	46.0
Daily commuter	11.1[c]	6.8[c]	-	-	-	1.0	18.9
Support (Resident)[e]	22.2	13.6	14.5	14.6	10.1	10.1	85.1[a]

[a] Remaining 14.9% is expended on "Personal Services".
[b] Assumes 80% of those expenditures will occur in employment area.
[c] Assumes 50% of those expenditures will occur in employment area.
[d] Assumes 30% of other goods will be purchased locally.
[e] Assumes 10% of these expenditures will be made locally.

Projected Expenditures. Using the preceding assumptions, annual expenditures by new employees were estimated for Itasca County for Case A and Case B as shown in Tables V-68 and V-69. Based on these calculations it can be estimated that countywide retail sales will increase by $3.0 to $4.5 million annually during 1979, the peak employment year of the Clay Boswell Station. This is an increase for the County of 3.5 to 5.2% over the base dollar volume of $87.2 million (Table V-70).

TABLE V-68
ESTIMATED RETAIL EXPENDITURES IN ITASCA COUNTY FOR CASE A

Employee Type	Estimated Employment	Estimated Total Annual Retail Expenditures	Percent of Retail Spent Locally	Estimated Local Retail Expenditures	Total Retail Expenditures
Weekend commuter	180	$ 6,044	46.0	$ 2,780	$ 500,400
Daily commuter	840	6,044	18.9	1,142	959,280
Support (resident)	80 to 127	6,044	100.0	6,044	483,520 to 767,588
Relocated (resident)	180	6,044	100.0	6,044	1,087,920
Total	1,280 to 1,327	6,044	39.2 to 41.3	2,368 to 2,498	3,031,120 to 3,315,188

TABLE V-69
ESTIMATED RETAIL EXPENDITURES IN ITASCA COUNTY FOR CASE B

Employee Type	Estimated Employment	Estimated Total Annual Retail Expenditures Per Employee	Percent of Retail Spent Locally	Estimated Local Retail Expenditures Per Employee	Total Retail Expenditures
Weekend commuter	360	$ 6,044	46.0	$ 2,780	$ 1,000,800
Daily commuter	480	6,044	18.9	1,142	548,160
Support (resident)	80 to 127	6,044	100.0	6,044	483,520 to 767,588
Relocated (resident)	360	6,044	100.0	6,044	2,175,840
Total	1,280 to 1,327	6,044	54.5 to 56.0	3,288 to 3,385	4,208,320 to 4,492,388

Retail sales data were not available for any local communities in Itasca County except Grand Rapids. Therefore, an analysis was conducted for only Grand Rapids and the 22 townships containing cities previously identified as potential impact areas. The following was assumed.

- Future resident sales in Grand Rapids will continue in proportion to its present share of County sales.
- Remaining retail sales dollars will be allocated on a per capita basis to the township areas outside Grand Rapids.
- Grand Rapids will capture 50% of local expenditures by daily commuters and weekend commuters living outside Grand Rapids.

TABLE V- 70
ESTIMATED INCREASE IN RETAIL BUSINESS DOLLAR VOLUMES

	Itasca County		Grand Rapids		Remaining Townships	
	Case A	Case B	Case A	Case B	Case A	Case B
Estimated 1975 base dollar volume ($000)	$87,216[a]	$87,216[a]	$58,856[b]	$58,856[b]	$16,449[c]	$16,449[c]
Projected employee expenditures ($000)	$ 3,031 to 3,315	$ 4,208 to 4,492	$ 1,592 to 1,725	$ 2,261 to 2,394	$ 1,439 to 1,590	$ 1,948 to 2,009
Projected total dollar volume ($000)	$90,247 to 90,531	$91,424 to 91,708	$60,448 to 60,591	$61,117 to 61,250	$17,888 to 18,039	$18,397 to 18,458
Percent increase	3.5 to 3.8	4.8 to 5.2	2.7 to 2.9	3.8 to 4.1	8.7 to 9.7	11.8 to 12.2

[a] ___, "Environmental Report Clay Boswell Steam Electric Station Unit No. 4," Minnesota Power & Light Company, New York, N.Y., 1976, Table III-H-31.

[b] Allocated based on percent of county sales in 1972.

[c] Non-Grand Rapids sales allocated on a per capita basis.

Based on these assumptions, retail expenditures were estimated for Grand Rapids and the 22 township area for Case A and Case B as shown in Tables V-71 and V-72. This analysis suggests that retail expenditures in the peak employment year will increase by $1.6 to $2.4 million in Grand Rapids and by $1.4 to $2.0 million in the remaining townships. This is an increase of 2.7 to 4.1% over the base dollar volume of $58.9 million in Grand Rapids as shown in Table V-70. It is an increase of 8.7 to 12.2% over the base dollar volume of $16.4 million in the townships outside Grand Rapids. Therefore, it is projected that there will be a significant impact on retail business dollar volumes in those communities (except Grand Rapids) within the 22 township area.

TABLE V-71
ESTIMATED RETAIL EXPENDITURES IN GRAND RAPIDS AND 22 TOWNSHIP IMPACT AREA - CASE A

Employee Type	Estimated Employment		Estimated Local Expenditures Per Employee	Retail Expenditures (thousands)		
	Grand Rapids	Other		Total	Grand Rapids	Remaining Townships
Weekend commuters	85	95	$ 2,780	$ 500	$ 368[a]	$ 132
Daily commuters	0	840	1,142	959	480[a]	479
Support	38 to 60	42 to 67	6,044	484 to 768	230 to 363	254 to 405
Resident	85	95	6,044	1,088	514	574
Total	208 to 230	1,072 to 1,097	2,368 to 2,498	3,031 to 3,315	1,592 to 1,725	1,439 to 1,590

[a] Grand Rapids resident employee expenditures plus 50% of other employee expenditures.

TABLE V-72
ESTIMATED RETAIL EXPENDITURES IN GRAND RAPIDS AND 22 TOWNSHIP IMPACT AREA - CASE B

Employee Type	Estimated Employment		Estimated Local Retail Expenditures Per Employee			
	Grand Rapids	Other		Total	Grand Rapids	22 Townships
Weekend commuters	165	191	$ 2,780	$ 1,001[a]	$ 735[a]	$ 266
Daily commuters	0	480	1,142	548	274[a]	274
Support	38 to 60	42 to 67	6,044	484 to 768	230 to 363	254 to 405
Resident	169	191	6,044	2,176	1,022	1,154
Total	376 to 398	904 to 929	3,288 to 3,385	4,209 to 4,493	2,611 to 2,394	1,948 to 2,099

[a] Grand Rapids resident employee expenditures plus 50% of the other employee expenditures.

Socio-Economic Impacts of Alternatives

No socio-economic impacts are expected to result from implementation of any of the reasonable alternatives to MP&L's proposed Unit 4.

LAND USE

Land Use Impacts of Proposed Action

Introduction

The analysis of land use impacts has been limited to traffic generation resulting from additional construction and operational employees at the Clay Boswell Station, the need to extend sewer and water service, and the changes in the amount of agricultural and forest land in Itasca County. Criteria were developed as a measure of the significance of these impacts.

Criteria

Three criteria were used to measure the impacts on land use resulting from the construction and operation of Clay Boswell Unit 4. These criteria are as follows.

- A significant impact will occur if traffic volumes cause the level of service "C" on State or Itasca County roads to be exceeded. Level of service is the term which denotes operating conditions which result from various traffic volumes. It is a function of speed, travel time, traffic interruptions, freedom to maneuver, driver comfort and safety. Six levels of service have been established, designated by the letters A through F. Level of Service "C" is a condition of stable flow, but speeds and maneuverability are more closely controlled by the higher volumes. Drivers are restricted in their freedom to select their own speed, change lanes, or pass. A freeway will accommodate 1,500 vehicles per lane per hour, and an intersection with traffic signals will accommodate 625 vehicles per lane per hour.

- A significant impact will occur if sewer and water systems must be extended beyond the boundaries of cities with public sewer and water systems.

- A significant impact will occur if the amount of agricultural or forest land in the County is reduced by 0.1% or more.

Traffic Impacts

Criteria. A significant impact will occur if traffic volumes cause the level of service "C" on State or County roads to be exceeded.

Assumptions. The following assumptions were made.

- The heaviest traffic volumes would occur during the peak construction month in the summer of 1979.

- The direction of traffic flow due to construction labor was based on the projected housing demand summarized in Table V-73.

- The critical area for traffic problems would occur between Grand Rapids and the Clay Boswell Station.

- o Automobile occupancy for those commuting daily was analyzed for 1, 2, and 3 persons per car. For persons living in the Clay Boswell vicinity, automobile occupancies of 1.0, 1.5, and 2.0 persons were also analyzed.

- o T.H. 2 is a four lane undivided highway with turn lanes from Grand Rapids to the Clay Boswell Station.

TABLE V-73
TEMPORARY CONSTRUCTION EMPLOYEE RESIDENTIAL LOCATIONS AND NUMBER OF VEHICLES COMMUTING TO CLAY BOSWELL STEAM ELECTRIC STATION

City	Relocate and Commute Weekly Temporary Employees		Commute Daily Temporary Employees		Vehicles					
					Case A			Case B		
	Case A	Case B	Case A	Case B	1[a]	2[b]	3[c]	1[a]	2[b]	3[c]
Bovey	20	38			10	14	20	19	26	38
Calumet	11	18			6	8	11	9	12	18
Cohasset[d]	13	21			7	9	13	11	14	21
Coleraine	25	42			13	17	25	21	28	42
Deer River	19	33			10	13	19	17	22	33
Grand Rapids	169	282	170	120	142	198	339	181	248	402
Keewatin	31	54			16	21	31	27	36	54
La Prairie	10	16			5	7	10	8	11	16
Marble	16	26			8	11	16	13	18	26
Nashwauk	31	52			16	21	31	26	35	52
Taconite	7	14			4	5	7	7	10	14
Warba	3	6			2	2	3	3	4	6
Zemple	2	3			1	2	2	2	2	3
Duluth			80	60	27	40	80	20	30	60
Iron Range	—	—	590	420	197	295	590	140	210	420
Total	360	600	840	600	464	663	1,200	504	706	1,200

a Assumes an auto occupancy of 3.0 for commute daily and 2.0 for commute weekly.
b Assumes an auto occupancy of 2.0 for commute daily and 1.5 for commute weekly.
c Assumes an auto occupancy of 1.0 for commute daily and 1.0 for commute weekly.
d Now included in Bass Brook Township.

It is estimated that 1,200 construction workers will be commuting to the Clay Boswell Station. The origins of these commuters and the number of vehicles are shown in Table V-73.

The present volume of traffic on T.H. 2, a four lane undivided highway in the vicinity of the community of Cohasset, is approximately 500 vehicles in the evening peak hour. The capacity of this section of roadway is approximately 6,600 vehicles. Level of service "C" represents a stable flow of traffic with a volume not exceeding 75% of capacity, or 4,950 vehicles for this section of roadway. The proposed action, assuming worst case, would add approximately 1,200 vehicles to the existing 500 vehicles in the evening peak hour for a total of 1,700 vehicles. With this added volume, an excess capacity of approximately 3,250 vehicles remain. Therefore, level of service "C" will not be exceeded.

The analysis of the 2 intersections of T.H. 2 and U.S. 169 found that they were operating above level of service "C" and would continue to do so when labor from the Clay Boswell Station is added to the traffic volumes. It is concluded that the impacts relating to traffic will not be significant.

Sewer and Water Systems

Criteria

- A significant impact will occur if sewer and water systems must be extended beyond the boundaries of cities which have public sewer and water systems.

Sewer and Water System Impacts. The present policy of the cities within the 22 township area is to extend sewer and water within the city limits to serve new development. It may be necessary for the city to borrow funds to finance sewer and water system construction. In most cases, the cost of this construction is then assessed against the developer or property owners to be serviced by the extension. Thus, the costs are shared by municipal government and users. At this time 10 of the 14 cities within the impact area have public sewer and water service.

There are 150 to 210 vacant lots within the 14 cities, including lots in mobile home parks. Approximately 100 lots will become available in Grand Rapids in the spring and summer of 1977. The estimate housing needs of the construction labor force range from 293 units for Case A to 488 units for Case B.

If 488 new single family units were constructed, 278 to 338 additional lots would be required. Assuming that each lot required one acre (.40 hectare) of land including additional street right-of-way, 278 to 338 acres would be required. Since there are 10,180 acres (4,120 hectares) of developed and undeveloped land within the incorporated area, it appears to be unnecessary to extend sewer and water beyond the incorporated areas. Given the criteria, the impact on sewer and water systems is assumed not to be of significance.

Agricultural and Forest Land

Criteria

- A significant impact will occur if the amount of agricultural or forest land in Itasca County is reduced by 0.1% or more.

Agricultural and Forest Land Impacts. The expansion of the Clay Boswell Station will require the acquisition of 2,813 acres (1,138 hectares) of land. Present land use is principally agriculture with 580 acres (235 hectares), pasture with 320 acres (129 hectares), and woodlands with 1,020 acres (413 hectares). The area to be acquired contains 38 dwellings of which 12 are farm dwellings.

The comparison of land use in the expansion area with the County total is presented in Table V-74. Forest or woodland acres acquired for the proposed action equal 0.06% of the forested land in the County. The 580 acres (235 hectares) of cultivated agricultural land represent 2.3% of the cultivated land in Itasca County. The pasture or open land to be acquired by MP&L represents 0.3% of the 102,920 acres (41,650 hectares) of this type land use in Itasca County. In addition, 12 farmsteads will be acquired. There were 519 farms in

Itasca County in 1969. Lands acquired by MP&L for the proposed action will reduce this number by 2.3%.

TABLE V-74
COMPARISON OF LAND USE
CLAY BOSWELL STEAM ELECTRIC STATION EXPANSION AREA
AND TOTAL ITASCA COUNTY LAND USE

Category of Land Use	Amount of Land of Proposed Site	Itasca County Total	Percent of Itasca County Total
Forest			
Wooded			
acres	1,020	1,518,120	0.06
hectares	413	614,361	
Agriculture			
Cultivated			
acres	580	24,920	2.3
hectares	235	10,085	
Open or pasture			
acres	320	102,920	0.3
hectares	129	41,650	

Based on the criteria established, the reduction in forested or wooded land is not a significant impact. The reduction of agricultural land is a significant impact.

Land Use Impacts of Alternatives

Waste Wood as Supplemental Fuel

To the extent that waste wood is used to generate electricity at the Clay Boswell Station and land area is not occupied by waste wood disposal on open land or in a landfill, positive land use impacts will result.

Coal Beneficiation

The alternative of coal beneficiation at the Big Sky Mine near Colstrip, Montana, will have no land use impacts in Minnesota. If coal rejects or waste can be disposed of with mining spoil, there should be no land use impacts at the Big Sky Mine.

Dry and Wet/Dry Cooling Towers

No additional land use impacts are expected to occur if dry or wet/dry cooling towers are substituted for MP&L's proposed Unit 4 wet cooling towers.

Disposal of Solid Waste in an Abandoned Mine

A significant land use impact has been projected because 2.3% of cultivated land in Itasca County will be removed from production due to land acquisitions by MP&L for the proposed action. To the extent that disposal of ash and SO_2 scrubber waste in an abandoned iron ore mine will result in a reduction or elimination of MP&L's new ash and SO_2 sludge pond, a positive land use impact will be possible if MP&L returns that 420 acres (170 hectares), or a portion of it, to agricultural production.

RECREATION

Recreation Impacts of Proposed Action

The major impact of the proposed action on recreation in northern Minnesota will be the result of an increased construction and operating force at the Clay Boswell Station and increased facilities use by the new workers and their families. Since the construction force will number approximately 1,200, while approximately 170 new operational employees will be required at the Clay Boswell Station, the temporary construction force will have a greater impact.

Two criteria were used to measure the impacts of the proposed action and alternatives on recreation. A significant impact can be expected to occur if regional recreational demand increases by 1% or more or if local demand increases by 5% or more. In addition, a significant impact will occur if increased industrial activity at the Clay Boswell Station is evident from adjacent public open space and recreational areas.

In addition to employment and population distribution assumptions described in the section on Socio-Economic Impacts, the following assumptions were made: Those recreational activities which are a day or less in duration would take place within the 22 township area due to proximity of the added population; and recreational activities that would require more than one day would take place in Region 2, Arrowhead Region 3, and Region 5.

Recreation Demand

Itasca County. The twenty two township area in southern Itasca County had a population of 27, 924 in 1975. The projected population that would relocate or commute weekends to this area in Case A (360) and Case B (750) represent a population increase of 1.3% and 2.7% respectively. Since these increases are below the 5% criteria and since it has been determined that there are no major recreation facility shortages in Itasca County, it is expected that the MP&L project will not cause detrimental impacts on recreation facilities in the area.

Region 2, Arrowhead Region 3, Region 5. To determine if the population added by the proposed action would increase demand for regional recreation facilities, the number of tourists now using these facilities had to be estimated for Regions 2, 3, and 5. This estimate was based on travel expense figures (lodging, food, entertainment, and gas) recorded by the Minnesota Department of Economic Development. In 1975 it was estimated that there were 6.7 million tourists in the State of Minnesota who spent a total of $1,106,000,000 (146), for an annual average expenditure of $165 per person. It is estimated that $219,418,000 was spent by tourists in Regions 2, 3, and 5 in 1974 (147). Tourist expenditures increased 9% in the State between 1974 and 1975. If a similar increase is added to 1974 regional tourist expenditures of $219,418,000, an estimated $239,166,000 was spent by tourists in Regions 2, 3, and 5 in 1975. Dividing this amount by $165, the assumed average annual amount spent by each tourist, it was determined that 1,449,000 "tourist trips" were made to Regions 2, 3, and 5 in 1975.

It was assumed that new MP&L workers and their families would use regional tourist facilities an average of 10 times per person due to their close proximity. The projected population increase of 360 under Case A would result in 3,600 additional visitor days. For the 750 population increase for Case B there would be 7,500 additional visitor days. These visits represent 0.2% and 0.5% respectively, of the total tourist trips for Regions 2, 3, and 5. Neither of these figures would represent a significant impact on regional tourism and recreational facility needs.

Visual Impacts

The visual impacts of the proposed action on recreational activities will vary considerably. Distance of the activity from the Clay Boswell Station is the greatest variable. Visual impacts tend to be greater for more stationary types of recreational activity, such as picnicking, camping, still fishing, and visiting resorts and vacation homes, because visibility is continuous. For mobile activities such as boating, pleasure riding, and trail use, the visual impacts would be less since views tend to be intermittent.

VIEW OF EXISTING UNITS 1, 2 AND 3 CLAY BOSWELL STEAM ELECTRIC STATION	FIGURE V-40

VIEW OF EXISTING UNITS 1, 2, AND 3 AND PROPOSED UNIT 4 CLAY BOSWELL STEAM ELECTRIC STATION	FIGURE V-41

For recreational areas over one or two miles away the main visual impact of proposed Unit 4 will be the visibility of the additional 600 ft (183 m)smoke stack on the horizon near the existing 700 ft (213 m) stack and the plume emitted by this stack. From some points the visual impact of the stack will be partially offset by the removal of one of the 400 ft (122 m) chimneys. The new boiler building will also be visible from some areas near the Clay Boswell Station.

The recreational area which will be affected most is the State-owned land around Blackwater Lake, especially the south shore. This area is not intensively used or developed, but is used for boating and fishing access and picnicking activities. Figure V-40 shows a view of the existing Clay Boswell Station from this area looking northward and Figure V-41 shows the same view with the proposed 600 ft (183 m) chimney superimposed and the 400 ft (122 m) chimney removed. Based on the criteria the impact of the proposed action will be significant.

Recreation Impacts of Alternatives

Waste Wood as Supplemental Fuel

No additional impacts on recreation are expected due to using waste wood as a supplemental fuel when compared to MP&L's proposed action.

Coal Beneficiation

The alternative of coal beneficiation at the Big Sky Mine near Colstrip, Montana, will not have any adverse recreational impacts in Minnesota. Thus, additional recreational impacts are not anticipated when this alternative is compared to MP&L's proposed action.

Dry and Wet/Dry Cooling Towers

Dry or wet/dry cooling towers could have beneficial visual impacts when compared to the visual impacts of MP&L's proposed wet cooling towers. Beneficial impacts could occur if the plume from dry or wet/dry cooling towers was less than the plume from the proposed wet cooling towers. For dry cooling towers, the tower plume will be eliminated and for wet/dry cooling towers, the plume will be greatly reduced.

Disposal of Solid Waste in an Abandoned Mine

No recreational impacts are expected due to disposal of the solid waste in an abandoned iron mine when this alternative is compared to MP&L's proposed action.

HISTORY AND ARCHAEOLOGY

Impacts

Construction of MP&L's proposed Unit 4 ash and SO_2 sludge disposal pond will destroy the Indian portage trail which runs across the northwestern corner of the Clay Boswell Station site. This trail is of minor historical significance. Construction of proposed Unit 4 and its associated facilities will have no visible impact on the ancient Indian habitation site at White Oak Point several miles up river from the Clay Boswell Station. The culturally significant resources at White Oak Point are buried underground, and will most likely be immune to air emissions from proposed Unit 4.

All the reasonable alternatives to MP&L's proposed action will affect construction at the Clay Boswell Station site. The alternatives for disposal of solid waste at an abandoned mine will require construction at the abandoned mine site. However, none of the reasonable alternatives appear to have significantly different history and archaeology impacts when compared with MP&L's proposed action.

AESTHETICS

Aesthetic Impacts of Proposed Action

Criteria

The following criteria were used to determine if MP&L's proposed action will produce significant aesthetic impacts.

- o There will be significant impacts if added industrial development is visible to the recreational traveler along Trunk Highway 2; and

- o There will be significant impacts if additional industrial development is visible from recreational areas such as the lakes in the region near the Clay Boswell Station.

Assumptions

MP&L's proposed expansion of the Clay Boswell Station will consist in part of additional buildings to house the generating equipment for Unit 4, cooling towers, a 600 ft (182.9 m) stack, and a new fly ash and SO_2 scrubber sludge disposal pond. When seen from any distance over one or two miles away, this size difference does not make a significant change in visual impact. The proposed expansion of the Clay Boswell Station will not make it more visible from greater distances, as none of the additional structures will be taller than the existing 700 ft (213.4 m) stack.

Figures V-42 through V-45 show the existing structure together with the proposed additions viewed from the 4 principal compass points. Figure V-42 shows a view from the west of the Station. The proposed generator building which is labeled 267 ft (81.9 m) in height, and all the structures to the left of it will be new. Obviously the most visible from any distance are the generator building, and the new 600 ft (182.9 m) stack. Other planned structures will include 2 cylindrical 160 ft (48.8 m) tall thickeners, cooling towers built in a structure 450 ft (137.2 m) long and 60 ft (18.3 m) tall, a 200 ft (61.0 m) tall absorber structure, an administration building, and a warehouse.

These structures are to be painted with graphics, except for the stack which will be natural concrete. The northernmost existing 400 ft (121.9 m) stack is to be torn down. Also there will be expansion of the existing switching yard and more high voltage power lines leaving the site. The plume from the Unit 4 stack is expected to extend up to 1,300 ft (396.2 m) in the summer, and in the winter, assuming stable conditions, the plume may extend 100 to 200 ft (30.5 to 61.0 m) higher. When there are prevailing northwest winds, the plume will extend many miles horizontally from the stack east of the Station. In winter, under overcast skies, the plume will not be as visible as on clear days. Plumes from the cooling tower may be greater in volume than the stack plume and may extend as high, but they are not as visible except in winter.

Aesthetic Impacts

The major travel route closest to the Clay Boswell Station, and therefore, of greatest concern, is U.S. Highway 2, which passes through the site vicinity and within approximately 0.75 miles (1.21 km) of the facilities buildings. Some of the structures at the Clay Boswell Station will be visible from more than 6 miles (9.6 km) along U.S. Highway 2 from Grand Rapids to the west.

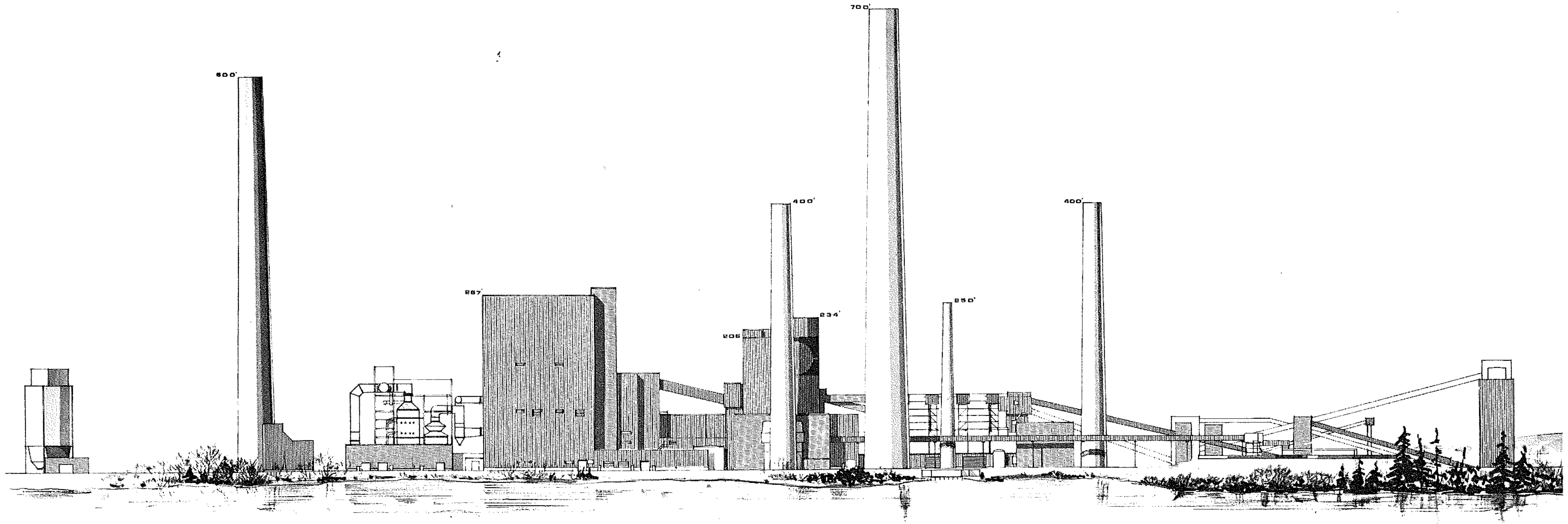
Figure V-46 shows a view of the Clay Boswell Station from U.S. Highway 2 at County Road 227 approximately one mile (1.6 km) away. Figure V-47 shows the same view with the proposed construction superimposed. The new generator building for Unit 4, and the new 600 ft (182.9 m) stack also will be visible from this point. It is assumed that travelers along this route will be moving at a speed of 40 to 60 mph (64 to 97 km per hr) and therefore, views of the added structures will be intermittent or of short duration.

The stack plume may be visible from as far away as 12 miles (19.3 km). The proposed fly ash and SO_2 scrubber sludge pond site along County Road 25 will be about 1,000 ft (305 m) from U. S. Highway 2, and is completely screened from the highway by woods.

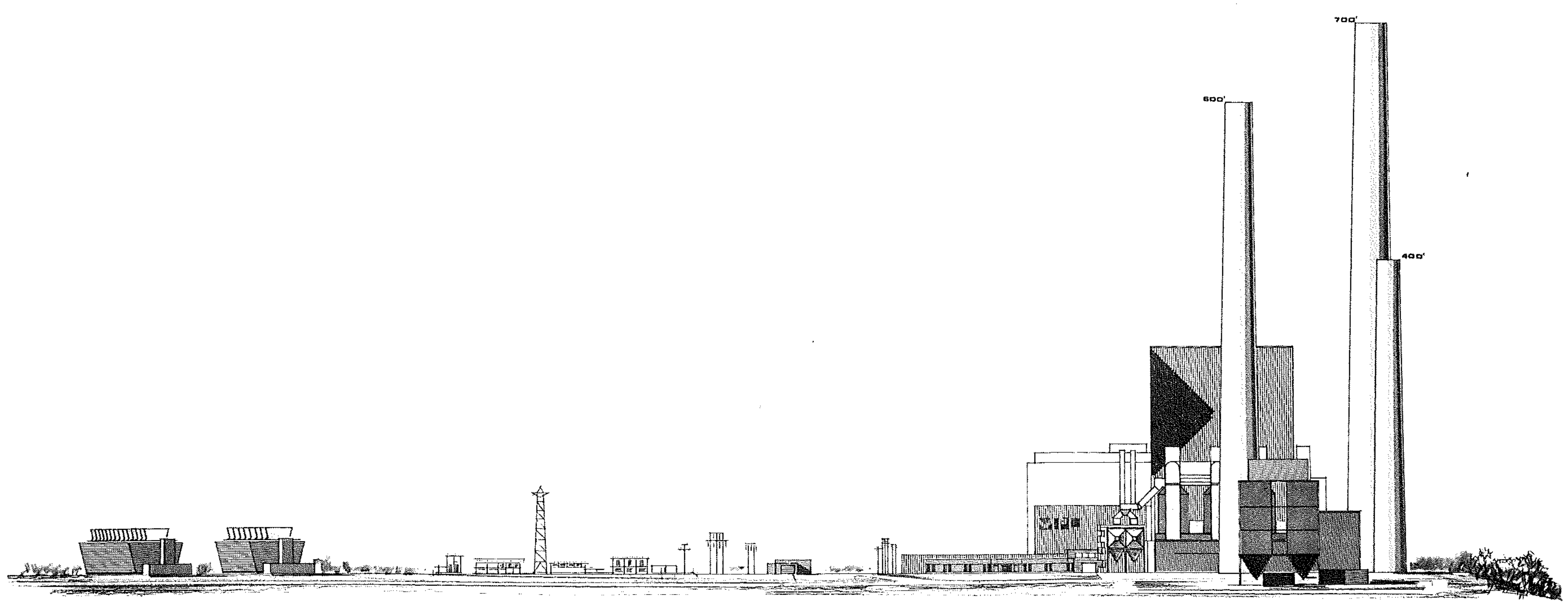
The majority of homes, seasonal cabins, and resorts from which the existing plant is visible will not be exposed to a significant increase in visual intrusion by the new structures. This is due to the fact that the most prominent feature is and will continue to be the 700 ft (213.4 m) stack. The aesthetic impact of the Unit 4 structures will be severe, but this impact will to some degree be lessened since Unit 4 will be an addition to an existing industrial development.

Aesthetic Impacts of Alternatives

All the reasonable alternatives to MP&L's proposed action are not expected to significantly increase the aesthetic impacts which will result from MP&L's proposed action. However, the alternative dry and wet/dry cooling towers will require larger cooling tower structures. For dry cooling towers, the tower plume will be eliminated and for wet/dry cooling towers, the plume will be reduced greatly.



VIEWED FROM THE WEST (FIGURE V-42)

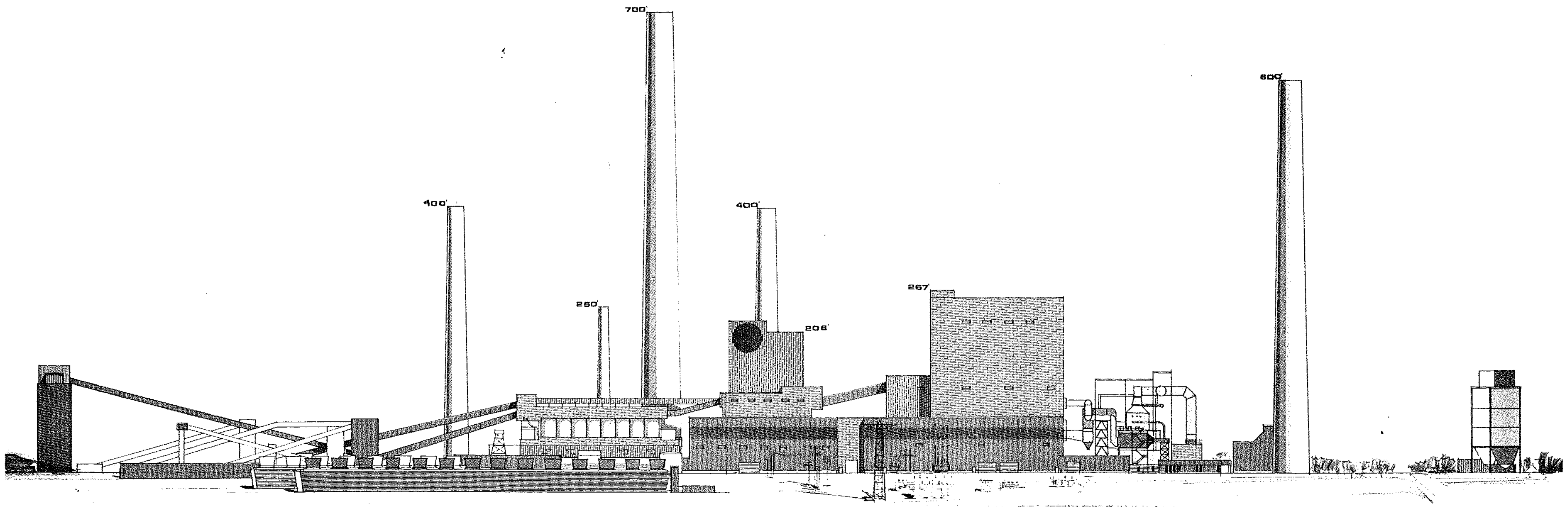


VIEWED FROM THE NORTH (FIGURE V-43)

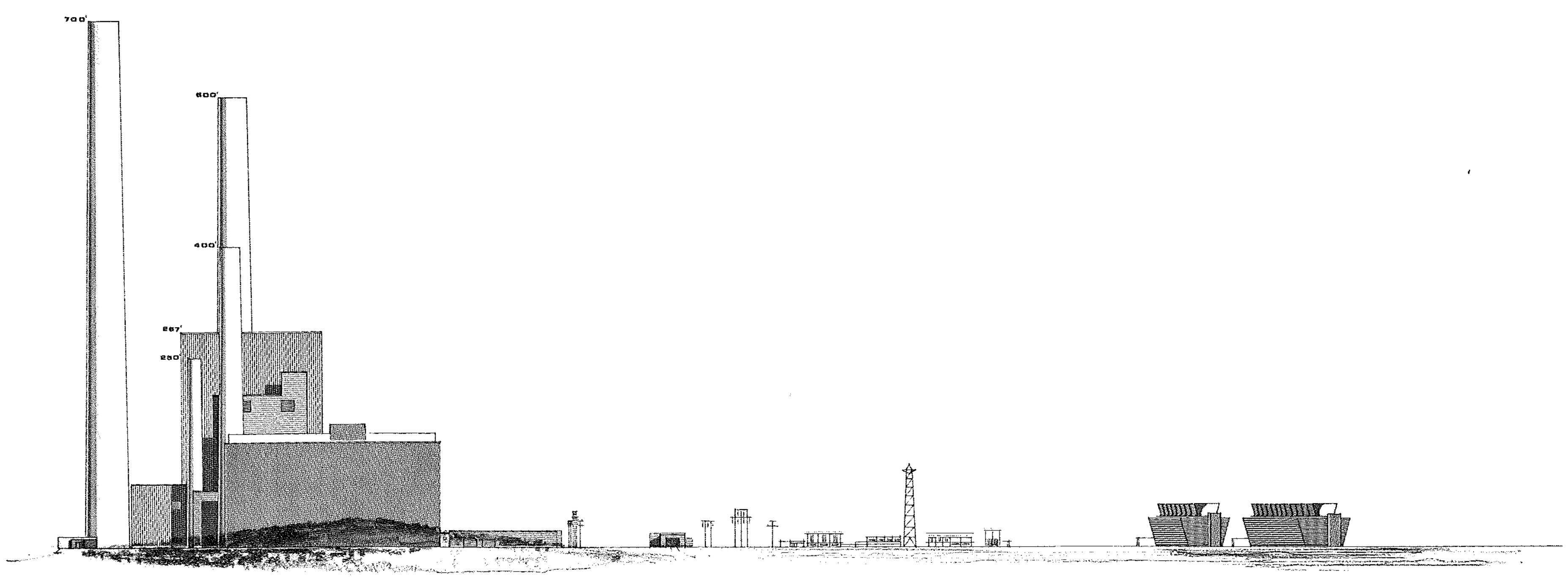
CLAY BOSWELL STEAM AND ELECTRIC STATION
UNITS 1, 2, AND 3, AND PROPOSED UNIT 4

SOURCE: MP&L

FIGURE V-42 AND FIGURE V-43



VIEWED FROM THE EAST (FIGURE V-44)

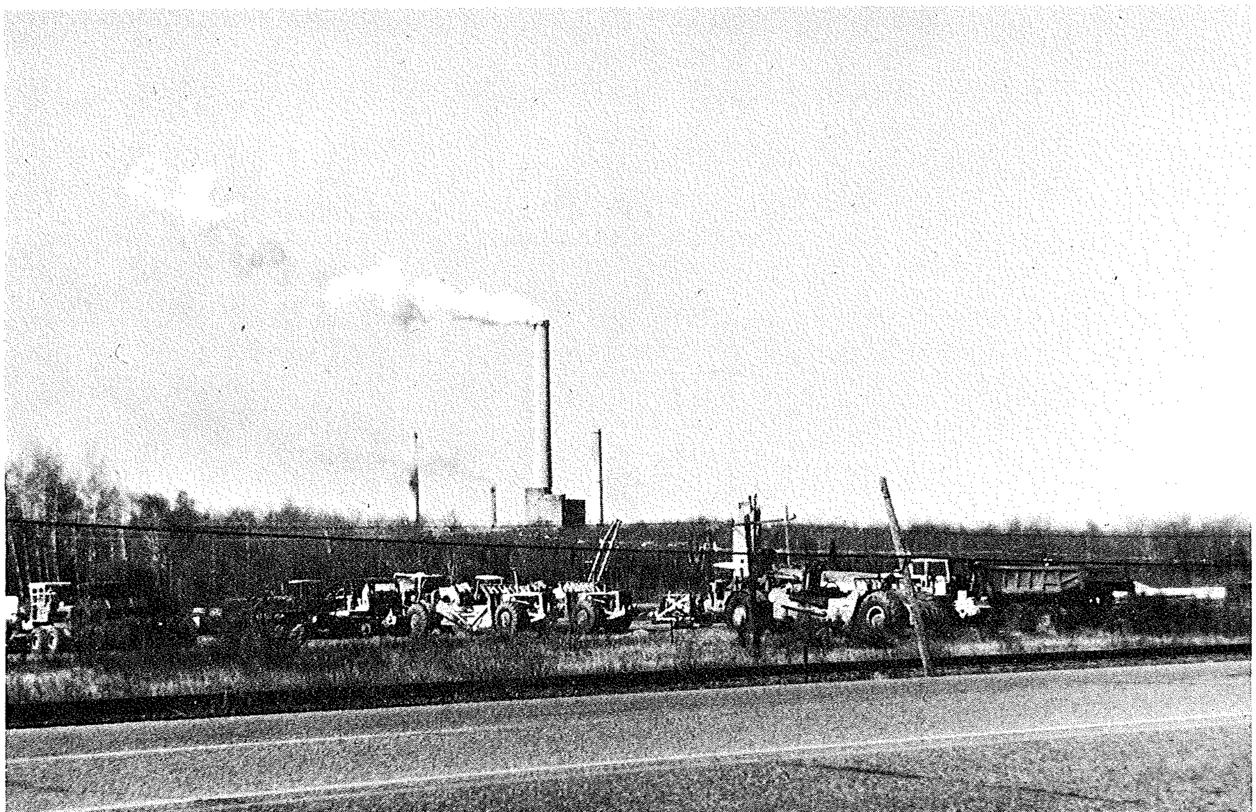


VIEWED FROM THE SOUTH (FIGURE V-45)

CLAY BOSWELL STEAM ELECTRIC STATION-
UNITS 1, 2, 3, AND PROPOSED UNIT 4

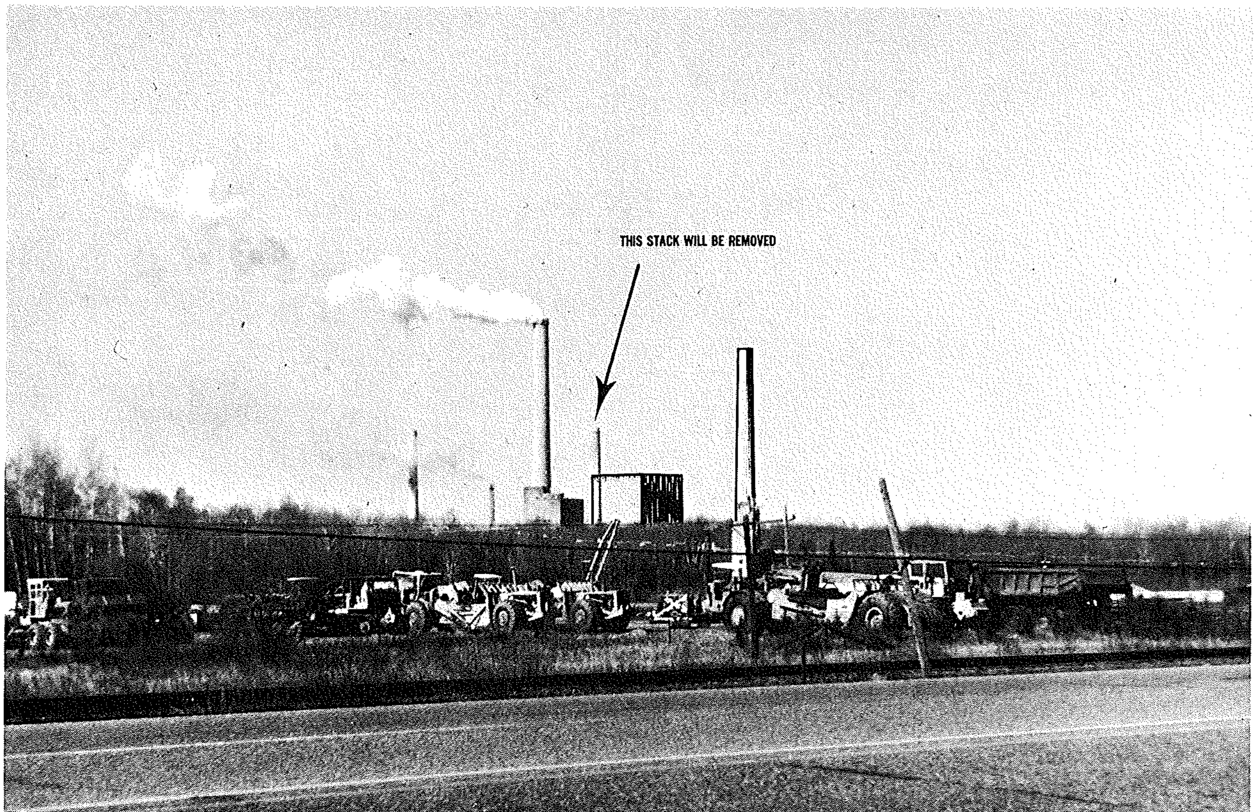
SOURCE: MP&L

FIGURE V-44 AND FIGURE V-45



VIEW OF EXISTING UNITS 1, 2, AND 3
CLAY BOSWELL STEAM ELECTRIC STATION

FIGURE V-46



VIEW OF EXISTING UNITS 1, 2, AND 3 AND PROPOSED UNIT 4 CLAY BOSWELL STEAM ELECTRIC STATION	FIGURE V-47

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CHAPTER VI

MEASURES TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS

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A mitigating measure is an action which could result in a reduction or elimination of environmental impacts associated with the construction and operation of MP&L's proposed Unit 4 at the Clay Boswell Steam Electric Station. Some measures have already been planned by MP&L for mitigating environmental impacts and are incorporated into the proposed action.

MITIGATING MEASURES FOR CONSTRUCTION IMPACTS

Erosion and Sediments

A potentially significant erosion problem could occur during the period of excavation, when bare earth is exposed to wind and rainfall. This problem can be minimized by reducing the length of time the soil will be exposed. Construction traffic on all cut-and-fill slopes can be restricted until a firm vegetative cover has been established.

Areas experiencing heavy construction traffic will require stabilization and protection. Construction roads and parking areas can be covered with a coarse base material and compacted. Other areas disturbed by construction can be shielded and/or stabilized to reduce erosion.

Appropriate methods, in addition to the use of a retention basin and diversion ditches, can be employed where possible to shield or allow stabilization of exposed soil. As each area reaches its final grade, the soil can be stabilized, covered, or seeded. The type of treatment used will depend upon the slope of the land, size of the area, and amount of construction activity.

The mitigative measures taken to ensure that rainfall runoff will contain minimal suspended solids can include strategic location of filtering networks such as straw bales and sod filters, which commonly are used on major construction sites. These filters can reduce suspended sediment concentrations by reducing runoff velocity and thereby allowing settling and entrapment of solids.

The mitigation measures taken to ensure that wind erosion does not substantially increase total suspended particulates can include watering exposed soils, treatment with chemical dust retardants, covering with straw or fiber mats, and covering with rock or coarse base material and compaction.

Dewatering operations could result in high-turbidity water. This water can be routed to the sedimentation basin before discharge to Blackwater Lake on the Mississippi River.

Petrochemical Wastes

Petrochemical waste discharges could result during construction activities from the use of oils, lubricants, paints, and other oil-based materials. The discharge of these wastes could result from construction equipment leaks and, from spillages in storage and maintenance areas during transfer operations. The quantities of such waste discharges can be minimized by restricting the equipment maintenance area, keeping equipment and construction vehicles in good operating condition, regularly inspecting equipment storage facilities, providing containment facilities at the construction site, and minimizing the amount of material on the site at any time. Waste sumps can be installed in storage and maintenance areas to contain spills and contaminated floor washwater. Secondary containment facilities are required for all above ground storage of petrochemicals.

Groundwater

Dike cutoffs - excavations designed to reduce ash and SO_2 sludge pond seepage to the near surface - can be used to minimize seepage. The cutoffs consist of trenches excavated to a suitable stratum of low permeability, such as clay or silt, then backfilled with an impervious material, usually bentonite.

Air Quality

Site preparation and plant construction activities may affect air quality in the immediate vicinity of the Clay Boswell Station. In accordance with Minnesota Pollution Control Agency (MPCA) Regulation APC 6, measures must be taken to prevent fugitive dust. Procedures for the control of such dust may include the following.

- Application of water or suitable chemicals to control dust from construction operations, dirt roads, and material stockpiles.

- Covering of vehicles in motion when transporting materials which are likely to become airborne.

- Prompt removal of earth or other material from paved streets when such material has been deposited by trucking, earthmoving equipment, or erosion.

The methods employed to control fugitive dust from coal handling in the operational phase will also serve to minimize dust emissions due to the initial stockpiling of coal in the preoperational phase. Prescribed procedures for the control of coal dust must be followed, including the installation of hoods, fans, and control equipment.

Socio-Economics

Housing

The adverse impacts associated with housing demand may be mitigated by providing temporary housing for the construction workers. The provision of a mobile home park, constructed and operated by MP&L, is one method to meet the temporary demand for housing. Such a mobile home park should be located to reduce other adverse impacts such as school overcrowding. The mobile home park will need to have both mobile homes to rent, and spaces available for those who have their own mobile homes. Such a park could also provide housing for the new permanent operating labor force either on a temporary basis until homes can be purchased or built, or on a permanent basis.

Criteria which should be followed in developing such a mobile home park are:

- The mobile home park should be located to mitigate other adverse impacts and not create new adverse impacts;
- Adequate sewer, water, and roadway systems must be available;
- The mobile home park must provide for the needs of the residents, including services such as laundry and recreation facilities; and
- Police and fire protection must be adequate, possibly requiring that existing services be improved or expanded to meet the additional demand.

A second approach to the housing shortage would be to construct an apartment complex within the area, which could be a profitable venture. By building it in the near future, a number of units could be occupied by the construction labor force for one or two years. MP&L may want to help finance such a project with the condition that a portion of the units be available for the construction labor force.

A third approach would be to have MP&L develop a housing search program. MP&L could contact owners of resort properties to develop a list of available rental units. This list could be supplied to construction workers to assist them in finding housing. Since resort properties are distributed widely throughout the 22 township area, the impacts on local government would be dispersed.

Schools

Secondary school enrollment will exceed capacity in the Grand Rapids School District 318 by from 68 to 112 students due to the construction labor force population increase. At present, school capacity is exceeded by 21 students. It is estimated that permanent operational employment at the Clay Boswell Station also will cause the present capacity to be exceeded by 71 students, making a permanent solution attractive.

Between 3 to 5 classrooms will be needed to accommodate the increased enrollment. This impact could be mitigated by an addition to existing school buildings.

Temporary classrooms could be constructed without adding permanent structures. However, the school district may want to enter into an Inter-District Agreement with one of the adjacent school districts, since reductions in school enrollment are projected for Itasca County. Such an agreement could take one of two forms. Students could be shifted to schools in other districts with excess capacity or the Grand Rapids School District could rent a vacant school building or portion of a building from one of the adjacent school districts. The Grand Rapids School District then would staff and maintain the building.

The addition of Unit 4 at the Clay Boswell Station will increase the revenues of School District 318 by approximately $587,000. This represents a 16% increase over 1975 school taxes collected by District 318. These added revenues could be used to help pay for added schoolroom space and teachers. The need for extra school capacity will precede the time when the full revenue will be available for the school district. This will occur because only the portion of the proposed Unit 4 constructed by January 1 of each year is taxed and because property tax collections are delayed one year. The school district may choose to either issue bonds to cover added costs or attempt to have MP&L prepay a portion of their school taxes before construction is complete so that funds will be available to meet the demand for classroom space.

Police Protection

Police service ratios will drop by more than 10% in Grand Rapids due to the construction labor force, dropping from 1.5 officers per thousand population to 1.2 or 1.3 officers per thousand population. There are a number of ways to mitigate this impact.

- Grand Rapids can expect to increase revenues by 20 to 24% over present revenues due to the Clay Boswell Station. These funds could be used for additional police if the funds become available within the time needed for these expenses.

- Itasca County will realize increased revenues through property taxes generated by the Clay Boswell Station. Staff could be added to the Sheriff's Department to assist the Grand Rapids Police Department.

- Itasca County could help to finance overtime pay for Grand Rapids Police Officers. Thus permanent staff which may not be needed in the future would not have to be hired.

- The use of volunteer auxiliary police on a temporary basis could assist in various duties which would reduce the work load on the permanent police staff.

MITIGATING MEASURES FOR OPERATIONAL IMPACTS

Primary Fuel Processing

Chemical Processing

Chemical processing involves the use of solvents or other chemicals to reduce contaminants contained in the coal to be burned, and has the potential to reduce the sulfur beyond that which could be achieved by water washing. Solvents react with the sulfur and serve to separate the sulfur from the coal. This is a relatively new technology and at present its reliability does not warrant evaluation for coal burned at the Clay Boswell Station.

Air Quality Control Systems

Variation of Stack Height

The stack height for MP&L's proposed Unit 4 could be increased to provide additional dispersion of air contaminants. However, this is not expected to significantly change the impacts unless the proposed stack is increased substantially in height. Even with a stack of much greater height, the impact reductions would be small. The proposed action includes a stack height of 600 ft (183 m), which is necessary for Unit 4 to comply with Prevention of Significant Air Deterioration (PSD) regulations (40 CFR 52.21). Assuming MP&L complies with PSD and ambient air quality standards, increased stack height will be unnecessary.

Fuel Additives

Chemicals could be added to the coal as it is burned to increase the combustion efficiency and/or collection efficiency for particulates and sulfur dioxide. This measure will not eliminate the need for collection systems such as the wet particulate scrubber and SO_2 absorber, nor is it expected to significantly improve collection efficiencies of the proposed air quality control system. Therefore, the use of fuel additives is judged to be unnecessary.

Stack Gas Reheat

Additional dispersion of air emissions could be obtained by increasing the reheat temperature of the stack gases. However benefits of this would have to be balanced with the cost of additional energy and coal consumption requirements. In addition, since the reheat system requires flue gas to by-pass the SO_2 absorber, the balance among the amount of flue gas by-passed, coal sulfur content, and SO_2 removal efficiency must be considered. As by-passed flue gas increases, additional SO_2 removal efficiency must be obtained from the SO_2 absorber to achieve the same level of air emissions. If MP&L demonstrates that the coal to be burned will allow full compliance with applicable air standards, additional reheat is judged to be unnecessary.

Use of a Single 700 foot (213 m) Stack for Units 1, 2, 3, and 4

The stack gases from all units could be routed to a single stack to increase plume rise and hence dispersion of pollutants. However, problems would arise during times when one or several units are not operating which would decrease the mass flow rate of gases leaving the stack. This would reduce the plume rise and consequently air dispersion and could cause increased air quality impacts. The proposed action of having a single stack for Unit 4 and a separate stack for Units 1, 2, and 3 is preferable, since the distance between Unit 4 and existing Units 1, 2, and 3 is great and breeching costs (ducting from the units to the stack) may be prohibitive.

Reinjection of the Fly Ash

Assuming dry collection, the amount of particulates in the system could be reduced by reinjecting fly ash back into the boiler or furnace from the ash collection facilities. The amount of the reduction, however, would be small since the composition of the fly ash is mainly oxidized silica, alumina, iron, and calcium, and the amount of material in the fly ash that could be oxidized further in the pulverized coal boiler is small. In addition, the present plant design incorporates a wet particulate scrubber rather than a dry collection system, which is required for reinjection. For these reasons, this measure is not considered to be a viable mitigating measure.

Solid Waste

Dry Disposal of Fly Ash

A reduction in the dissolved solids of the ash and SO_2 sludge pond recycle water and in the consumption of water which is lost through evaporation and entrapment in the scrubber sludge will be obtained by fly ash being collected and disposed in a dry condition. However, this will require a complete re-design of air quality control system (AQCS) and the flue gas ductwork. It will be necessary to find space for and insert a high-efficiency dust collection system between the boiler and the SO_2 scrubber system. Such dust collection equipment could be one of the following:

- A hot electrostatic precipitator ahead of the air preheaters;
- A cold electrostatic precipitator, with or without gas conditioning, after the air preheaters; and
- A bag house.

Any of the above will involve extensive engineering and additional capital cost with questionable benefits. Incorporation of both dust and SO_2 removal steps in the wet scrubbers simplifies the AQCS and enables the use of the alkaline constituents in the fly ash to supplement and reduce the required quantity of lime or limestone. Furthermore, a dry fly ash system will add complications in necessitating the provision of a hyrdraulic system for transporting the fly ash, silos for storage, equipment for wetting and mixing the dry ash, trucks or other hauling equipment, and a disposal area for the ash.

Commercial Utilization of Solid Waste as Gypsum

Studies have indicated the possible use of SO_2 sludge as a building material, such as gypsum. The primary components of the sludge to be produced by MP&L's proposed air quality control system (AQCS) are calcium sulfate, calcium sulfite, calcium carbonate, and fly ash. The Unit 4 sludge is estimated to contain 10% gypsum (calcium sulfate) and 72% fly ash. Utilization of a sludge of this type as a building material has not been demonstrated. The only successful use of relatively small quantities of sludge has involved a material containing 90% gypsum and negligible quantities of fly ash. It would be possible to produce a gypsum product, but this would require redesign of the AQCS to incorporate separate collection of fly ash and scrubber sludge, with the addition of an oxidation step in the scrubber to force oxidation of the sulfite to sulfate.

Tests at other utility installations indicate a gypsum by-product usually exhibits better dewatering and handling properties than a mixed sulfite-sulfate sludge and can be disposed of dry, rather than wet. Gypsum, however, is more soluble than calcium sulfite, and may, therefore, produce a leachate higher in dissolved solids than sludge anticipated from the MP&L's proposed AQCS. If a gypsum product were produced, it is unlikely that all the quantity produced would or could be used commercially. Small quantities of gypsum wall board have been manufactured in the United States on a demonstration basis utilizing scrubber gypsum and there has been an expression of interest by some wallboard manufacturers in utilizing scrubber gypsum as a substitute for natural gypsum. However, no operations presently exist in the United States for making wallboard or other gypsum products based on scrubber sludges.

Impermeable Linings

As part of the proposed action, it is proposed to construct an impermeable liner of natural clay material which covers the bottom and is keyed into the dikes of the new ash and SO_2 sludge disposal pond. Such a barrier will retain the pond water and dissolved solids in the disposal pond and minimize leachate.

The subsurface investigation indicates that there is sufficient quantity of natural clay on site to construct a continuous liner of sufficient thickness to insure minimal seepage. The subsurface investigation also indicates that the geology of the site is quite complex and the clay layer is not naturally continuous. Particular caution must, therefore, be exercised in the construction of the clay liner to insure its integrity.

There has been some concern that natural clay liners are subject to chemical attack with subsequent deterioration and failure over time by leachate in contact with the liner. This concern has not been verified and is currently under investigation by EPA.

An artificial liner made of rubber, asphalt, or other materials could be utilized to prevent seepage of ash pond water. An artificial liner will be more costly, but no more effective than an impermeable liner constructed of natural on-site materials.

Dry Disposal of Scrubber Sludge and Scrubber Sludge Fixation

Dry disposal of scrubber sludge in a landfill or stockpile would be advantageous in reducing the quantity of leachate potentially generated from wet disposal in a sludge pond and in facilitating reclamation of the sludge disposal site. Dry disposal of scrubber sludge will be impractical without dry fly ash being available for admixing and reducing the moisture content. One or more stages of dewatering could be employed to reduce the moisture content of the sludge, but dry fly ash will still be required to accomplish dry disposal.

In lieu of the addition of fly ash, chemical fixation will be possible after dewatering. Chemical fixation, as presently applied in the utility industry, is the addition of lime or other similar lime-bearing materials (and in some cases, dry fly ash), to the dewatered sludge to produce a structurally stable material which can be disposed of dry and in an environmentally acceptable manner. The final product may have properties varying from a soil-like consistency to a weak concrete material, depending on the process used and other variables. When properly placed, compacted, and cured, the material has very low permeability and reduces the quantity of atmospheric moisture percolating through the sludge disposal area.

There may be sufficient alkalinity present in the fly ash collected with the SO_2 for the sludge to partially stabilize by itself. However, some experimental work will be necessary before this conclusion can be verified.

There are two firms offering commercially viable fixation processes: IU Conversion Systems (IUCS) and Dravo Corporation. Both IUCS and Dravo Corporation are providing fixation of scrubber sludge at full-scale utility installations elsewhere in the United States. The IUCS process requires the addition of dry fly ash along with lime to accomplish fixation. Unless MP&L's proposed air quality control system (AQCS) is changed to include collection of dry fly ash, Dravo Corporation will be the only firm capable of providing commercial fixation.

Employing fixation of the scrubber sludge using Dravo's process will require pH adjustment of the sludge to about pH 11 through the addition of from 5 to 10% fixation additive. This will result in a 5 to 10% increase in dry solids and a somewhat greater increase in volume of solids for ultimate disposal. Fixation also will increase the cost and complexity of sludge disposal through the addition of additive unloading, storage, mixing facilities, and related equipment, and perhaps, sludge mixing, storage, transfer, and disposal facilities.

Scrubber Sludge Disposal with Fly Ash

MP&L's proposed action provides for disposal of the combined fly ash/sulfur-oxide sludge after removal by the air quality control system (AQCS). To obtain a landfill material from the sludge, it will be necessary to remove the fly ash by some method prior to scrubbing, then combining it with dewatered sludge. Excessive costs will be involved in both the engineering effort and in the purchase and installation of equipment. No particular benefit by this disposal method is evident.

Disposal Area Reclamation

MP&L's proposed action does not include a plan for reclamation of the new ash and SO_2 sludge pond. If left unrelcaimed, the pond may eventually revegetate through natural processes. However, this is not certain. Also, it is unlikely that the scrubber solids will dewater and consolidate sufficiently under their own weight to safely support man-made structures.

Limited reclamation could be accomplished by covering the filled ash and sludge pond with a suitable depth of topsoil and revegetating the surface. Conceivably, the pond might be suitable for farming or silviculture. However, the pond will not be suitable for building construction unless special foundation construction measures are utilized. Nearly complete reclamation could be accomplished if fixation were employed or the ash and sludge were disposed of dry.

Water Management Systems

Maximum Utilization of Water Recycle

Recycling of plant wastewater discharges as makeup water to other plant water systems offers the advantages of decreased makeup water requirements and discharge volumes at the plant. MP&L's proposed action includes recylcing of bottom and fly ash transport water to comply with Federal New Source Performance Standards. However, there are other potential areas for water reuse at the Clay Boswell Station beyond regulatory requirements. For example, boiler blowdown is relatively high quality water and, after neutralization, could be used as makeup to several plant water systems, including ash transport systems, cooling towers, or the demineralizers. Cooling tower blowdown or central waste treatment facility effluent, with or without additional treatment, may be used as makeup to the SO_2 absorber system. These effluents also could be used as makeup to the ash transport system if additional capacity for internal softening of transport water is included. Assuming acceptable water chemistry control, there are definite advantages of additional recylce over the proposed action, especially the possible reduction of intake and discharge quantities.

Sanitary Waste Treatment

MP&L's proposed action includes a sewage treatment plant for handling the sanitary waste from the existing and proposed units. The sewage treatment plant will discharge to the proposed central waste treatment facility. There are other types of systems which could be used for sewage treatment such as septic tanks, oxidation ponds, physical/chemical treatment, activated sludge, and trickling filters. None of these other systems would offer any overall, cost-effective environmental advantages over the selected system; however it is possible that the sewage effluent could be discharged to the ash ponds instead of the central wastewater treatment facility. Benefits of this are considered to be insignificant. Technology exists to treat sanitary waste to reduce organics and nutrients to low levels or to eliminate the wastewater discharge.

Cooling Water Treatment

Due to the toxicity of chlorine residuals to aquatic biota, the following options to MP&L's proposed use of chlorine as a biocide have been considered.

Ozone and Ultraviolet Light

There are several types of potential cooling water treatments other than MP&L's proposed use of chlorine. Ozone and ultraviolet are possibilities. They would be used similarly to the present chlorine although, they have not been used to the extent that chlorine has been used. Also, it is possible that although alternate cooling water treatments are implemented, chlorine may still have to be used in certain circumstances to treat cooling tower water.

Biocides Other Than Chlorine

There are two types of biocides commonly used to control microbes or bio-fouling organisms which can inhibit heat transfer in cooling systems. These are oxidizing and non-oxidizing (reducing) biocides. Oxidizing biocides are chlorine based compounds such as chlorine, hypochlorites, and organo-chlorine compounds.

Non-oxidizing biocides are frequently used to supplement chlorine or other oxidizing biocides to reduce chlorine usage, to compensate for the deficiencies of chlorine performance, and to improve blowdown quality by eliminating toxic chloro-hydrocarbons which may be formed in the circulating water. Non-oxidizing biocides are often used in controlling fungus attack of lumber in wood cooling towers, where chlorine is not effective. There are a great variety of non-oxidizing biocides, such as organo-sulfur compounds, chlorinated phenols, cationic biocides, and organo-metallic compounds. Often a combination of several of these non-oxidizing biocides can be used in a treatment program which, along with timely use of chlorine, offers a very high level of microbe control.

The use of non-oxidizing biocides could offer the possibility of complete replacement of chlorine use. Methylene-Bis-Thiocyanate, an organo sulfur compound, has been successfully used to completely replace chlorine. However, as biological control problems are highly site-specific, no accurate prediction can be made before operation as to the extent to which chlorine might be replaced.

Chlorine Reducing Agents

Chlorine in cooling tower blowdown can be reduced by using chlorine reducing agents. Sulfur dioxide, sodium bisulfite, and sodium sulfite are chemicals used in dechlorination which react with available chlorine in oxidation-reduction reactions to form inert chlorides.

Dechlorination is a method normally used in controlling chlorine in discharges that have been chlorinated to very high levels (superchlorinated). Since residual chlorine levels above 1 ppm are damaging to wood cooling tower fill, superchlorination is not appropriate at the Clay Boswell Station.

Dechlorination of the blowdown is more appropriate for continuous chlorination systems than for intermittant systems. Certain chlorine levels are maintained throughout the circulating water system for continuous systems. Thus, it may be necessary to reduce chlorine in the blowdown to acceptable levels before discharge. In intermittant closed cylce chlorination systems, the blowdown valve is closed while chlorine is injected for shock treatment. The chlorine then decays due to natural reducing agents in the water, microorganisms, and aeration in the towers. The blowdown valve is reopened when chlorine levels have decayed to acceptable levels for discharge.

Cooling Tower Design for Chlorine Control

Cooling tower design can affect the quantity of chlorine required to control biological growth in the towers. When the mechanical cleaning system is used to clean the condenser, the chlorine requirement for algae control at the condenser is substantially or totally eliminated. The cooling towers then become the critical item for biological control.

Factors which affect the amount of biological growth in the towers are: type and number of microorganisms in the water and air; cooling tower operating mode; climate and season of the year; nutrients available for algal growth; amount of exposure to sunlight; and type of tower fill material. Rough cooling tower surfaces (wood and cement asbestos) are most susceptible to algal growth, thus requiring more chlorine than other types of fill. Wood is also subject to fungus attack, which is not controlled by chlorine, but by non-oxidizing biocides. Plastic (polypropylene and poly vinylchloride) and ceramic tower fills have smooth surfaces, are less susceptible to algal growth and are not subject to fungus attack. The structural members of plastic and wood cooling towers are usually constructed from wood which could require protection from fungus attack. This is usually achieved by pressure pretreatment of the wood with preservatives. Sunlight, particularly indirect sunlight, cannot be totally eliminated from cooling towers, however, certain tower designs include totally enclosed walls which cut down on direct sunlight, and black internal surfaces which minimize indirect light. Covering the water distribution basin is another means to cut down direct light.

Cooling tower operation affects biological growth for a number of reasons. Cycles of concentration (blowdown rate) directly affect the number of organisms and nutrients in the water. The amount of heat load, which depends on the generating unit load, and the design Delta-T tower, indirectly affect biological growth through temperature changes.

The elimination of the use of chlorine in the cooling tower water may result in increased algal growth and reduce tower efficiency. Also, fouling of the condenser can result from algae which sloughs off the cooling tower into the circulating cooling water. The use of chlorine will be reduced and may possibly be eliminated by a cooling tower design which minimizes sunlight and the use of wood as a construction material in combination with a mechanical condenser cleaning system.

Mechanical Condenser Cleaning Systems

Mechanical condenser cleaning systems which utilize small sponge or abrasive balls or brushes to scour the inside of condenser tubes can be used to remove, and to prevent the buildup of, slime and scale which can cause reduced heat transfer efficiency in the condenser. These systems have high initial costs, but may provide an overall better condenser slime control than chlorine and also provide the extra benefit of some scale control.

General Wastewater Treatment

All of the wastewaters from the Clay Boswell Station will be routed to the central waste treatment facility, with the exception of cooling system discharges. The processes at the central waste treatment facility include mixing/neutralization, chemical precipitation, clarification, and primary oil separation. These are described in detail in Chapter II. Other wastewater treatment units at the Clay Boswell Station, aside from ash and SO_2 sludge ponds, include a primary oil separator on the floor drain discharge line and chemical softening of the recirculating bottom ash transport water. This system represents the Best Practicable Control Technology Currently Available (BPCTCA) and has been designed to produce an effluent which will comply with applicable effluent and water quality regulations. Other unit processes in addition to those proposed by MP&L could be substituted or used to obtain a cleaner effluent. The benefits derived, however, do not appear commensurate with the additional expenditure in view of the objective of regulatory compliance. The following are alternate processes.

Equalization

A large holding basin with a mixer can be used to smooth the variability of flow and constituents of industrial wastewaters. This is a particularly important step when a biological treatment unit follows to protect against shock loading. Since no biological units are planned at the central waste treatment facility, the benefits derived from equalization are not significant.

Dissolved Air Flotation

In this process, dissolved air is injected into the waste stream under pressure. The waste is subsequently discharged to an open basin where the dissolved air forms tiny bubbles which rise to the surface, causing fine suspended solids, emulsified oil, and other emulsified and colloided particles to float. This treatment process could be used on refinery wastes and other wastes which contain these pollutants. Most of the oil in the power plant wastes will be free oil and should be removed in the primary oil separator/clarifier. Consequently, dissolved air flotation is considered to be an inappropriate treatment step in this instance.

Biological Treatment

Activated sludge and trickling filters employ biological oxidation to destroy organic matter in wastewaters. These processes are applicable to sewage and other wastes with high biochemical oxygen demand (BOD). Since power plant wastes do not contain high BOD, biological treatment is not particularly applicable.

Tertiary Treatment

Tertiary treatment methods such as activated carbon adsorption or ozonation are used to further reduce pollutant levels in relatively clean treated effluents. Activated carbon adsorption involves the contacting of the wastewater with a bed of granular activated carbon for the removal of organic pollutants. The organic contaminants are adsorbed on the surface of the carbon. The spent activated carbon containing the contaminants is either disposed of or regenerated in a furnace for reuse.

Ozonation involves the oxidation of organic pollutants and other oxidizable materials into their elemental constituents by ozone. The required ozone is generated at the treatment facility in an ozone generator. A benefit of ozonation is its strong disinfectant capability. The high expense of ozonation is the main drawback to its use.

Tertiary treatment could be considered at the Clay Boswell Station if the effluent did not comply with applicable effluent or water quality standards due to organic contaminant loading. Since this will not occur, tertiary treatment is not required.

Ion Exchange, Reverse Osmosis, and Distillation

Ion exchange is a physical treatment process in which the waste is passed through a column of resinous material for removal of dissolved minerals. Undesirable cations or anions in the waste are collected by the resins. The resins are regenerated by passing a chemical solution through, the units resulting in a strong waste effluent. Suspended solids, oil, and grease of the influent must be kept at low levels to achieve proper operation. The units require careful supervision by a trained operator due to their complex nature.

In reverse osmosis, pressure is applied to the waste to overcome osmotic pressure, and to force the water through a semi-permeable membrane. Dissolved solids thereby are separated from the waste in this filtration-like process. The units with their ancillary equipment and piping are expensive, and often have maintenance problems. Pretreatment of the influent is required due to the sensitivity of the membrane to undissolved substances.

In distillation or evaporation, the waste is heated to create water vapor, which is condensed to produce pure water. When used for treating wastewater, operational difficulties due to scaling and fouling often occur. Large amounts of energy are required to operate the unit.

Ion exchange, reverse osmosis, and distillation are all forms of demineralization, and are used only when a very pure effluent is required. Ion exchange units are presently used at the Clay Boswell Station to produce boiler feedwater. These units could be used as a final treatment step on wastewater at the Clay Boswell Station if recylcing of effluents into high purity, deminerlaized water was economically beneficial. This situation would occur only if a satisfactory ground water supply was not available for the plant.

Wastewater Sludge Treatment

Several methods of sludge dewatering and disposal are available for wastewater sludges. Dewatering processes include mechanical dewatering in presses, filters, or centrifuges; gravity thickening; biological digestion; and sludge drying beds. These processes reduce the volume of sludge to facilitate handling and disposal. Ultimate disposal methods available include landfilling and incineration.

Sludge dewatering operations can vary from very expensive filters, presses, or digestors to relatively inexpensive methods such as drying beds. However, the simplest and most economical method for disposal is sludge lagooning when sufficient land is available. Since land is available for lagooning at the Clay Boswell Station, this method is planned for proposed Unit 4.

Cooling System Blowdown

Clarification of Makeup

It is possible to provide certain types of treatment for makeup water to reduce the amount of cooling system blowdown water or increase the cycles or concentration in the cooling towers. This could include clarification, softening, and/or filtration of the makeup water. All of these could result in much higher cycles of concentration in the cooling towers, thus reducing the amount of blowdown from the cooling tower system. Assuming a blowdown reduction of approximately 25 to 75% of that presently proposed, the overall makeup requirements to the cooling tower would be reduced 5 to 15%. Use of these pretreatment schemes would cause increased wastes, increased energy consumption, and increased cost. The benefits of pretreatment are considered to be small and, therefore, serious consideration of this mitigating measure is not warranted at this time.

Evaporation Pond

An evaporation pond could be used to eliminate the discharge of cooling system blowdown water to the environment, with the blowdown water directed to the pond and allowed to evaporate. However, the atmospheric conditions at the site are such that this measure would not be viable.

Evaporation

The blowdown water from the cooling tower system could be processed through evaporation schemes. Blowdown water could be purified by the addition of thermal energy, evaporating the water and leaving behind the impurities. This measure is considered to be unwarranted due to the energy requirements and high costs.

Neutralization

The cooling tower blowdown could be neutralized by the addition of appropriate chemicals. However, the pH of the blowdown is not significantly different from that of the ambient water, and there is no need for additional chemical treatment.

Distillation

The process of distillation would be similar to that used for evaporation. Water would be separated from impurities by the application of thermal energy to the cooling tower blowdown. As with the evaporation process, this scheme increases energy requirements and solid waste volume. The benefits derived from this measure do not justify the increased expenditures.

Reverse Osmosis

Reverse osmosis could achieve separation of impurities from the cooling tower blowdown water by the use of a separation medium such as a selective membrane. This arrangement would increase energy consumption, maintenance and solid waste disposal requirements, and costs. Overall reverse osmosis is not considered to be beneficial.

Socio-Economics

Housing

The potential residential location of new operational employees was based on the residential location of the present operating personnel at the Clay Boswell Station. Based on this projection, the populations of the community of Cohasset and the City of Deer River will increase more than 5%. This demand alone does not create an adverse impact, but if local services are not available, adverse impacts could result. Mitigation of these impacts may be accomplished by local government officials determining what services and facilities will be required to meet the needs of the new population. Since the proposed Unit 4 is scheduled to begin operation in 1980, a decision could be made in advance to expand or improve local services and facilities.

Schools

Permanent operational employment at the Clay Boswell Station is estimated to cause secondary school enrollment in School District 318 to be exceeded by 71 students. This is within the range of the increase projected during construction. Thus, permanent solution to the problem of increased school population during both construction and operation seem appropriate.

Land Use

The analysis of land use impacts found that the proposed action will reduce the amount of agricultural land in Itasca County by more than 0.1% and will reduce the amount of cultivated land in Itasca County by 2.3%. The 12 farmsteads to be acquired represent 2.3% of the farms that existed in the County in 1969.

Mitigation of these impacts may be accomplished by returning a segment of the land purchased by MP&L for the proposed action to agricultural uses. While 2,800 acres (1,133 hectares) of land were purchased for the proposed action, not all of this land will be used for proposed Unit 4 and its ancillary facilities. The area designated for fly ash and SO_2 slurry ponds and the borrow area is presently crop, pasture, and open land, and will not be suitable for agricultural uses in the future. Agricultural land acquired, but which will not be used for the proposed Unit 4 or its ancillary facilities could continue in agricultural use, which would lessen the adverse impacts on Itasca County agricultural production.

Recreation and Aesthetics

MP&L's Clay Boswell Station is visible from the area along the south bank of the Mississippi River, which is used for access to the river and for various recreational activities by the public. The Station also is visible to travelers driving west from and east to Grand Rapids. The addition of proposed Unit 4 will increase the visibility of the Clay Boswell Station. The visibility of the Station may be reduced by painting the buildings in natural tones and/or planting trees between the buildings and the shore of the Mississippi River. This will not hide the Clay Boswell Station facilities, but will interrupt the continuous view.

CHAPTER VII

SHORT-TERM USES OF THE ENVIRONMENT VERSUS LONG-TERM PRODUCTIVITY

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MP&L proposes to construct Unit 4 at the Clay Boswell Station to meet rising energy demands in their service area. These rising energy demands are due primarily to the expansion of the taconite mining industry, and to a lesser extent the expansion of the wood products industry. Expansion of these industries, facilitated by an available energy supply, will in turn bring both the problems and benefits of economic growth - providing new jobs and stimulating the general economy of the area, while creating new demands for more energy.

DEFINITION OF SHORT-TERM AND LONG-TERM

Short-term refers to the construction period, estimated to be 46 months, and the operating life of the Clay Boswell Station Unit 4, which MP&L estimates to be 35 years. Long-term refers to the time after the 35 year period.

THE TRADE-OFF

The short-term and long-term benefits to the natural environment of the construction and operation of proposed Unit 4, if there are any, are minimal. There will be no long-term productivity benefits, since energy production will end when Unit 4 ceases operation. The only clearly defined benefits associated with construction and operation of proposed Unit 4 are short-term economic benefits which are related to the expansion of the taconite mining industry. In the short-term, proposed Unit 4 will provide energy for economic growth in the MP&L service area. The question of long-term economic benefits rests on whether this growth can be sustained beyond the 35 year lifetime of Unit 4. The future of the taconite industry depends in large part on economics. At present, it is economically feasible to mine low-grade deposits of taconite iron ore which are near the surface. In the future, when these surface concentrations have been depleted, it may become economic to mine deeper deposits. This will be costly, and may consume more energy than present mining practices. However, continued high demand for iron ore probably will stimulate mining of these deeper ore deposits. If, after its 35 year lifetime, proposed Unit 4 at the Clay Boswell Station is used only to provide energy for peak loads and outages, then a new power source for the taconite industry will have to be found.

There are many potential adverse impacts which could occur during the short-term, or 35 year lifetime of MP&L's proposed Unit 4, with some impacts extending beyond the short-term. The major adverse and beneficial impacts which have been identified and will occur because of the construction and operation of MP&L's proposed Unit 4 are as follows.

- Coal consumption by the proposed Unit 4 is expected to average 1,867,239 tons (1,693,931 mt) annually. During the 35 year expected life, Unit 4 will consume an estimated 65,353,365 tons (59,287,566 mt) of coal.

- Coal transportation from the Big Sky Mine to the Clay Boswell Station will require 2.38 million gal (9.01 million liters) of diesel fuel annually. During the expected 35 year lifetime of Unit 4, coal transportation will consume an estimated 83.3 million gal (315 million liters) of diesel fuel.

- Construction of proposed Unit 4 will consume energy in the form of materials, supplies, operation of construction equipment, and transportation of personnel.

- Auxiliary electrical requirements for proposed Unit 4 will require 50 MW of electrical energy. Pollution control equipment will require 7.1 MW of this total.

- Transportation of new operating personnel will use approximately 55,250 gal (209,138 liters) annually of gasoline, or 1.9 million gal (7.2 million liters) during the expected 35 year lifetime of Unit 4.

- Construction of Unit 4 ash and SO_2 sludge ponds could result in a reduction of the water level in the lake on the Clay Boswell site, and a subsequent reduction in that lakes biotic population.

- Significant erosion and sedimentation resulting from surface water runoff may occur during the construction period due to clearing of and construction on 17% or 620 acres (250 hectares) of the Clay Boswell Station site.

- A reduction in the ground water table level could result from dewatering processes during construction.

- The maximum height dike section for the ash and SO_2 sludge pond may have marginal stability during and immediately after construction.

- A reduction in the ground water table level could result from the presence of impermeable structures such as buildings and parking lots, which will hinder recharge of the ground water table. This condition will exist during the entire life of the Unit 4 facilities, whether operational or not.

- Critical low flow of the Mississippi River in the Vicinity of the Clay Boswell Station could drop to 100 cfs (2.83 cu m per sec).

- Increased concentrations of lead, selenium, and cadmium will occur in the Mississippi River.

- Pollution of surface water may occur during the construction period from petrochemical and sanitary wastes.

- Discharge of cooling water and Station effluents via the discharge canal has a great potential for affecting the water quality of the Mississippi River.

- Operation of the Clay Boswell Station will increase background levels of sulfates, chlorides, and total hardness in the Mississippi River at the Clay Boswell Station, and downstream from the Station.

- Adverse impacts on ground water from the Unit 4 ash and SO_2 scrubber sludge pond may result from pond seepage.

- Entrainment of aquatic biota associated with the Clay Boswell Station water intake structures can occur during the Station's operation.

- Salt deposition from cooling tower operation will affect water bodies in the vicinity of the Clay Boswell Station. The impacts will be greater on lakes than on the Mississippi River.

- Air contamination from engine exhaust and small heating sources could occur during construction of the proposed Unit 4.

- During operation, the emissions of proposed Unit 4 are projected to contribute 2.0% of the annual geometric mean particulate PSD increment (Class II), 12.6% of the 24-hr maximum particulate PSD increment, 13.3% of the annual arithmetic mean SO_2 PSD increment, 66% of the 24-hr maximum SO_2 PSD increment, and 36% of the 3-hr maximum SO_2 increment. These contributions will effectively limit new construction of major air pollution sources in the Clay Boswell Station region.

- The ambient pollutant concentrations resulting from the combined operation of Units 1, 2, 3, and 4 will cause the 24-hr maximum and 3-hr maximum SO_2 Ambient Air Quality Standards (AAQS) to be exceeded by substantial amounts. This could cause significant adverse short-term health and environmental impacts.

- The emissions of the proposed Unit 4 and the combined operation of Units 1, 2, 3, and 4 are projected to cause ambient sulfate concentrations which have the potential to adversely affect human health.

- Acid rain may result from the atmospheric oxidation of SO_2 and NO_2 to form sulfuric, sulfurous, and nitric acids which lower the pH of rainfall. This would cause the greatest change in lakes in the Clay Boswell Station vicinity.

- Emission of trace elements from the burning of coal, and accumulation of those metals in the area surrounding the Clay Boswell Station may represent a serious potential impact. These trace elements could have adverse impacts on soils and water quality, which in turn would have an adverse effect on terrestrial and aquatic vegetation. Impacts on fish and wildlife could result from ingestion of these trace elements through the vegetative food chain. Based on current knowledge, it is unlikely that the accumulation of these elements in the amounts projected would significantly lessen the productivity of soils near the Clay Boswell Station. Based on current knowledge, it is unlikely that the accumulation of these elements in the amounts projected would significantly lessen the productivity of soils near the Clay Boswell Station. The long-term human and wildlife health risks associated with the trace element emissions are not known.

- NO_x emissions could potentially provide supplemental nitrogen which could be beneficial to terrestrial vegetation.

- SO_2 emissions could potentially provide supplemental sulfur. If there is a shortage of soil sulfur, this could be beneficial.

- Fugitive dust could occur from the operation of vehicles and equipment during construction.

- Fugitive dust will result from the stockpiling and handling of coal during the operation of the proposed Unit 4.

- Ground level fogging and icing will result from the operation of Unit 4 wet cooling towers.

- Visible plumes will result from cooling tower operation.

- The plume from the Unit 4 stack is expected to extend up to 1,300 ft (396 m) in the summer and 1,400 to 1,500 ft (426 to 457 m) in the winter. The plume from the wet cooling tower may be as high, but not as visible except in winter.

- During proper weather conditions, the plume will extend many miles horizontally from the Station.

- Noise regulations may be violated during construction from steam pipe blowout.

- Ash and SO_2 scrubber pond construction is expected to cause noise regulations to be exceeded during work days and during possible extended work periods.

- The noise impact of coal train unloading is unknown.

- The loss of hardwood forests and black spruce bog forests, with attendant loss of wildlife habitat, will occur.

- Appropriation of 2.3% of cultivated land in Itasca County will result from the proposed action.

- Plans for covering filled disposal ponds are undocumented. If they are not filled and revegetated, the area will remain barren and unsuitable for habitat or other use.

- A significant increase in housing demand will occur in the Clay Boswell Station area as a result of its construction and operation.

- Revenues will increase in Grand Rapids School District 318.

- An increase in school age population beyond facility capacity as a result of proposed Unit 4 construction force will occur.

- Revenues will increase in Bass Brook Township and Itasca County.

- Increased demand for public services such as police and fire protection will occur in Itasca County.

- Unemployment will decline in Itasca County.
- Business activity will increase by 3.5 to 5.2% during 1979 in Itasca County.

An Environmental Impact Statement is not a decision-making document, but presents the information on which to base decisions. The balancing of short-term and long-term benefits and losses, as well as beneficial and adverse impacts, must be done by the decision-makers.

CHAPTER VIII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

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The construction and operation of MP&L's proposed Unit 4 at the Clay Boswell Steam Electric Station will inevitably result in the irreversible and irretrievable commitment of resources. Fuels and other raw materials will be consumed during construction and operation of the proposed Unit 4. Several hundred acres of land will be converted to industrial use, causing destruction of vegetation and wildlife habitats. Water will be consumed for cooling and other purposes during operation. Financial resources will be committed for construction, and operating costs will be incurred during the life of Unit 4. Construction and operation will require substantial human resources.

Coal burned in the proposed Unit 4 steam generator for producing electrical energy will constitute a major irreversible and irretrievable commitment of resources. Based on an estimated capacity factor of 71.4%, the estimated Unit 4 coal consumption during the 35 year expected life is 65 million tons (59 million mt). Limestone will be consumed in the air quality control system to remove SO_2 from Unit 4 stack gas. Based on an average coal sulfur content of 1.03%, the limestone consumed during the 35 year expected life is 1,120,000 tons (1,016,947 mt). Transporting coal from the Big Sky Mine in Montana to the Clay Boswell Station will require diesel fuel. Diesel fuel consumption by unit trains is estimated to be 83.3 million gal (315 million liter) during the 35 year expected life of proposed Unit 4. Transportation by employees commuting to and from work at the Clay Boswell Station is estimated to consume 1.9 million gal (7.2 million liter) of gasoline during the expected life of the Station. Chlorine consumed in the circulating cooling water system to control biological fouling of the condenser cooling water system during the 35 year expected life of Unit 4 is estimated to be 1,340 tons (1,217 mt). These raw materials do not include construction fuels, materials, and supplies or operating materials and supplies except for lime and chlorine.

Materials used in construction of the proposed Unit 4 will include resources of galcial origin such as sand, gravel, lacustrine clay and silt. Peat, often found overlaying glacial deposits, is present in minor quanitities at the site of the proposed new ash and sludge disposal pond. This peat will remain in place, rendering it irretrievable for use in agriculture or the nursery industry. Although utilization of clay, sand, gravel, and silt represents an essential irretrievable commitment of resources, these materials commonly are available in the immediate vicinity of the Clay Boswell Station and throughout the region.

Certain man-made or processed resources used for construction of MP&L's proposed Unit 4 may not be recoverable, at least not in kind. Such resources include materials such as finished steel, aluminum, copper, zinc, plastics, lead, lumber, concrete, sand, and gravel. Most of the metals will be incorporated into machinery and buildings, while the concrete, sand, and gravel will be incorporated into building foundations, solid waste disposal ponds, parking lots, and other ancillary facilities. Eventually, when the Station is dismantled, there will be a certain amount of salvageable materials, especially the metals in the machinery and buildings for which there will be some recovery value. It is possible that these materials could be used "as is" for other facilities and structures at other sites.

Construction of MP&L's proposed Unit 4 will require about 620 acres (251 hectares) of land to be cleared. Of this land, approximately 310 acres (125 hectares) are crop land and approximately 175 acres (71 hectares) are a combination of nearly mature hardwood forest and black spruce bog forest. These stands are replaceable, but many years are necessary for their development. The remaining 135 acres (55 hectares) consist of other forested or open plant communities, and roads and residential areas. Restoration of the plant communities to their natural state will not be possible. Thus, clearing of this land, and the roads and residential areas will constitute an irretrievable commitment of resources. The land to be covered with ash and SO_2 sludge ponds may not be reclaimable for productive use because of the unstable state of the solid waste. Thus, the 507 acres (205 hectares) used for ash and SO_2 sludge ponds may constitute both an irreversible and irretrievable commitment of resources.

Air emissions from MP&L's proposed Unit 4 may cause irreversible damage to soils because of long term deposition and accumulation of trace elements. The increased levels of trace elements in the soils could lessen soil productivity, which could affect the quality of vegetation. Lower quality vegetation could affect wildlife and livestock, because of decreased vegetative productivity, lower nutrient levels in the vegetation, or hazardous levels of trace elements in the vegetation. Irreversible changes also could occur in the vegetation ecotypes, but these cannot be fully identified. A Summer 1977 Field Study is in progress and potential impacts will be evaluated.

The wet cooling towers proposed by MP&L for Unit 4 will have a consumptive water use of approximately 4,075 gpm (15,425 lmp). This water will be consumed through evaporation, wind drift, seepage, and similar losses and the makeup water will be obtained from the Mississippi River. During the 35 year expected life of Unit 4, water consumption will total approximately 230,055 acre ft (283,768 million cu m). The water consumed will not be removed from the global environment, but will be retained in the total hydrologic cycle. The principal cause of water consumption by the proposed wet cooling towers will be evaporation into the atomsphere. Thus, most of the water consumed by the proposed Unit 4 wet cooling towers will not constitute an irreversible and irretrievable commitment of resources as related to the global hydrologic cycle. However, the water consumed will be lost as it relates to the water resources in the vicinity of the Clay Boswell Station. Thus, the water consumed will constitute an irreversible and irretrievable commitment of resources for the region.

Construction of the Clay Boswell Station will commit financial resources of approximately $400 million. During the 35 year expected life of the Station, MP&L will incur substantial operating costs. Recovery of invested capital and operating costs will be through service charges for electrical energy consumed by customers in the MP&L service area.

About 1,200 construction workers will be employed at the Clay Boswell Station during the peak construction period for MP&L's proposed Unit 4. The number of construction workers employed at the Station will gradually increase to a maximum during the 32nd month of construction and then will gradually decline until construction is completed. Construction will expend an estimated 30,740 person-months of labor, or 2,562 person-years of labor over the 46 month construction period. During operation of the proposed Unit 4, MP&L will employ an additional 170 persons at the Clay Boswell Station. During the 35 year life of Unit 4, labor expended for operations is estimated to be 5,950 person-years.

An undetermined amount of labor has been and will continue to be expended by public and private employees as well as private citizens. This labor will be involved with the issuance of a certificate of site compatibility, certificate of need, environmental impact statement, issuance of permits, and evaluation of limited work authorizations for MP&L's proposed Unit 4 at the Clay Boswell Steam Electric Station.

CHAPTER IX

THE IMPACT ON STATE GOVERNMENT OF ANY FEDERAL CONTROLS ASSOCIATED WITH THE PROPOSED ACTION

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Minnesota and Federal laws and regulations relating to MP&L's proposed Unit 4 at the Clay Boswell Steam Electric Station interact in many areas. However, there does not appear to be any significant areas of conflict between the two sets of laws and regulations.

FEDERAL VERSUS MINNESOTA ENVIRONMENTAL IMPACT STATEMENT

The two Federal agencies most directly involved with the proposed Unit 4 are the Army Corps of Engineers (COE) and the Environmental Protection Agency (EPA). Large steam electric generating stations are generally affected by two programs of the Army COE, the first relating to construction of water intake structures and resultant alterations in the channel characteristics of navigable waters, and the second relating to appropriation and consumption (i.e. net appropriation) of water from navigable waters. Since the proposed Unit 4 will utilize the existing intake structure of Units 1, 2, and 3, no new construction permit is needed from the Army COE. The consumption of water by the Clay Boswell Station will increase dramatically if the Unit 4 uses wet cooling towers as proposed by MP&L. This increase in consumption may require a major review of the water management policies used by the Army COE in maintaining proper levels in the Leech Lake and Lake Winnibigoshish upper Mississippi reservoirs. The Minnesota DNR also is involved in the management of these waters. It is not yet clear if these possible policy changes will require a Federal EIS.

The EPA has determined that their involvement in the proposed Unit 4 does not involve major Federal actions (1). Therefore, the EPA will not draft a Federal EIS for MP&L's proposed Unit 4.

EFFECTS OF FEDERAL AIR, WATER, AND NOISE POLLUTION LAWS AND REGULATIONS UPON COMPARABLE MINNESOTA LAWS AND REGULATIONS

The Federal authority over air, water, and noise pollution derives primarily from the commerce clause of the U.S. Constitution (2). In theory, this power is limited to activities affecting commerce among the states. In practice, however, the power touches nearly every aspect of the U.S. economy, including the externalities of environmental contaminants (3). The Federal authority over air, water, and noise pollution is not, however, plenary. Minnesota's authority to regulate air, water, and noise pollution derives from the Minnesota Constitution and from the powers reserved to all states by Amendment X of the U.S. Constitution.

Air Quality Laws and Regulations

As noted in Chapter I, the EPA's authority over air pollution generally takes the form of approval and supervisory control. The EPA ambient air quality standards (AAQS) and emission regulations set maximum levels which are to be met nation-wide within certain time limits. The states retain the authority to establish regulations more restrictive, but they cannot cause the relaxation of the Federal regulations.

The initial efforts of the EPA under the Clean Air Act Amendments of 1970 (4) were directed toward establishment of the AAQS. Many regions of the country, and more specifically St. Louis County, are not yet in compliance with the AAQS. In Minnesota the AAQS and most other air pollution control programs are implemented and enforced by the MPCA. Therefore, noncompliance is a problem primarily to be corrected by MPCA action. For example, the EPA has had no direct involvement in the formulation of the Air Quality Stipulation Agreement (5) between the MPCA and MP&L to reduce the particulate and acid mist emissions of Units 1, 2, and 3 at the Clay Boswell Station. In severe cases of air pollution where state control schemes are ineffective, the EPA can assume direct control, place the major emitters on compliance schedules, and monitor the progress. This has not been done in Minnesota.

The program for the regulation of emissions from new stationary sources, such as the proposed Unit 4, was implemented pursuant to the Clean Air Act in order to bring air pollution within the concentrations established by the AAQS. The EPA has promulgated emission regulations (New Source Performance Standards or NSPS) for 19 categories of stationary sources. The MPCA has adopted most of these verbatim, including the one for large steam electric generating stations. Consequently, the NSPS which apply to the proposed Unit 4 will be enforced by the MPCA and will require no Federal involvement. The same is true for the regulation of emissions containing acutely toxic or hazardous emissions. However, there are no hazardous emission standards, Federal or State, which apply to the Clay Boswell Station.

As the result of a recent law suit, the EPA is now required to insure that air which is currently less polluted than the levels established by the AAQS remains at that "pristine" level of purity. This Prevention of Significant Deterioration (PSD) program has not been adopted by or delegated to the MPCA. Rather, the EPA still directly administers the program. The PSD regulations create the requirement that MP&L submit information to the EPA from which the EPA can determine whether the proposed Unit 4 will significantly deteriorate the air quality in the vicinity of the Clay Boswell Station. Based on the information, the EPA will grant or deny the PSD permit for the proposed Unit 4. This EPA action is not of the magnitude which requires a Federal EIS, but under the current PSD regulations construction cannot begin on the proposed Unit 4 until MP&L has been granted the PSD permit. The final EPA decision on the PSD permit is expected in June, 1977. The denial of this permit would supercede any approval granted by the MPCA or other Minnesota agencies.

Water Quality Laws and Regulations

Minnesota agencies have had water pollution control powers over a longer period of time than have Federal agencies. The Federal Water Pollution Control Act of 1972 (FWPCA) (6) has, however, established a uniform, nation-wide scheme within which the MPCA programs now operate. Once again, the MPCA administers the program while the EPA retains approval and supervisory control.

The FWPCA established a 1983 goal of swimmable and fishable waters and a 1985 goal of zero discharge. The MPCA has encoded these ambiguous goals into water quality standards which limit the concentrations or ranges of various compounds or characteristics (refer to Chapters I and IV). The EPA has little involvement in this program, except to review MPCA water quality inventory reports (7) and other indications of progress toward the FWPCA goals.

The principal mechanism used to achieve the water quality goals is to reduce the discharge of pollutants by new and existing point sources. This program, called the National Pollutant Discharge Elimination System (NPDES), is administered in Minnesota by the MPCA. The program establishes the requirement of an NPDES permit for every major source of polluted effluents. The NPDES permits are issued by the MPCA, with the EPA retaining a veto authority over each permit. The NPDES permit for the Clay Boswell Station will expire in 1979 (8). The effluents of the proposed Unit 4 will be taken into consideration when MP&L applies for renewal of the NPDES permit. The EPA will probably have little involvement in the issuance of this NPDES permit for the proposed Unit 4.

Noise Control Laws and Regulations

Noise emitted by stationary sources is a transient phenomenon which seldom causes interstate problems. Consequently, the Federal government's role in controlling noise is limited to noise emissions from transportation-related sources and from new products moved through interstate commerce (refer to Chapter I). Therefore, the MPCA has the only substantial authority over noise emitted by the Clay Boswell Station.

REFERENCES

1. Adamkus, V.V., Deputy Regional Administrator, Region V, U.S. Environmental Protection Agency, Chicago, Personal communication to Peter L. Gove, Executive Director, Minnesota Pollution Control Agency, November 8, 1976.

2. U.S. Constitution, Article I, §8, Clause 3.

3. Soper, P., "The Constitutional Framework of Environmental Law," Federal Environmental Law, Dolgin, E.L, and T.G.P. Guilbert eds., West Publishing, St. Paul, Minnesota, 1974, pp. 20-122.

4. Clean Air Act Amendments of 1970, Public Law No. 91-604, 84 Stat. 1676, 42 U.S. Code §§1857 et. seq. (1970).

5. _____, "In the Matter of Minnesota Power & Light Company, Clay Boswell Steam Electric Generating Station, Cohasset, Minnesota, Air Quality Stipulation Agreement," June 25, 1976, Minnesota Pollution Control Agency.

6. Federal Water Pollution Control Act, Public Law No. 92-500, 86 Stat. 816, 33 U.S. Code §§1251 et. seq. (1972).

7. e.g., _____, "1976 Minnesota Water Quality Inventory, Report to Congress Under FWPCA § 305(b)," April 1976, Minnesota Pollution Control Agency, Division of Water Quality.

8. _____, "Authorization to Discharge and Construct Wastewater Treatment Facilities under the National Pollutant Discharge Elimination System and State Disposal System Permit Program," Permit No. MN 0001007 granted by the Minnesota Pollution Control Agency to the Minnesota Power & Light Company, November 18, 1975.

CHAPTER X

THE MULTI-STATE RESPONSIBILITIES ASSOCIATED WITH THE PROPOSED ACTION

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THE MULTI-STATE RESPONSIBILITIES ASSOCIATED WITH THE PROPOSED ACTION

Because the Clay Boswell Station lies well within Minnesota borders, there are no formal multi-state responsibilities associated with the proposed action. There are, however, many multi-state implications.

The coal to be used by proposed Unit 4 will come from the Big Sky Mine near Colstrip, Montana. It will be transported by unit train from the Big Sky Mine near Colstrip, Montana to the Clay Boswell Station via the State of North Dakota.

The air pollutant emission of the Clay Boswell Station may be transported beyond Minnesota's boundaries under certain weather conditions. The magnitude and effect of this incremental increase in air pollution in adjacent regions cannot be calculated, but the multi-state impact of the proposed Unit 4 and other steam electric generating stations currently planned or under construction will be significant.

MP&L's proposed action of using mechanical draft cooling towers will increase the water consumption of the Clay Boswell Station, reducing the Mississippi River's flow. This reduction will be negligible as the Mississippi River leaves the State. The addition of the proposed Unit 4 to the Clay Boswell Station will result in the discharge of additional effluents into the River. The construction of many power plants along the Mississippi River will consume river water and discharge effluents. The cumulative impacts of these power plants will be significant.

Construction of proposed Unit 4 will have benefits beyond the State through the purchase of machinery and construction materials.

The proposed action has national implications by providing energy to the taconite mining industry which, in turn, provides a major share of the ore for United States steel production.

CHAPTER XI

ORGANIZATIONS AND PERSONS CONSULTED

CHAPTER XI
ORGANIZATIONS AND PERSONS CONSULTED

STATE GOVERNMENT

Minnesota Legislature

Senate

Former Senator Norbert Arnold, District 3, Pengilly

Senator Winston W. Borden, District 13, Brainerd

Senator Florian Chmielewski, District 14, Sturgeon Lake

Senator Neil Dieterich, District 62, St. Paul

Former Senator Ralph R. Doty, District 8, Duluth

Former Senator A. J. Perpich, District 6, Eveleth

Senator George F. Perpich, District 4, Chisholm

Senator Sam Solon, District 7, Duluth

Senator Gerald Willet, District 4, Park Rapids

Senator James Ulland, District 8B, Duluth

House of Representatives

Representative Joseph R. Begich, District 6A, Eveleth

Representative Roy Carlson, District 14A, Pine City

Former Representative Gary Doty, District 8A, Duluth

Representative Peter X. Fugina, District 5A, Virginia

Representative Mike Jaros, District 7B, Duluth

Former Representative Marvin Ketola, District 14B, Cloquet

Representative Willard Munger, District 7A, Duluth

Representative Norman Prahl, District 3B, St. Paul

Representative Glen Sherwood, District 4B, Pine River

Former Representative Howard E. Smith, District 13B, Crosby

Representative John J. Spanish, District 5B, Hibbing

STATE GOVERNMENT

Minnesota Legislature

Legislative Staff

Jacquelyn M. Burke, Administrative Assistant
House of Representatives Committee on Environment and Natural Resources

Dennis Ferche, Senate Research

Gary Johnson, Senate Counsel

Governor's Office

Rudy Perpich, Governor

Andrew Kozak, Special Assistant to former Governor Wendell Anderson

Hank Helgen, Aide to former Governor Anderson

Ronnie Brooks, Special Assistant to Governor Rudy Perpich

Minnesota Environmental Quality Board

Citizen Members

Wesley Ohman, Chairperson
Alice Keller, Vice Chairperson
Mel Bessemer
Barbara Lukerman
Richard Magnuson
Allan E. Mulligan
Loren Rutter
Gwen Schwartz
Frank Snowden
Bernard E. Youngquist

Minnesota Department of Agriculture

Jon Wefald, Commissioner
Rollin M. Dennistoun
Randall Young

Minnesota Department of Economic Development

Lee A. Van, Commissioner

STATE GOVERNMENT

Minnesota Department of Health

Warren Lawson, Commissioner
Robert S. Banks
Ed Ross
Charles Settle

Minnesota Department of Natural Resources

Robert Herbst, Former Commissioner
Michael O'Donnell, Acting Commissioner
Milton Stenlund, Regional Administrator
William Berg
Joselyn Blair
Jan Chichester
Avonell Hagen
Robert Jessen
Milton Krona
Anthony Pascale
James Ruhl
LeRoy Rutske
Bonnie Skelton
James Tarbell
Roy J. Tarbell
Albert Wald
Kenneth Wald

Minnesota Department of Public Service

Lawrence Anderson, Director

Minnesota Department of Transportation

James Harrington, Director
Frank Marzitelli, Former Highway Commissioner
Kathy Briscoe
Dennis Brott
Darryl Durgen
Lyle Hanson
Terry Hoffman
Robert Linel
Kermit McRae
Richard L. Thiesen
Michael Weiss

Minnesota Energy Agency

John Millhone, Director
Karen Cole

STATE GOVERNMENT

Minnesota Geological Survey

Matt Walton, Director

Minnesota Land Management System

James Menter

Minnesota State Planning Agency

Peter Vanderpoel, Director
Charles Hawkins, Permit Coordinator, EQB
John Hynes, Power Plant Siting
Donald Kannas
Charles Kenow
W. J. Kortesmaki
Nancy Onkka
Kenneth Pekorek
Jock Robertson
Thomas Rulland
Joseph Sizer
Mary Sullivan

Minnesota Regional Development Commission

Region	
1	Ervin Strandquist, Chairman Eugene Abbott, Executive Director Stanley Wieber Vernon Scott
2	Al Monico, Chairman Richard A. Pearson, Executive Director
3	Jerry Jubie, Chairman Rudy Esala, Executive Director Les Darling Dr. Gary Glass
4	Leslie Aukes, Chairman John Sem, Executive Director Robert Moe
5	Mary Koep, Chairman Robert F. Benner, Executive Director Raymond LaVoie Sylvester Schmith

STATE GOVERNMENT

Minnesota Regional Development Commission (continued)

Region	
6E	Ernie Bullert, Chairman Eugene Hippe, Executive Director Wayne Thompson
6W	John Thompson, Chairman Dennis Dahlem, Executive Director Bob Pulford
7E	William Jokela, Chairman John Hill, Executive Director Larry Wheeler
7W	Ralph Thompson, Chairperson Otto Schmid, Executive Director Paul McAlpine
8	F.A. "Jim" Miller, Chairman Mark Atchison, Executive Director Martin Byers
9	Terence Stone, Chairman Dean Doyscher, Executive Director
10	John Linbo, Chairman Rolf Middleton, Executive Director Harold Moe
11 (Metropolitan Council)	John E. Boland, Chairman

LOCAL GOVERNMENT

Counties

Aitkin County

District	
1	Michael Zilverberg, County Commissioner
2	Donald Davies, County Commissioner
3	Eugene Wayrynen, County Commissioner
4	Kenneth Geving, Chairman, County Commissioner

LOCAL GOVERNMENT

Counties

Aitkin County (Continued)

District

5 Jacob Norberg, County Commissioner

Michael Johnson, County Planning and Zoning Administrator

Anoka County

Michael O'Bannon, County Commissioner

Benton County

Al Zeppelt, County Commissioner

Carlton County

District

1 Rita Balisus, County Commissioner

2 Wayne Prucell, County Commissioner

3 Paul Nordman, County Commissioner

4 Ralph Hammitt, County Commissioner

5 Kenneth Brown, Chairman, County Commissioner

Albert Anderson, Planning and Zoning Administrator

Cass County

District

1 Clarence Howe, County Commissioner

2 Raymond Ackerson, County Commissioner

3 Glenn W. Witham Jr., County Commissioner

4 Mahlon P. Swentkifske, County Commissioner

5 Virgil E. Foster, County Commissioner

Mrs. Carol Newstrand, Planning and Zoning Administrator

LOCAL GOVERNMENT

Counties

Clay County

Robert J. Roberts, Planning Director

Isanti County

Roderick Ericson, County Commissioner

Itasca County

District

1 Walter Brink, Chairman, County Commissioner

2 Malcolm Campbell, County Commissioner

3 George Predovich, County Commissioner

4 Alfred Madsen, County Commissioner

5 George Orlovich, County Commissioner

James MacKenzie, County Planning and Zoning Office

William Powers, Chairman, Itasca County Environmental Council

James Sullivan, County Planning and Zoning Administrator

William Marshall, County Land Commissioner

LeSueur County

Henry Simon, County Commissioner

McLeod County

Lawrence Fiecke, County Commissioner

Meeker County

Norman Olson, County Commissioner

Mille Lacs County

Jake Koppendrayer, County Commissioner

Sherburne County

John Nord, County Commissioner

LOCAL GOVERNMENT

Counties (continued)

Stearns County

Robert Gambrino, County Commissioner

St. Louis County

District

1 Floyd Anderson, County Commissioner

2 Deidre Dodhe, County Commissioner

3 Clifford Donaghy, County Commissioner

4 Alvin S. Hall, County Commissioner

5 Lloyd Shannon, County Commissioner

6 Edwin A. Hoff, County Commissioner

7 Fred Barrett, County Commissioner

William Boynton, Planning and Zoning Administrator

Towns and Townships

Arrowhead Township

Karen L. Bober, Clerk

Aurora

Carl Glavan, Mayor

Babbitt

Richard Mahal, Mayor

Bass Brook Township

Ted Tinquist, Township Board Chairman
Robert Fieldsend, Board Member
Dorothy Schumaker, Board Member
Donavan Wendt, Board Member

Becker

Harold Cox, Sr., Mayor

Towns and Townships (continued)

Bigfork

James McGarry, Former Mayor

Biwabik

Robert Woods, Mayor

Bovey

Loren A. Solberg, Mayor

Brookston

Leon Swendson, Former Mayor

Buhl

Lawrence Haglund, Former Mayor

Calument

James A. Ross, Former Mayor

Carlton

Francis Roy, Former Mayor

Chisholm

Lawrence Belluzza, Former Mayor

Cohasset (Now part of Bass Brook Township)

Diana Skelly, Mayor

Cloquet

Floyd D. Jaros, Former Mayor

Coleraine

Vincent Nyberg, Mayor

Cook

Marvin Chase, Former Mayor

Towns and Townships (continued)

Cromwell

Aate Parviainen, Mayor

Culver Township

Carolyn Belin, Township Clerk

Deer River

Thomsa Giles, Mayor

Duluth

Robert C. Beaudin, Mayor

Effie

Waldo Dahlberg, Mayor

Elk River

Clifford Lundberg, Mayor

Ely

Dr. J.P. Grahek, Mayor

Eveleth

Clement A. Cossalter, Mayor

Floodwood

Donald Rautio, Former Mayor
Otto Westenfield, Former Mayor

Franklin

Ben Gruendemann, Former Mayor

Frazee

Cloyd Jacobs, Mayor

Gilbert

Ben Verbick, Former Mayor

Towns and Townships (continued)

Grand Rapids

Robert Horn, Mayor

Hibbing

Kenneth R. Lund, Former Mayor

Hill City

Ronald Christensen, Mayor

Hoyt Lakes

Harry Helmer, Former Mayor

Iron Junction

Frank Klabechek, Mayor

Keewatin

Leslie Hartmann, Former Mayor

Kelsey Township

Helen Schindler, Township Clerk

Kinney

Mary Anderson, Mayor

La Prairie

Edwin A. Bruns, Mayor

Lavell Township

Martha Hill, Township Clerk

Leonidas

Edward J. Hoglund, Mayor

Marble

Lyle F. Hachey, Mayor

Towns and Townships (continued)

McKinley

Frank J. Siskar, Mayor

Meadowlands

Eino Mattson, Mayor

Monticello

Conrad O. Johnson, Mayor

Monticello Township

M. Goetzke, Township Clerk

Nashwauk

William Brown, Mayor

Orr

Arvid Kaukala, Former Mayor

Proctor

Leon W. McDermott, Mayor

Remer

Vernon Chenvert, Former Mayor

Scanlon

K.C. Holmstrand, Mayor

Squaw Lake

Harry Over, Mayor

St. Cloud

Alwin L., Mayor
Duane Beckstrom, St. Cloud Health Department
John Miller, St. Cloud Area Council on Governments

Taconite

Edward Phillips, Mayor

Towns and Townships (continued)

Tower

Harry Anderson, Former Mayor

Virginia

J.E. Pearsall, Former Mayor

Warba

Jordan Richardson, Former Mayor

Winton

Charles Jankowski, Mayor

Wright

Henry Beutow, Former Mayor

Zemple

Bruno Nordahl, Jr., Mayor

FEDERAL GOVERNMENT

U.S. Army Corps of Engineers

Robert Post
John Seamen
Kelsy Willis

U.S. Department of Agriculture

Soil Conservation Service

Jerry Sharp
Ernest Schober

Forest Service

John E. Mathisen
John Benzie
Dave Alban
Frank Voytas
Ed Vandermillon
L.D. Meech

U.S. Department of Housing and Urban Development

Alan L. Cleveland

U.S. Department of the Interior

Bureau of Sport Fisheries and Wildlife

Nadsen, Carl R.
Scott, Joseph

U.S. Geological Survey

George Carlson
Charles Collier
Lowell Luetzhow

U.S. Environmental Protection Agency

Valdas V. Adamkus, Deputy Regional Administrator, Region V, Chicago

Gary Williams, Division of Surveillance Analysis, Federal Activities Branch, Review Section

Peter Kelley, Air Quality and Permits Division

PROJECT PROPOSER

Minnesota Power and Light Company

Kenneth Carlson, Vice President - Operations
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E.J. App
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G.W. Harries
David Hoffman
R.J. Humphrey
E.R. Kilpatrick
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Lowell Schuknecht
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Beck Associates

Wm. Beck

John T. Boyd Company

Robert M. Quinlan

Peabody Coal Company

James Addington
John S. Freeman
George H. Morris
Leonard Scherer

CONCERNED ORGANIZATIONS AND PERSONS

Concerned Organizations

Association of Minnesota Counties
St. Paul, Minnesota
John E. Chapuran

Blandin Paper Company
Grand Rapids, Minnesota
R.W. Schneider, Woodland Manager
G.W. Goelz, Vice President and Chief Engineer

Boise Cascade
Big Falls, Minnesota
W.A. Jeekkola, Mill Manager

Cass Lake League of Women Voters
Cass Lake, Minnesota
Nancy Engel, President

Common Sense
Clearbrook, Minnesota

Cooperative Power Association
Minneapolis, Minnesota
Jerry G. Kingrey

Dairyland Power Cooperative
LaCrosse, Wisconsin
Thomas A. Steele

Fond du Lac Indian Reservation
Cloquet, Minnesota
Reservation Business Committee

Grand Rapids Chamber of Commerce
Grand Rapids, Minnesota
Glenn Titus

Great Lakes Transmission Company
Duluth, Minnesota
R.F. Osborne

KDAL Radio
Duluth, Minnesota

Lake Superior Industrial Bureau
Duluth, Minnesota
Alfred E. France, President

CONCERNED ORGANIZATIONS AND PERSONS

Concerned Organizations (continued)

MAPP Coordination Center
Minneapolis, Minnesota
David Lingo

Marcell Mill and Lumber Company
Marcell, Minnesota

Mid-Mesabi League of Women Voters
Britt, Minnesota
Dorothy Salmi

Minnesota Association of Electric Coops
Minneapolis, Minnesota
Edmund Tiemann

Minnesota Municipal Utilities Association
Buffalo, Minnesota
Dick Kirkham, Executive Director

Minnkota Power Cooperative
Grand Forks, North Dakota
Ellef Krogen

The Nature Conservancy
Minneapolis, Minnesota
John Flicker

Northern States Power Company
Minneapolis, Minnesota
Robert O'Connor, Environmental Affairs Department
G.V. Welk, Director, Regulatory Affairs
Glenn Olson
William Seeley

Project Environment
Minneapolis, Minnesota
Candy Luecke

Public Utilities Commission
Rochester, Minnesota
Harold O. Moe, Superintendent

Rajala Timber Company
Deer River, Minnesota
R.B. Rajala

Remer Timber Company, Inc.
Remer, Minnesota
James Andrews, President

CONCERNED ORGANIZATIONS AND PERSONS

Concerned Organizations (continued)

St. Regis Paper Company
Wheeler Division
Cass Lake, Minnesota
Martin Coyer, Resident Manager

SCARE
Brookston, Minnesota
Dale Rundell

Sierra Club/North Star Chapter
Minneapolis, Minnesota

Staples Energy Conservation Program
Staples, Minnesota
Ray Gildown, Director

United Power Association
Elk River, Minnesota
Dan McConnon, Manager, Environmental and Safety Department

Concerned Persons

Prof. Dean E. Abrahamson, Minneapolis

Leonard Anderson, Cloquet

Carole Anderson, Floodwood

Floyd Ahlgren, Floodwood

Mr. and Mrs. Elmber Amborn, Saginaw

Arthur H. Anderson, Cloquet

Betty Anderson, Culver

Mrs. G.J. Anderson, Floodwood

Mr. and Mrs. Gary Anderson, Brookston

George Anderson, Culver

Norman Anderson, Holmes City

Sidney L. Anderson, Kelsey

John G. Appelget, Bovey

Mrs. Ferm Arpi, Virginia

Steven Ariv, Brookston

Janice Barber, Culver

Ted Bassa, Jr., Brookston

John G. Benjamin, Minneapolis

Betty Boebel, Floodwood

Caroline Bong, Culver

Darryl Booker, Minneapolis

Wendell G. Bradley, St. Peter

Mary Braku, Floodwood

Dennis Brodin, Anoka

Lisette Callahan, Backus

Doug Carlson, Sandstone

CONCERNED ORGANIZATIONS AND PERSONS

Concerned Persons (continued)

Harry Carlson, Cloquet
Karen Carlson, Larsmont
Robert Ciscarelli, Floodwood
Marvin Clark, Brookston
Allie Clegg, Brookston
Mr. and Mrs. George Clegg, Brookston
Bob Clock, Brookston
Jim Clowes, Regal
Mr. and Mrs. Arnold Collman, Crommell
Dr. Lawrence Conroy, Minneapolis
Prof. Edward J. Cushing, St. Paul
K.L. Cutkomp, St. Paul
Dave Danelson, Northfield
Dennis Dean, Culver
Marylyn Deneen, St. Paul
Luke Dnsek, Floodwood
Mr. and Mrs. Orel Dougherty, Saginaw
John E. Drawz, Minneapolis
Judy Erickson, Hibbing
Prof. Rouse Farnham, St. Paul
Edward Finklea, Minneapolis
Jerry Flinn, Saginaw
Donald Fjild, Floodwood
Floyd C. Fulton, Cloquet

Bill Gerard, Cloquet
Jane Gilbert, Duluth
Margaret Gnakaw, Floodwood
Bernard Goebel, Floodwood
Bernice Goinerk, Floodwood
Frank Gors, Brookston
Ethel Goutermont, Floodwood
Dave Grow, Minneapolis
Dave Grohall, Saginaw
Jim Hall, Brookston
Ed Helland, Cloquet
Diane Hansen, Culver
Lawrence Hansen, Culver
Don Hanson, Cloquet
Robert L. Hanson, Brookston
Gail Hart, Floodwood
John Hasking, Floodwood
Richard D. Herman, Duluth
Roberta Hosking, Floodwood
William Houle, Cloquet
William House, Two Harbors
Mr. and Mrs. Pete Isaacson, Brookston
Prof. Herbert S. Isbin, Minneapolis
Prof. James Jack, Mankato

CONCERNED ORGANIZATIONS AND PERSONS

Concerned Persons (continued)

Mary A. Johnson, Culver
Phyllis Johnson, Floodwood
Richard Johnson, Culver
Ron Johnson, Saginaw
Shirley Johnson, Floodwood
Wayne F. Johnson, Carlton
Robert D. Johnson, Floodwood
George Johnson, Floodwood
Joyce Johnston, Floodwood
Shirley Jokinen, Grand Rapids
Dennis A. Junsola, Floodwood
Roland Jussila, Floodwood
Jan Jussila, Floodwood
Glenn M. Johnson, Brookston
E. Johnson, Floodwood
Jordon Johnson, Floodwood
Wilke Kanniainen, Floodwood
Richard Kastler, Rochester
Daniel Kereldo, Floodwood
Adlph Kieffer, St. Paul
William Kiffmeyer, Clear Lake
Gary Kjaberg, Floodwood
Nancy Kmecik, Floodwood
Mrs. Kenneth Knight, Floodwood
Ray Koivisto, Floodwood

Enoch E. Korhanen, Wright
Kenneth J. Krael, Brookston
Prof. Sager V. Krupa, St. Paul
Edward Kuehnel, Roseville
Elmer Kummala, Crommell
Lis Kundel, Duluth
Mr. and Mrs. Kunelius, Brookston
Dave C. Kurtlla, Fine Lakes
Clifford Lahti, Floodwood
P.W. Larimore, Albert Lea
Norman Larson, Worthington
Daniel Laukek, Floodwood
John Laukela, Duluth
Matt Laululi, Floodwood
Len Libbey, Minneapolis
John Love, Floodwood
Michael Madden, Duluth
Kenneth Maki, Brookston
Ray Martinson, Minneapolis
Judy Matonich, Hibbing
Robert R. Matthew, Brookston
Mrs. Ernest Mattson, Brookston
Evert E. Mattson, Brookston
Gerald McTagart, Floodwood
Roy Melin, Culver

CONCERNED ORGANIZATIONS AND PERSONS

Concerned Persons (continued)

Otto Milfait, Kelsey

Roger C. Miller, South St. Paul

Michael F. Morgan, Duluth

Prof. Thomas Morley, St. Paul

Nancy Mueller, Meadowlands

Robert Mueller, Meadowlands

B.E. Murray, Iron

Swante Narlund, Floodwood

Charles A. Nash, Floodwood

Lucille Nash, Floodwood

Jolen Neuback, Minneapolis

Darrell Nicholson, Minneapolis

Orin Minlos, Cohasset

Robert Nolan, Minneapolis

Charlene Norman, Floodwood

Meredith G. Norman, Grand Rapids

Oscar Norman, Floodwood

Ray Norman, Floodwood

Prof. Dale Olsen, Duluth

Raph H. Olson, Grand Rapids

Dr. Richard Olson, Virginia

Jim Ostrander, Hibbing

Arnold Overby, Beaver Bay

Prof. Gerald G. Owenby, St. Paul

Charles A. Palmer, Floodwood

Janette Palmer, Floodwood

Joanne Palmer, Floodwood

Robert S. Palmer, Floodwood

Emil Parantala, Floodwood

Donald Penn, Hibbing

Kathy Peppo, Minneapolis

Richard Peterson, Brookston

Mrs. William Peterson, Moose Lake

George Polo, Floodwood

Norman Poupon, Brookston

William Radzwill, Cokato

Henry W. Raihala, Floodwood

Charles Ramos, Deer River

Julia Randa, Floodwood

Mr. and Mrs. Wilho Randa, Brookston

Irene Randall, Cloquet

Mr. and Mrs. Ranta, Brookston

Clarence J. Reimer, Floodwood

Robert L. Reynard, Cloquet

Mr. and Mrs. James Rissanen, Saginaw

Gene A. Roach, Silver Bay

Thomas G. Robinson, Boston, Mass.

John Rose, Underwood

Dick Rudnitski, Culver

Steve Rufer, Fergus Falls

CONCERNED ORGANIZATIONS AND PERSONS

Concerned Persons (continued)

Loren S. Rutter, Kinney
Arno Salli, Brookston
Arend J. Sandbulte, Duluth
Wayne Schanik, Floodwood
Robert Scharnberg, Floodwood
Carole Schminski, Floodwood
Leonard Schminski, Floodwood
Norma Schminski, Floodwood
Mr.& Mrs. William Schminski, Floodwood
Mr.& Mrs. Jeff Scnarighi, Brookston
Larry Schultz, Osakis
John Shannon, Deer River
Ellen Simons, Brookston
Don C. Skinner, St. Paul
M.K. Smith, Ref. Librarian, Bemidji
Frank Sojka, Brookston
Gene Spicer, Culver
Victoria Lenore Stagg, Floodwood
Mrs. E.L. Stayton, Cromwell
Bill Swanson, Minneapolis
Dr. Michael Sydor, Duluth
Clifford Tahti, Floodwood
Irja Talirtier, Brookston
Mr. and Mrs. Talvitie, Brookston
Chuck Taverna, Floodwood
Leslie Teippo, Floodwood
Robert Thornton, Virginia
Prof. Robert Temin, St. Paul
Dr. Paul Toren, Mahtomedi
Paul Toruit, Floodwood
Mr. and Mrs. Arnold Trieit, Floodwood
Helen Tvert, Floodwood
Dr. Matt Walton, St. Paul
Hall D. Werner, Staples
Prof. Clifford M. Wetmore, St. Paul
DePaul Willette, Olivia
John Wilminko, Floodwood
Floyd William, Floodwood
Olga Wiltan, Brookston
Charles Witte, Cloquet
Dean Wolf, Carlton
Mrs. Arlene Wolner, Cloquet
Nancy Woolworth, White Bear Lake
Matt Wuotiba, Floodwood
Mat Vuotila, Floodwood
Ralph Zainhar, Floodwood
Luella Zauhar, Floodwood
Ralph Zauhor, Floodwood
Michael Zavhar, Floodwood
John Zelazny, Floodwood

GLOSSARY

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Adiabatic	Denotes a change in volume or pressure without a simultaneous change in heat.
Albedo	The ratio between the sunlight reflected from the earth, and the total sunlight falling on the earth.
Allocthonous	Refers to deposits of material that originated elsewhere; e.g., drifted plant materials on the bottom of a lake.
Ambient	That which encompasses or surrounds on all sides.
Anaerobic	Capable of life or activity in the absence of air or free oxygen.
Arithmetic mean	Average, or the sum of the values divided by number of values.
Autocthonous	Refers to local origin; e.g., indigenous species, deposits produced within a lake.
Baghouse filters	Air filtration system using fabric filters.
Bars	Units of measurement typically used in acoustics.
Baumé	The relationship of specific gravity of a fluid as compared to specific gravity of water.
Beneficiation	The dressing or processing of coal for the purpose of removing unwanted constituents.
Biota	All species of plants and animals occurring within a certain area or region.
Calcareous	Material having a high percentage of lime carbonate.
Canopy	The aerial branches of terrestrial plants together with their complement of leaves are said to be a complete canopy when the ground is completely hidden when viewed from above.

Climax community	The final, stable community in an ecological succession which is able to reproduce itself indefinitely under existing conditions.
Community	A grouping of organisms which grow together in the same general place and mutually interact.
Density	A specialized term to indicate the number of plant individuals per unit area - It may be expressed in absolute terms or as relative density, which is the number of individuals of a particular species as a percentage of the total number of individuals of all species.
Diversity	The number of species per unit area or volume; the richness of species in a given area.
Dominance	A measure of the total size, bulk, or weight of the individuals of a particular species on a particular area.
Dominant	A species which is of great importance in a community by virtue of size, number, or other characteristics which enable it to receive the brunt of external forces and modify them before they affect the lesser members of the community.
Drift	Any deposit in a glaciated area originating as a result of glaciation. Also, the phenomenon of a small amount of cooling water being entrained in the air and released to the atmosphere in liquid form.
Dry bulb temperature	Normal outside air temperature.
Ecotonal	A transition line or strip of vegetation between two communities which has characteristics of both kinds of neighboring vegetation as well as characteristics of its own.
Edaphic	Relating to soil.
Electrostatic precipitator	Device which uses an electrical field for precipitating or removing solid or liquid particles suspended in a gas.

Emergent	A plant rooted in a shallow water and having most of the vegetative growth above water.
Entrainment	The passive movement of planktonic organisms through a power plant intake structure, during the withdrawal of cooling water.
Ericads	A member of the heath family.
Esker	A long narrow ridge of gravel and sand deposited by a stream flowing under or within a glacier.
Eutrophic	This refers to bodies of water, accumulations of peat, etc., which are rich in mineral nutrients and organic materials and are therefore productive. Oxygen may be deficient seasonally in lakes or ponds.
Frequency	The degree of uniformity with which individuals of a species are distributed in an area, and more specifically in a stand.
FTU	Furtwangler Turbidity Unit - measures transmission of the visible spectrum.
Geometric mean	The nth root of n values. Geometric mean is equal to the arithmetic mean times the standard geometric deviation raised to the power of 0.5 times the natural logarithim of the standard geometric deviation.
Geomorphic	Of or relating to the form of the earth or its surface features; resembling the earth.
Groundlayer	The herbs, shrubs and woody vines found beneath the trees in a forest. This excludes seedlings and saplings of overhead trees.
Icthyoplankton	This includes the eggs and larvae of fish.
Impingement	The striking of fish or other aquatic organisms upon intake screens, often resulting in injury or death.

Inversion	Level at which temperature gradient reverses direction.
JTU	Jackson Turbidity Unit - measures light transmission through water.
Kame Terrace	A short ridge or mound of sand or gravel deposited by a stream under a glacier.
Kilopascal	1000 pascals, units of pressure equal to one Newton acting uniformly over one square meter.
Lacustrine	Referring to a lake.
Leachate	Liquid that has percolated through the soil or other medium.
Leaching	Removal of soluble material from soil by the passage of water through it.
Lichen	Plants made up an alga and a fungus growing in symbiotic association.
Lithology	The delineation of rocks into major rock types, such as linestone, sandstone, and shale.
Loam	Soil containing 7 to 27% clay, 28 to 50% silt and less than 52% sand.
Macroinvertebrates	Relatively large (non microscopic) animals without backbones.
Macrophytes	Large aquatic plants.
Makeup	Water required to replace the water which leaves by evaporation, drift, blowdown, or leakage.
Mechanical cyclone	Device which collects matter by centrifugal force.

Mesic	Of medium moisture.
Moraine	Unconsolidated rock and mineral debris deposited by glacial ice. It commonly consists of a heterogeneous mass of unsorted material, but that which is deposited by glacial melt water is sorted.
Muck	An organic soil consisting of fairly well decomposed unrecognizable material that is finely divided, dark in color, and with a relatively large content of mineral matter.
Newton	The force necessary to give acceleration to one meter per second to one kilogram of mass.
NTU	Nefolometer Turbidity Unit - measures light refraction through water - more sensitive than JTU.
Periphyton	The assemblage of organisms attached to surfaces submerged in water, above the bottom.
Phytoplankton	Plants occurring in plankton.
Phytotoxic	Toxic to plants.
Population	A group of interacting individuals of the same species, or smaller taxa in a common spatial arrangement.
Saprophytic	Obtaining food from dead or decaying matter.
Saturation deficit	The difference between the amount (mass) of water vapor required to saturate a given air volume and the ambient amount of water vapor naturally occurring in that air volume.
Seal well	Concrete sealed well where effluents combine before being discharged.
Seral stage	Stage which follows another in ecologic succession.

Sphagnum moss	A kind of community characterized by the presence and often the abundance, of sphagnum, acid substrata, and the accumulation of peat.
Spray tower absorber	Process of passing a gas through a liquid spray for removal of SO_2.
Stand	A particular example of a plant community.
Stratigraphy	That branch of geology which treats the formation, composition, sequence and correlation of stratified rocks as parts of the earth's crust.
Succession	The replacement of one kind of community by another kind; the progressive changes in vegetation and in animal life which may culminate in the climax.
Tandem compound	A turbine generating unit in which various components are arranged on a single shaft.
Teratogenic	Substance that causes birth defects.
Till	Unstratified and unsorted glacial drift deposited directly by a glacier.
Understory	Collectively the trees in a forest below the upper canopy cover.
Varve	Layer in a mass of lacustrine sediments which may consist of coarser and finer sediments, deposited annually in a lake or sea.
Wet bulb temperature	Dynamic equilibrium temperature attained by a water surface.
Wet scrubber	Device used to collect particles in suspension from a gas using a liquid medium.
Wind rose	Graphic illustration of frequency of winds of given directions and velocity.
Zooplankton	Animals occurring in plankton.