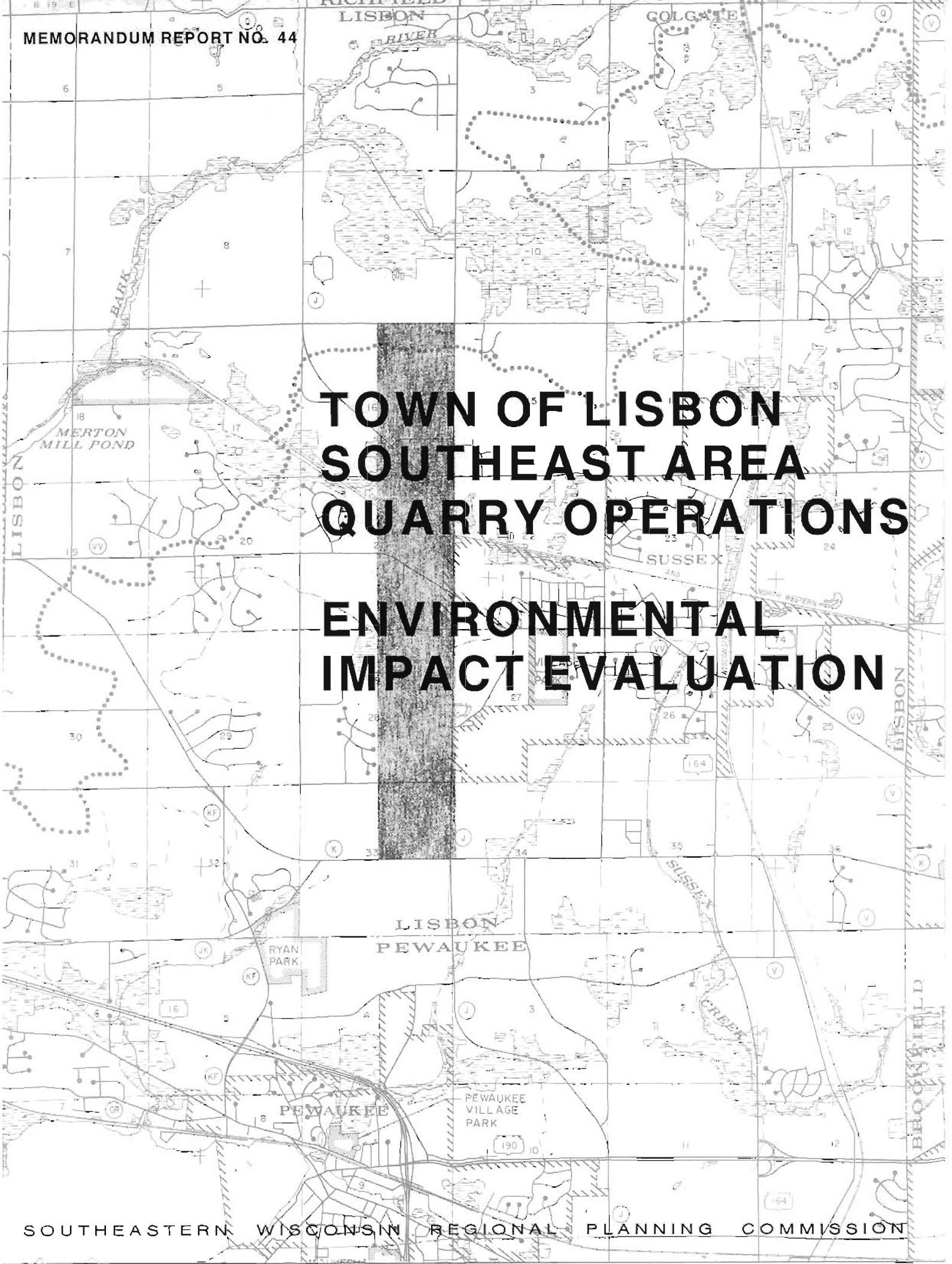
MEMORANDUM REPORT NO. 44



TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS

ENVIRONMENTAL IMPACT EVALUATION

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

KENOSHA COUNTY

Leon T. Dreger
Francis J. Pitts
Sheila M. Siegler

RACINE COUNTY

David B. Falstad
Jean M. Jacobson, Secretary
Earl G. Skagen

MILWAUKEE COUNTY

John R. Bolden
Thomas W. Meaux
Jean B. Tyler

WALWORTH COUNTY

John D. Ames
Anthony F. Balestrieri
Allen L. Morrison, Vice-Chairman

OZAUKEE COUNTY

Allen F. Bruederle
Alfred G. Raetz
Elroy J. Schreiner

WASHINGTON COUNTY

Daniel S. Schmidt
Patricia A. Strachota
Frank F. Uttech, Chairman

WAUKESHA COUNTY

Richard A. Congdon
Robert F. Hamilton
William D. Rogan, Treasurer

TOWN OF LISBON OFFICIALS

BOARD OF SUPERVISORS

Donald R. Holt, Chairman
Michael J. Ertl
Daniel F. Meissner
Jane Stadler
Teryl E. Williamson

PLAN COMMISSION

Leonard P. Anhalt
William A. Grigg
John Manz
Richard J. Martin
James H. Zindl

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION STAFF

Kurt W. Bauer, PE, AICP, RLS . . . . . .Executive Director
Philip C. Evenson, AICP . . . . . .Assistant Director
Kenneth R. Yunker, PE . . . . . .Assistant Director
Robert P. Biebel, PE . . . . . .Chief Environmental Engineer
John W. Ernst . . . . . .Information Systems Manager
Leland H. Kreblin, RLS . . . . . .Chief Planning Illustrator
Donald R. Martinson . . . . . .Chief Transportation Engineer
John R. Meland . . . . . .Chief Economic Development Planner
Bruce P. Rubin . . . . . .Chief Land Use Planner
Roland O. Tonn, AICP . . . . . .Chief Community Assistance Planner
Joan A. Zenk . . . . . .Administrative Officer

Special acknowledgement is due Mr. David Kendziorski, SEWRPC Principal Planner, Ms. Tami J. Dake, SEWRPC Planning Analyst, and Ms. Nova Clite, former SEWRPC Planning Analyst, for their efforts in the conduct of this study and in the preparation of this report.

MEMORANDUM REPORT
NUMBER 44

TOWN OF LISBON
SOUTHEAST AREA QUARRY OPERATIONS

ENVIRONMENTAL IMPACT EVALUATION

Prepared by the

Southeastern Wisconsin Regional Planning Commission
P. O. Box 1607
Old Courthouse
916 N. East Avenue
Waukesha, Wisconsin 53187-1607

September 1990

Inside Region $ 5.00
Outside Region $10.00

(This page intentionally left blank)

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

916 N. EAST AVENUE • P.O. BOX 1607 • WAUKESHA, WISCONSIN 53187-1607 • TELEPHONE (414) 547-6721
TELECOPIER (414) 547-1103

Serving the Counties of: KENOSHA
MILWAUKEE
OZAUKEE
RACINE
WALWORTH
WASHINGTON
WAUKESHA

September 21, 1990

Mr. Donald R. Holt, Chairman
Town of Lisbon
W234 N8676 Woodside Road
Sussex, Wisconsin 53089

Dear Mr. Holt:

In 1987, the Town of Lisbon requested the assistance of the Southeastern Wisconsin Regional Planning Commission in assessing the potential environmental impacts of the expansion of quarrying operations in the southeast section of the Town, including the specific proposal to expand the Halquist Stone Company, Inc., quarry operations located west of STH 164 and on both sides of CTH K (Lisbon Road). In order to assure that all potential impacts of the proposed expansion were properly considered, the geographic study area considered in the evaluation included a nine-square-mile area, including portions of the Towns of Lisbon and Pewaukee and the Village of Sussex. The work on the study was initiated and largely completed in 1988. However, it was deemed necessary to verify the groundwater information obtained in 1988 with additional data obtained in 1989 to assure that the unusually low rainfall conditions that occurred in 1988 did not skew the analyses relating to groundwater impacts.

The Regional Planning Commission has now completed the technical work required and is pleased to transmit to you the findings and recommendations of the requested study. As you know, the initial draft of the report was reviewed by the Town Plan Commission and at a public informational meeting held on October 19, 1989. The comments received at that hearing have been specifically addressed in the report.

The report identifies those potential environmental impacts of significance which may be expected to be associated with continued and expanded quarrying operations within the study area, and identifies mitigative measures which can be considered to minimize those impacts. The Southeastern Wisconsin Regional Planning Commission is particularly appreciative of the contributions of the Town's planner and engineer and the owners and operators of the Halquist Stone Company, Inc., and the Vulcan Materials Company quarries for their cooperation in the conduct of the study.

Sincerely,

Kurt W. Bauer
Executive Director

(This page intentionally left blank)

Chapter I

INTRODUCTION

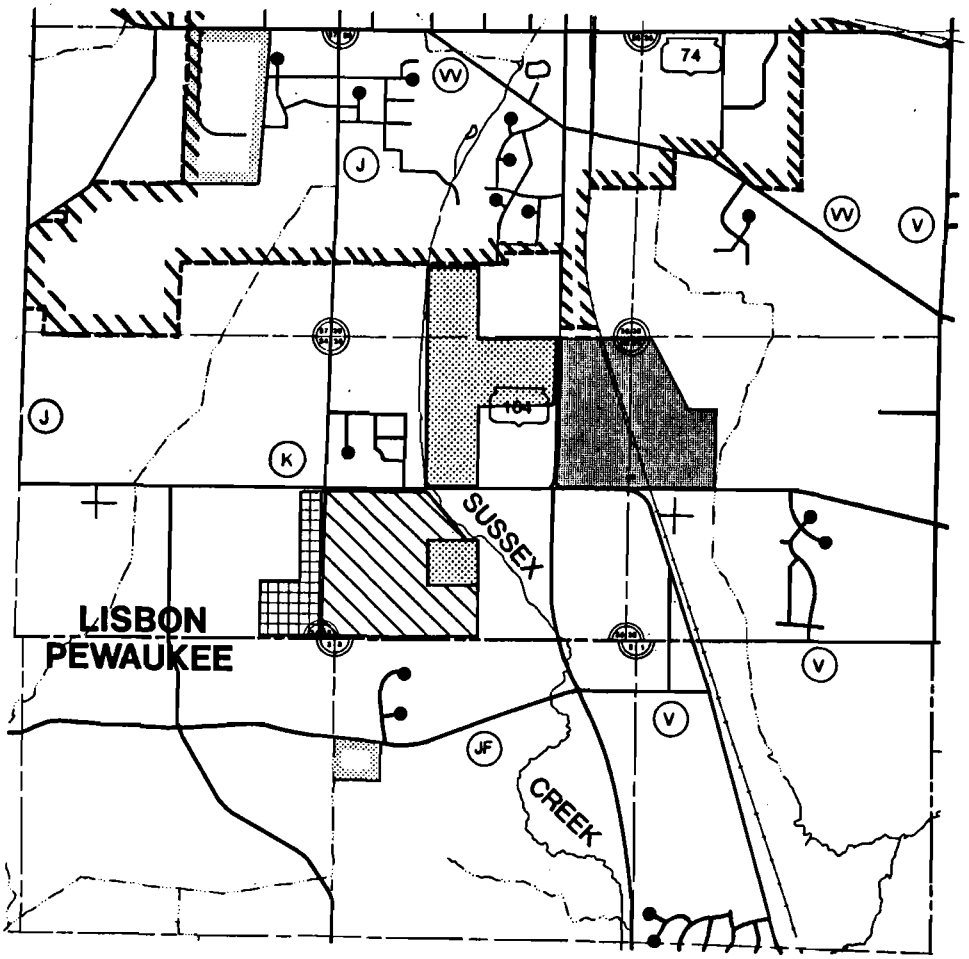
By letter dated June 9, 1987, the Town of Lisbon requested the assistance of the Southeastern Wisconsin Regional Planning Commission in assessing the potential environmental impacts of the proposed expansion of the Halquist Stone Company, Inc. quarrying operations in the Southwest one-quarter of U.S. Public Land Survey Section 35, Township 8 North, Range 19 East. Work on the study was initiated in early 1988. While most of the work on the study was completed in 1988, it was deemed important to verify groundwater information obtained in 1988 with selected data obtained early in 1989 to assure that the unusually low rainfall conditions which occurred in 1988 would not skew the analyses relating to groundwater impacts. As part of the assessment, consideration was given to future land uses in the vicinity which could potentially be impacted by quarrying operations. The findings of the study are set forth in this memorandum report, which includes: 1) a description of the existing condition on the Halquist Stone Company, Inc. land and environs; 2) a description of the probable future use and development considerations of the Halquist site and its environs; and 3) an assessment of the environmental impacts of the proposed quarry operation expansion.

The area of primary concern is the 160-acre expansion site and the lands immediately adjacent to the expansion site. However, in order to assure that all potential impacts of the proposed expansion were considered, the geographic study area was delineated to include the existing and proposed quarry site and the surrounding area to a distance of about one mile. As shown on Map 1, the area selected for the study was bounded on the north by STH 74 (Main Street), on the west by CTH J, on the south by a line parallel to and one mile south of the boundary between the Towns of Lisbon and Pewaukee, and on the east by CTH "V" (Town Line Road). The study area totals about nine square miles in area and includes portions of the Town of Lisbon, the Village of Sussex, and the Town of Pewaukee.

An initial draft of this report was reviewed by the Town Plan Commission and the public at a public information meeting held on October 19, 1989, by the Plan Commission. A summary of the comments received at that meeting is included in Appendix A. The comments have been addressed in the report.

Map 1

TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS - STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Vulcan Materials Company Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- Adjacent Lands Owned by Halquist Stone Company Inc.

GRID NORTH

0' 800' 1600' 2800'
GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

Chapter II

DESCRIPTION OF THE ENVIRONMENT

This chapter summarizes the characteristics of the study area pertinent to a sound evaluation of the potential environmental impacts of an expansion of the Halquist Stone Company quarry operations in the Town of Lisbon. The chapter includes a description of certain natural and man-made features of the nine-square-mile study area. More specifically, data are provided on the physical environment of the study area, including climate, topography, drainage, floodplains and shorelands, surface water quality, geologic, hydrogeologic, and air quality conditions; on the biological environment, including environmentally-sensitive areas, wildlife habitat and fish and aquatic life; and on the socio-economic environment, including current and planned land use and attendant population and employment levels, zoning, traffic, and noise. As background, this chapter first presents a description of the current quarrying operations.

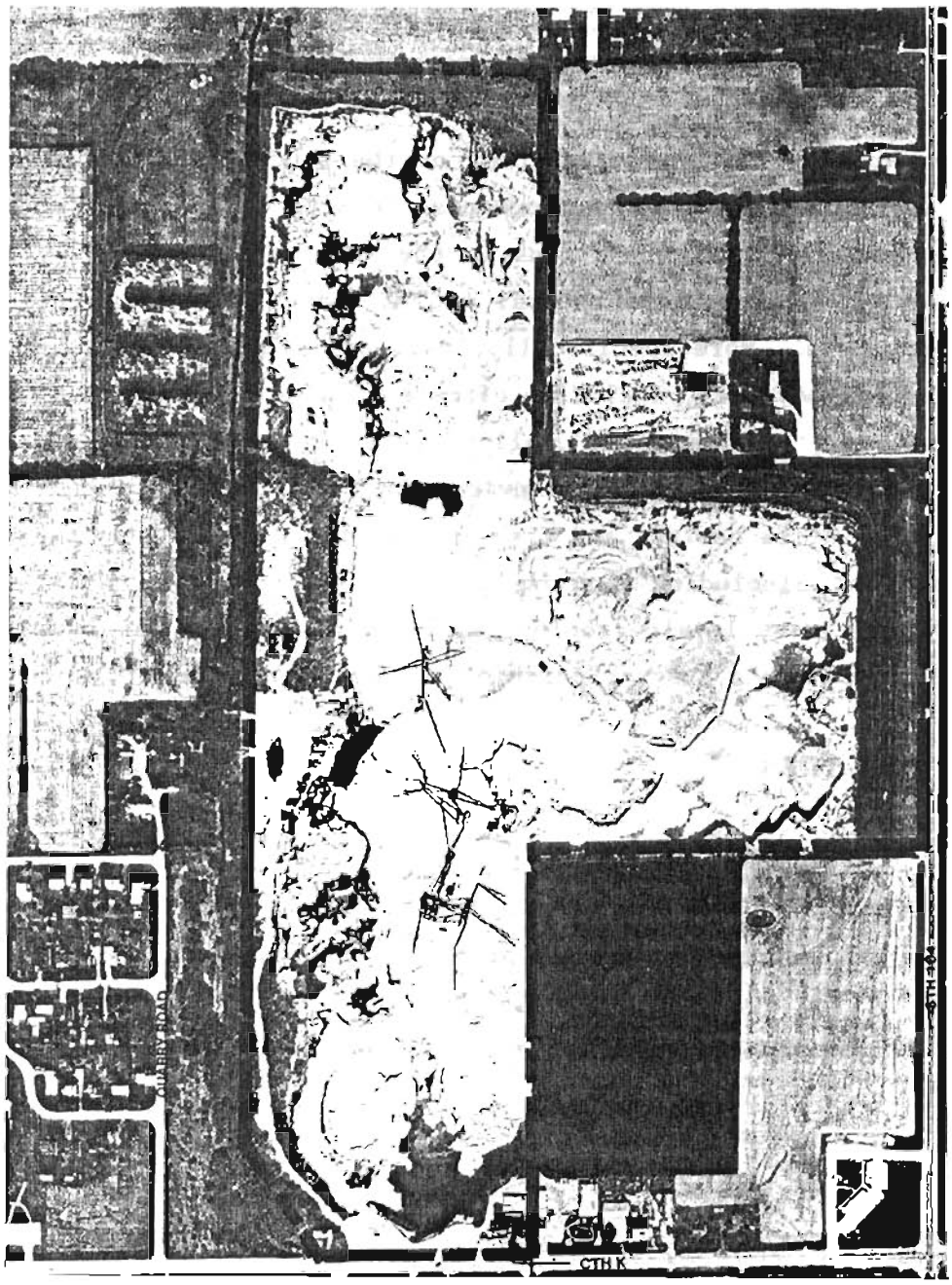
CURRENT QUARRY OPERATIONS

Currently, there are two major quarrying operations located in the study area--the Halquist Stone Company, Inc., and the Vulcan Materials Company. This section of the report provides a brief description of each operation. While the focus of the study is to be the proposed expansion of the Halquist quarry, it was considered pertinent to also discuss the current operations of both these existing operations.

Halquist Stone Company, Inc.

The Halquist Stone Company, Inc., is located at N52 W23564 Lisbon Road, in the southeastern portion of the Town of Lisbon. The facility typically produces 400,000 to 500,000 tons of crushed limestone of various grades and agricultural lime per year with maximum annual amounts of up to about 900,000 tons. In addition, Halquist operates a retail store selling facing stone and other building materials. The Halquist Stone Company employs over 50 persons in its quarrying, retail, and manufacturing operations. Quarrying operations occur at two sites. In 1988, the main quarry, located north of Lisbon Road and west of STH 164, encompassed an area of approximately 130 acres, as shown on Map 2. A photograph showing the current internal operation of the north quarry is

Map 2
EXISTING HALQUIST STONE COMPANY INC. NORTHERN QUARRY SITE

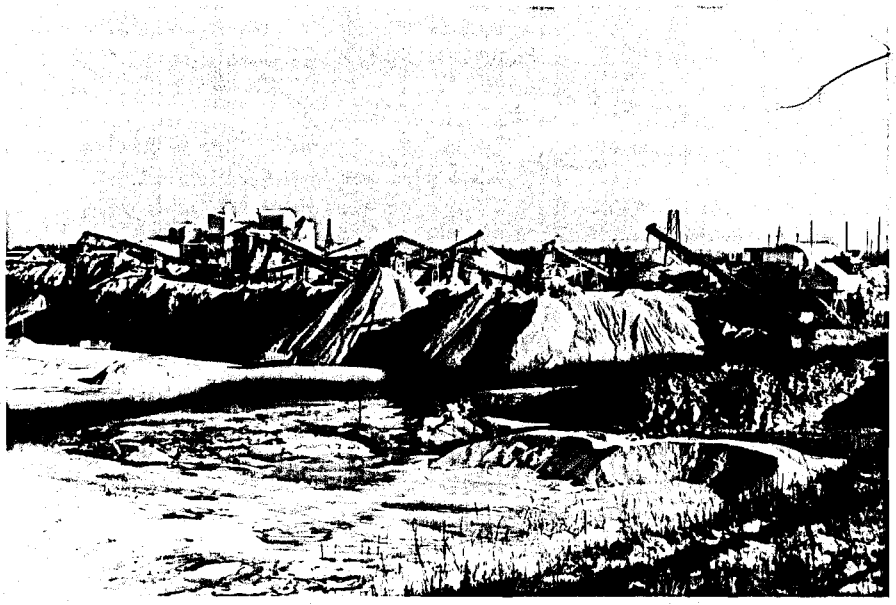


QUARRY BOUNDARY

Source: SEWRPC.

Figure 2

PHOTOGRAPH OF VULCAN MATERIALS QUARRY INTERIOR



VULCAN MATERIALS QUARRY VIEW NORTHEAST FROM THE SOUTHWEST

above National Geodetic Vertical Datum (NGVD). The quarry is being extended laterally towards the east, with active quarrying occurring only east of the Wisconsin Central Ltd. railway tracks. Lime production and rock processing occur west of the railway in the inactive part of the pit.

PHYSICAL ENVIRONMENT

Climate

Average annual precipitation in the study area is 32.3 inches, including the water equivalent of about 49 inches of snow and sleet. Average monthly precipitation in the study area ranges from about 0.9 inches in February to about 3.6 inches in July. Precipitation is the primary form of recharge of the shallow glacial and dolomite aquifers underlying the study area.

Topography

The topography of the study area is typical of the glacial terrains of Southeastern Wisconsin. Surface features include gently rolling hills, fair to poor drainage patterns, and sandy to clay-rich soils. Total relief in the study area is approximately 140 feet, with the maximum elevation of 970 feet above mean sea level occurring in the northwestern part of the study area, and the minimum elevation of about 830 feet above mean sea level occurring in the extreme southeastern part of the study area. The topography in the vicinity of the Halquist Quarry is generally of low relief at elevations of about 880 to 890 feet above mean sea level and varying by not more than about 10 feet.

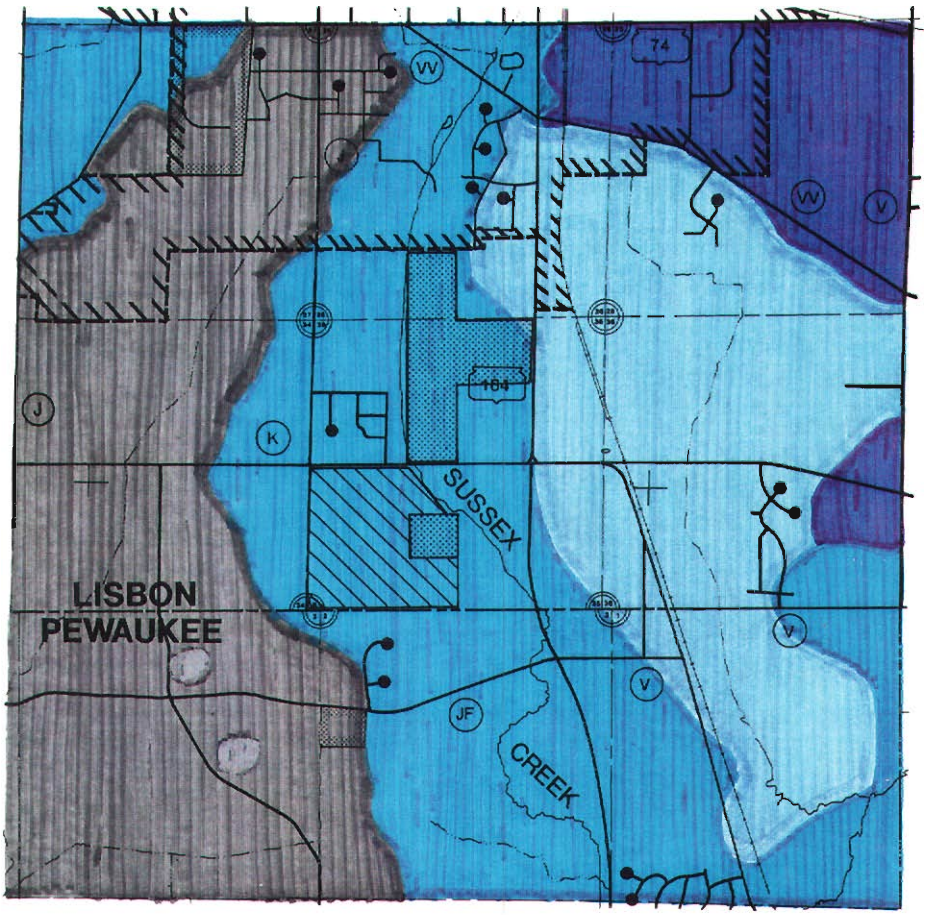
Drainage

As shown on Map 4, the study area is drained by Sussex Creek, the Pewaukee River, and by unnamed tributaries of the Fox River. About 5.2 square miles, or 58 percent of the study area, is drained by Sussex Creek and its tributary. About 2.8 square miles, or 38 percent of the study area, is drained to the Pewaukee River. The remaining 1.0 square mile, or 11 percent, is drained by the unnamed tributaries to the Fox River.

Of most concern to the planned Halquist quarry expansion is the main stem of Sussex Creek which flows just west of the west wall of the current Halquist quarry north of CTH K and then flows southeast traversing the northeast portion of the proposed expansion site. Sussex Creek, a headwater tributary of

Map 4

SUBWATERSHEDS IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- Pewaukee River Subwatershed
- Sussex Creek Tributary Subwatershed
- Sussex Creek Mainstem Subwatershed
- Fox River Tributary Subwatershed

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP	T7NR19E PEWAUKEE TOWNSHIP

the Fox River, originates northwest of the study area and flows southerly and southeasterly through the study area and has a total drainage area of about 11.6 square miles above the point where it leaves the study area at CTH V. Of this drainage area, 6.4 square miles are upstream of the study area and 5.2 square miles are located within the study area. Sussex Creek has an average gradient through the study area of 20 feet per mile.

The mean annual average discharge rate of 5.9 cubic feet per second was estimated for Sussex Creek under existing land use conditions at the point where the Creek leaves the study area at CTH V. The seven-day, 10-year low flow in Sussex Creek is about 0.2 cubic feet per second. The Halquist Stone Company discharges approximately 0.5 cubic feet per second, or about 300,000 gallons per day, of treated quarry wastewater and non-contact cooling water to Sussex Creek, according to the Wisconsin Department of Natural Resources wastewater discharge records. The Village of Sussex public sewage treatment plant discharges effluent to Sussex Creek at a location about 1,100 feet upstream of the northern limits of the Halquist Quarry. The 1988 average daily discharge of that sewage treatment plant was about 1.1 cubic feet per second, or about 700,000 gallons per day. Under a proposal currently being reviewed by the Department of Natural Resources, the sewage treatment plant would be expanded to an average daily hydraulic capacity of about 4.3 cubic feet per second, or about 2.8 million gallons per day. The flow rate in the Sussex sewerage system is expected to increase to that design level over the next 20 years.

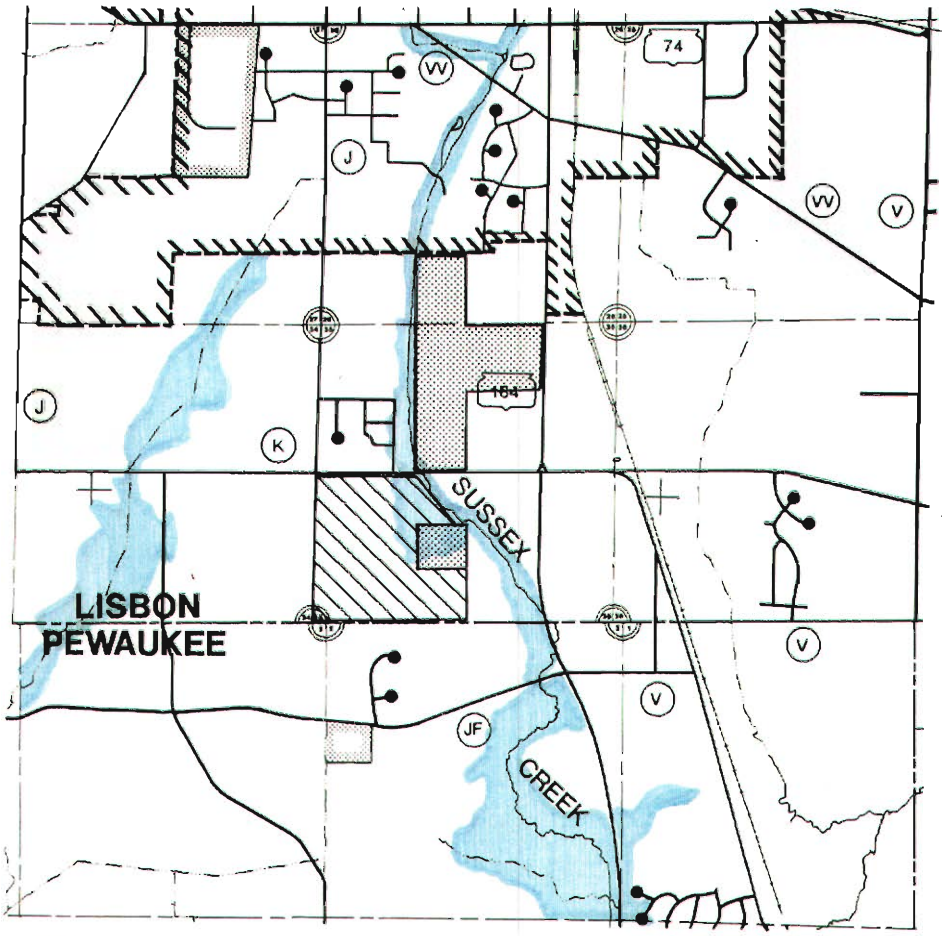
An intermittent tributary to Sussex Creek flows south through land owned by the Vulcan Materials Company, as shown on Map 4. The Vulcan Materials Company discharges its treated quarry wastewater to the stream via a drainage ditch at an estimated average rate of 1.85 cubic feet per second, or about 1.2 million gallons per day, according to 1987 records of the Wisconsin Department of Natural Resources.

Floodlands and Shorelands

The floodlands within the study are shown on Map 5. The floodlands shown on this map consist of surface water plus those areas which may be expected to be inundated by a flood having a 100-year recurrence--that is, a flood have a 1 percent chance of occurring in any given year. This flood is recognized nationally as the appropriate flood for floodplain regulation purposes.

Map 5

FLOODLANDS IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

100-Year Floodplain

Halquist Stone Company Inc. Current Site

Halquist Stone Company Inc. Proposed Expansion Site

GRID NORTH

0' 500' 1000' 2500'

GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

Floodplains in the area have been defined along Sussex Creek and the Pewaukee River.

Of particular importance are the floodplain areas on the site of the proposed Halquist quarry expansion, which are shown on Map 6. Consideration of any expansion proposal would have to take into account impacts on the floodplain area which may impact on upstream or downstream flood flows and stages. The 100-year recurrence interval flood flow on Sussex Creek at the CTH K crossing is 759 cubic feet per second under planned land use and existing channel conditions based upon a floodland information report prepared in 1977.[1] The flood stages on Sussex Creek for a 100-year recurrence interval flood event are at an elevation of 877.3 feet above National Geodetic Vertical Datum at the CTH K crossing and an elevation of about 875.2 feet above NGVD at the expansion site boundary.

Shorelands have been defined by the Wisconsin Legislature as all lands lying within 1,000 feet of a navigable lake, pond, or flowage, or within 300 feet of a navigable river or stream, or to the landward side of the floodplain, whichever is greater. Thus, by definition, shorelands include floodplains. The shorelands on the site of the proposed quarry expansion site are also shown on Map 6.

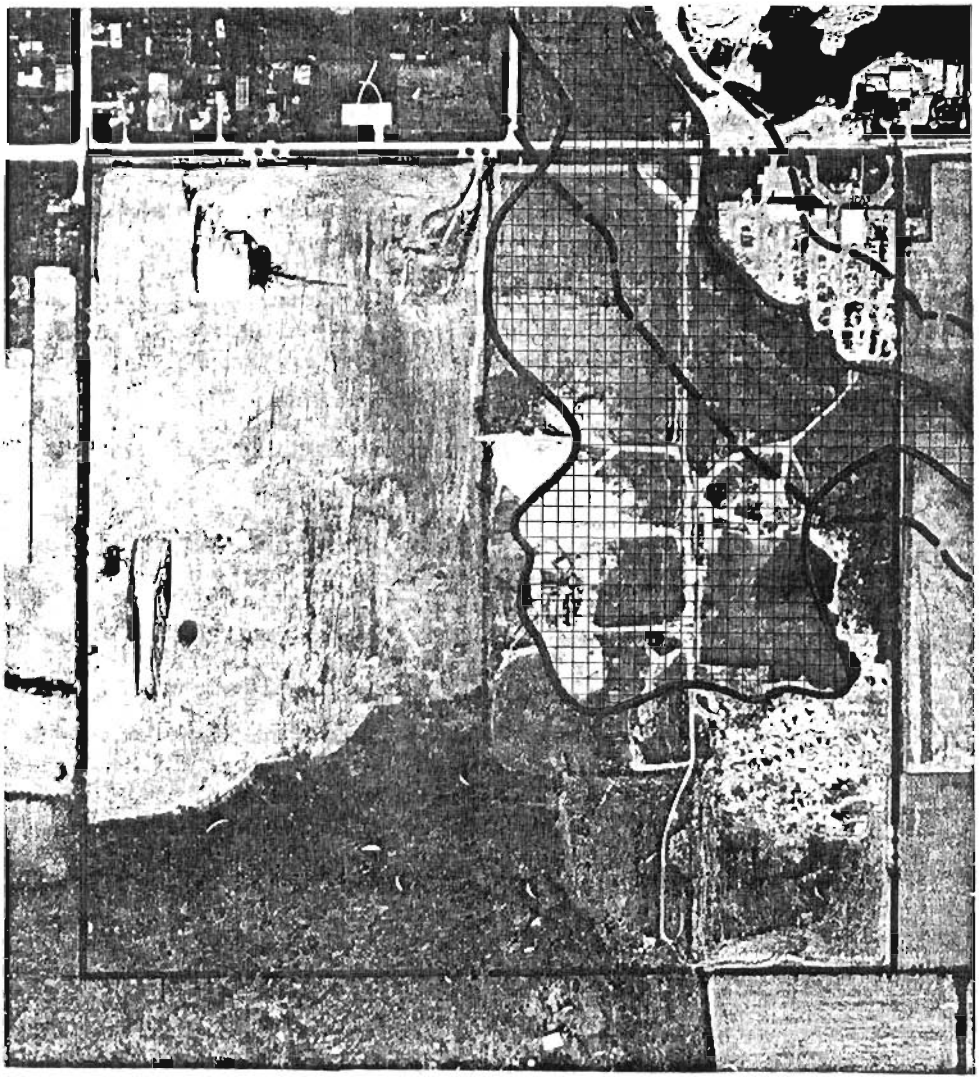
Surface Water Quality

Definitive data on the existing water quality conditions in Sussex Creek are important for assessing the potential changes in water quality conditions which may be anticipated if the quarry operations are expanded or changed. As part of the Regional Planning Commission's long-term water quality monitoring program, water quality conditions in Sussex Creek at State Trunk Highway 164 were monitored annually from 1968 through 1975. The sampling site was located about three miles downstream of the Sussex wastewater treatment plant discharge outfall and about 1.8 miles downstream of the Halquist Stone Company

---

[1]SEWRPC Community Assistance Planning Report No. 11, Floodland Information Report for Sussex Creek and Willow Spring Creek, Village of Sussex, March 1987.

Map 6
FLOODLANDS AND SHORELANDS ON THE HALQUIST QUARRY EXPANSION SITE



—··— EXPANSION SITE BOUNDARY

– – – – SHORELAND BOUNDARY

100-YEAR FLOODPLAIN

GRAPHIC SCALE

0 400 800 FEET

Source: SEWRPC.

south quarry discharge outfall. Stream water samples were generally collected during summer low-flow conditions. Storm event samples are not available. A summary of the resulting water quality data is set forth in Table 1.

A review of the water quality data presented in Table 1 indicates that Sussex Creek exhibited relatively high concentrations of nutrients--nitrogen and phosphorus--and fecal coliform organisms through 1975. The high nutrient concentrations present through 1975 are largely attributable to discharges from the Sussex wastewater treatment facility. In 1975, the Sussex wastewater treatment facility effluent discharge contained an average of 4.5 mg/l of total phosphorus. The installation of phosphorus removal facilities at the Sussex wastewater treatment plant in 1976 has substantially reduced the concentrations of phosphorus contained in the effluent. In 1981, the treatment plant effluent contained an average phosphorus concentration of only 0.16 mg/l. In 1988, the average phosphorus concentration in the plan effluent was 0.29 mg/l. The average fecal coliform level measured in Sussex Creek over the period of 1968 through 1975 was twice as high as the recommended standard for fecal coliform to support full-body contact recreational water uses. Common sources of high levels of fecal coliform are malfunctioning onsite sewage disposal systems; bypasses, discharges, and leaks from sanitary sewers and treatment facilities; livestock raising operations; and domestic pet and wildlife wastes. The dissolved oxygen concentrations and temperature levels measured in Sussex Creek were generally suitable to support desirable forms of fish and other aquatic life. The chloride concentrations, often used as an indication of human impact on a water body, were relatively high, but within the range of values found in the Fox River watershed. Sources of chloride include wastewater treatment facility effluent, septic tank systems, street deicing salts, and runoff from livestock operations.

A stream survey conducted by the Wisconsin Department of Natural Resources in 1978 reported very turbid water with a white chalky color at the discharge from the Halquist quarry. The survey report also indicated the presence of a fine white shifting substrate in the downstream reaches. Water quality conditions in Sussex Creek were more recently assessed on July 20, 1982, by the Department of Natural Resources. Table 2 presents water quality conditions measured upstream and downstream of the Sussex wastewater treatment plant outfall and the Halquist Stone Company outfall. The major impact of the

NPS9.DBK/ib

Table 1

WATER QUALITY CONDITIONS IN SUSSEX CREEK AT STH 164 LOCATED ABOUT THREE MILES DOWNSTREAM OF THE VILLAGE OF SUSSEX: 1968 THROUGH 1975

Parameter	Number of Analyses	Maximum	Mean	Minimum
Chloride (mg/l)	22	98.0	64.9	37.0
Dissolved Oxygen (mg/l)	29	13.7	7.1	4.4
Ammonia-Nitrogen (mg/l)	8	0.58	0.22	0.08
Organic-Nitrogen (mg/l)	8	1.75	1.12	0.68
Total-Nitrogen (mg/l)	8	5.09	3.95	2.56
Specific Conductance (umhos/cm at 25°C)	29	1,036	825	360
Nitrite-Nitrogen (mg/l)	12	0.33	0.17	0.05
Nitrate-Nitrogen (mg/l)	12	3.23	2.55	0.99
Total Phosphorus (mg/l)	8	0.87	0.51	0.02
Fecal Coliform (MFFCC/100 ml)	12	2,500	809	10
Temperature (°C)	30	26.6	18.6	15.5
pH (standard units)	22	8.7	8.0	7.6

Source: SEWRPC

TABLE 2

WATER QUALITY CONDITIONS IN SUSSEX CREEK: JULY 20, 1982

PARAMETER	Upstream of Sussex WWTP Outfall	Downstream of Sussex WWTP Outfall	Upstream of Halquist Stone Company Outfall	Downstream of Halquist Stone Company Outfall
Water Temperature (°C)	17.0	18.8	20.0	20.9
Total Solids (mg/l)	606	822	794	662
Total Volatile Solids (mg/l)	172	186	188	206
Total Suspended Solids (mg/l)	8	8	3	17
Total Volatile Suspended Solids (mg/l)	3	4	2	3
Turbididty (NTU)	3.8	3.6	3.8	8.7
Dissolved Oxygen (mg/l)	10.5	8.7	8.8	8.3
Biochemical Oxygen Demand (mg/l)	0.8	0.8	1.2	1.2
pH (S.U.)	8.0	7.7	8.1	8.0
Total Phosphorus (mg/l)	0.06	0.23	0.20	0.08
Dissolved Ortho-Phosphorus (mg/l)	0.028	0.194	0.162	0.052
Total Kjeldahl Nitrogen (mg/l)	0.7	0.7	0.7	0.4
Ammonia Nitrogen (mg/l)	0.06	0.03	0.03	0.04
Nitrate-Nitrite Nitrogen (mg/l)	2.6	7.9	6.6	4.4
Chloride (mg/l)	69	170	160	87
Fecal Coliform (MFFCC/100ml)	530	20	460	570
Fecal Streptococcus (Counts/100ml)	420	10	670	660

Source: Wisconsin Department of Natural Resources

Sussex wastewater treatment plant was to increase the stream nutrient levels: despite the installation of phosphorus removal facilities in 1976, total phosphorus increased by four-fold, dissolved ortho-phosphorus by seven-fold, and nitrate and nitrite nitrogen by three-fold. The major impact of the Halquist Stone Company quarry discharge was to increase the total suspended solids levels by almost six-fold, and to more than double the turbidity levels. Excessive solids loadings can reduce water clarity, cover valuable benthic habitats, impede navigation, and fill downstream wetlands and ponds.

Wastewater from the Halquist Stone Company quarry dewatering operations is discharged to Sussex Creek under a permit issued under the Department of Natural Resources Wisconsin Pollutant Discharge Elimination System (WPDES). Water quality standards which must be met under the permit are established by the Department of Natural Resources under Chapter 147, Wisconsin Statutes and Chapter NR 102 and Chapter NR 140 of the Wisconsin Administrative Code. The Company is required to file quarterly discharge volume and wastewater quality reports. Reports on file with the Department for 1987 indicate that discharge from the Halquist Stone Company quarry is well within the permit limits for suspended solids (less than 40 mg/liter) and a pH (range of 6.0 to 9.0 standard units). Wastewater samples are analyzed once per month by a state-certified private laboratory, under a separate contract with the Halquist Stone Company. Currently, the Halquist Stone Company dewaters both the main and south quarry sites by sump pumping, that is, by collecting surface runoff, groundwater seepage and other wastewater in a sump pit and then pumping it for disposal. Halquist discharges treated quarry wastewater and untreated noncontact cooling water into Sussex Creek. Treatment of wastewater in the main quarry consists of gravity settling in two settling ponds connected in series. Surface water from the second pond is pumped into Sussex Creek. Treatment of wastewater in the south quarry is by gravity settling in only one pond. The Halquist Stone Company recycles all of its rock-processing water from the two-pond system in the main quarry.

It should be noted that in 1979, the Halquist Stone Company instituted treatment process changes to provide for a better settling of solids prior to the discharge to Sussex Creek. According to Department of Natural Resources records for 1987, the Halquist Stone Company discharged an average of 0.25 cubic feet per second (cfs), or about 0.16 million gallons per day (mgd), from

the main quarry site. An additional average rate of 0.22 cfs, or about 0.14 mgd, are pumped from the south quarry site. Discharge rates were considerably less during the dry summer of 1988, according to Halquist Stone Company officials. Quarterly mean suspended solids and pH levels in the discharge from the Halquist Stone Company for 1987 and 1988 are shown in Table 3. As shown in Table 3, the reported average quarterly suspended solids levels were a maximum 13 mg/l during 1987 and 12 mg/l in 1988. About one-half of the time, samples had concentrations of less than 4.0 mg/l, during the two-year period. Thus, the suspended solids concentrations discharged to Sussex Creek are relatively low and would not be expected to have negative impacts on fish and aquatic life. Recent observations by the Regional Planning Commission staff downstream of the Halquist discharges indicate no sign of increased turbidity or excess siltation as had been reported in the 1978 Department of Natural Resources survey.

Dewatering of the Vulcan Materials Company quarry is accomplished in a manner similar to the Halquist Stone Company quarry. Groundwater seepage, surface runoff, and other quarry wastewater is collected in one of two sump ponds, and then pumped to a nearby stream for disposal. The Vulcan Materials Company discharges its wastewater to an unnamed tributary of the Sussex Creek via a drainage ditch that runs along Lisbon Road. The tributary joins Sussex Creek at a point about two miles downstream of the site of the proposed expansion. In 1987, sump water was discharged at an average rate of 1.85 cfs (1.19 mgd). Water used in rock processing, lime production, and dust control is drawn from one of two sump pits and much of this water is recycled. Sample data taken in 1988 indicates a maximum suspended solids concentration of 18 mg/l with most samples having a concentration of less than 4.0 mg/l.

Geologic and Hydrogeologic Conditions

The study area is blanketed by varying thickness of unconsolidated Pleistocine glacial material. The surficial deposits are deepest in the northwest part of the study area where over 30 feet of drift overlies bedrock. Large portions of the southeastern part of the study area have ten feet or less of glacial material covering the bedrock. The glacial deposits vary in composition, as well as depth, within the study area, ranging from unsorted, unstratified clay tills to well-sorted, stratified sand and gravel alluvium. Some sand and gravel lenses are water-bearing and provided a source of groundwater supply

Table 3

QUARTERLY SUSPENDED SOLIDS AND pH MEASUREMENTS IN HALQUIST STONE COMPANY WASTEWATER DISCHARGED TO SUSSEX CREEK: 1987-1988

Quarter	1987		1988	
	Total Suspended Solids (mg/l)	pH (s.u.)	Total Suspended Solids (mg/l)	pH (s.u.)
January-March	<4.0	7.8	8.0	8.2
April-June	<4.0	7.4	<4.0	7.8
July-September	<4.0	7.6	6.0	7.8
October-December	13.0	8.0	12.0	7.9

Source: Wisconsin Department of Natural Resources

for a limited number of residents of the study area. Due largely to the shallow depth and the contamination potential of these shallow-lying, intermittent aquifers, most wells in the study area are finished in the Silurian dolomite aquifer underlying the glacial deposits.

Underlying the glacial drift is 170 to 300 feet of dolomite bedrock This bedrock dips gently in a southeasterly direction. Most individual wells in the study area are finished in this limestone aquifer which provides water to approximately 1,400 residents, or just over 53 percent of the residential population of the study area. A recent study conducted by the Wisconsin Department of Natural Resources[2] in the southeastern one-quarter of the Town of Lisbon, including all of the portion of the study area within the Town, had determined that there is significant bacterial contamination of the wells servicing the area. The Department of Natural Resources is, therefore, currently requiring that new wells in that area be extended into the deeper sandstone aquifer.

Regional groundwater flow in the shallow dolomite aquifer is generally from northwest to southeast. Water levels in wells in the study area are generally representative of the water table of the shallow dolomite aquifer, although water levels in isolated wells may reflect the artesian head in semi-confined layers within the aquifer. A report prepared by the U.S. Geological Survey in 1986[3] indicated the presence of up to three discontinuous low-permeability zones within the Silurian dolomite--the shallow dolomite aquifer--underlying the study area. Groundwater table elevations in the study area for 1972 and 1988 are shown on Maps 7 and 8. The 1972 map was prepared by the U.S. Geological Survey and published in a 1975 report.[4] The 1988 map was prepared by the Regional Planning Commission for the subject study and was based upon

---

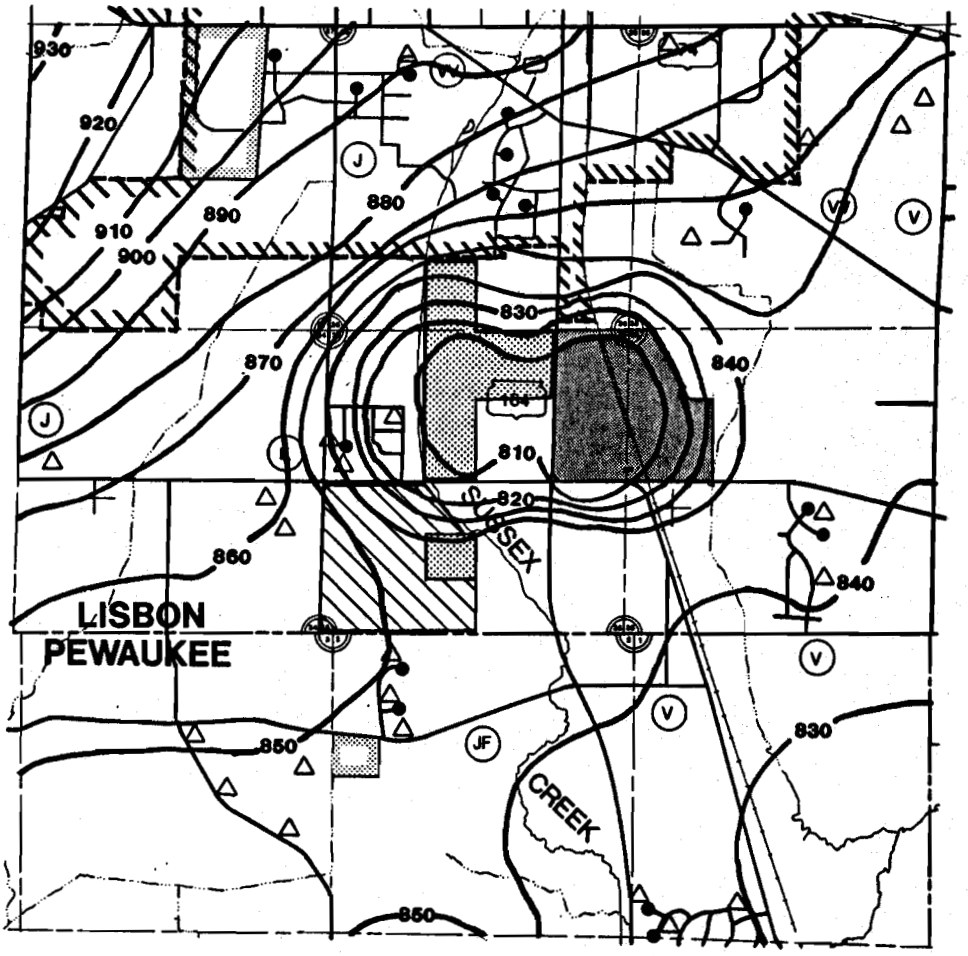
[2]Wisconsin Department of Natural Resources, Lisbon/Lannon Groundwater Study, July 1986.

[3]U.S. Geological Survey, Hydrogeology and Groundwater Quality of the Lannon-Sussex Area, 1986.

[4]U.S. Geological Survey, Groundwater Resources of Waukesha County, Wisconsin, October 1975.

Map 7

ELEVATION OF THE GROUNDWATER TABLE IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA: 1972



LEGEND

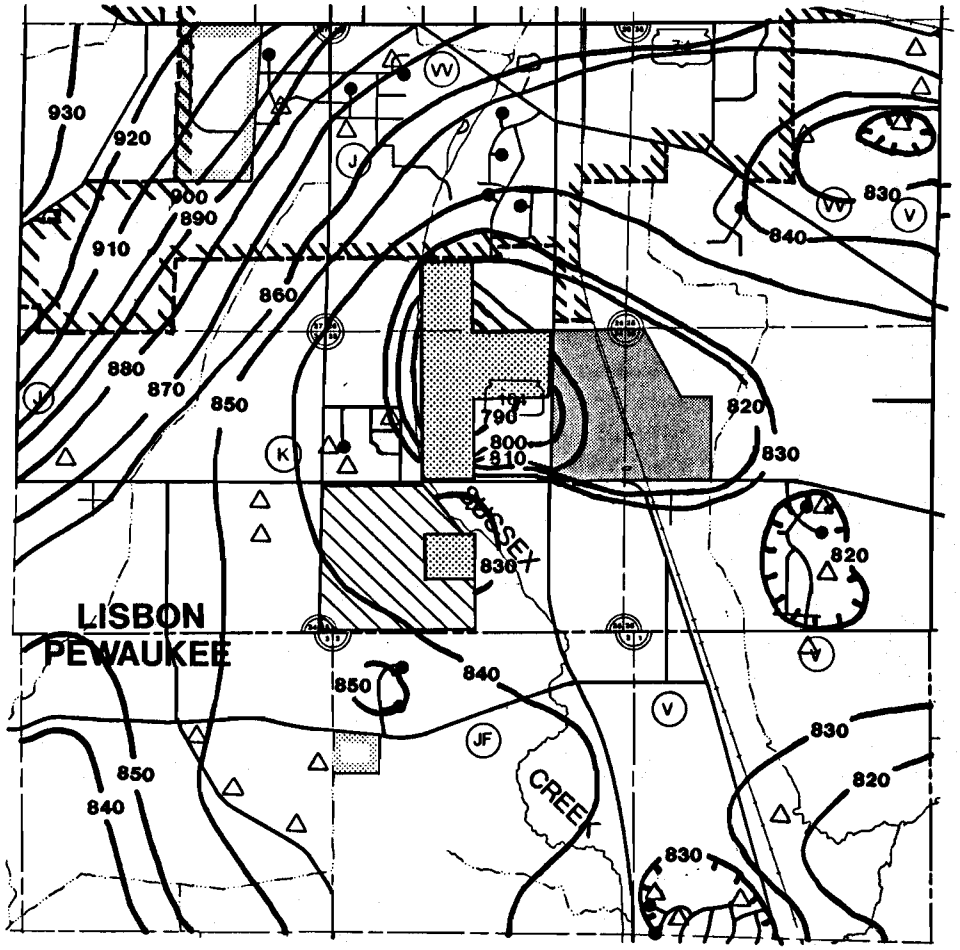
- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- Vulcan Materials Company Current Site
- Well Location
- 850 Groundwater Elevation (NGVD)

Source: U.S. Geological Survey and the University of Wisconsin-Extension Geological and Natural History Survey; Groundwater Resources in Waukesha County, Oct. 1975.

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E T7NR19E LISBON TOWNSHIP PEWAUKEE TOWNSHIP

Map 8

ELEVATION OF THE GROUNDWATER TABLE IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA: 1988



LEGEND

- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- Vulcan Materials Company Current Site
- Well Location
- 840 Groundwater Elevation (NGVD)

GRID NORTH

GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

measurements of 50 well levels within and adjacent to the study area during the fall of 1988. Comparison of the maps indicates no significant changes in the general groundwater flow and elevations, with the 1972 and 1988 elevations being similar in the northwestern portions of the study area, and from 10 to 20 feet lower in 1988 than in 1972 within the central and southeast portions of the study area.

Groundwater in the shallow dolomite aquifer is transmitted by solution-enlarged cavities, fractures, and bedding planes, in an otherwise dense rock. The hydraulic conductivity of the formation, a measure of the ability of the rock to transmit water, can, therefore, vary significantly. For the purposes of this study, several sources of hydraulic conductivity values were examined. The aforementioned 1975 report prepared by the U.S. Geological Survey[5] indicated the mean hydraulic conductivity of the Silurian dolomite in Waukesha County to be 2.8 feet per day for domestic wells and 2.3 feet per day for high capacity wells. An analysis of well completion tests of 41 wells in the study area found a median hydraulic conductivity of 6.2 feet per day. These data are included in Appendix B. The higher average hydraulic conductivity in the study area may be due to the presence of fracture zones and layers of relatively high permeability dolomite in the study area.

The Silurian dolomite--the shallow dolomite bedrock--is also an important economic resource in the study area. It is the rock being quarried by Halquist Stone Company and Vulcan Materials Company in the study area.

The Silurian dolomite is underlain by the Maquoketa Shale formation, a 200-foot thick unit of low-permeability rock that hydraulically separates the upper limestone aquifer from the deeper sandstone aquifer. Several dolomite and sandstone formations beneath the Maquoketa are important sources of groundwater. The three community wells serving the Village of Sussex and several other industrial and domestic wells in the study area are finished in the St. Peter sandstone aquifer. Because the Maquoketa Shale transmits water so slowly as to be loosely regarded as impermeable, it may be assumed that

---

[5]Ibid.

pumping of groundwater from the lower aquifers has minimal effect on the Silurian dolomite aquifer. Therefore, the lower-lying aquifer was not considered in this study.

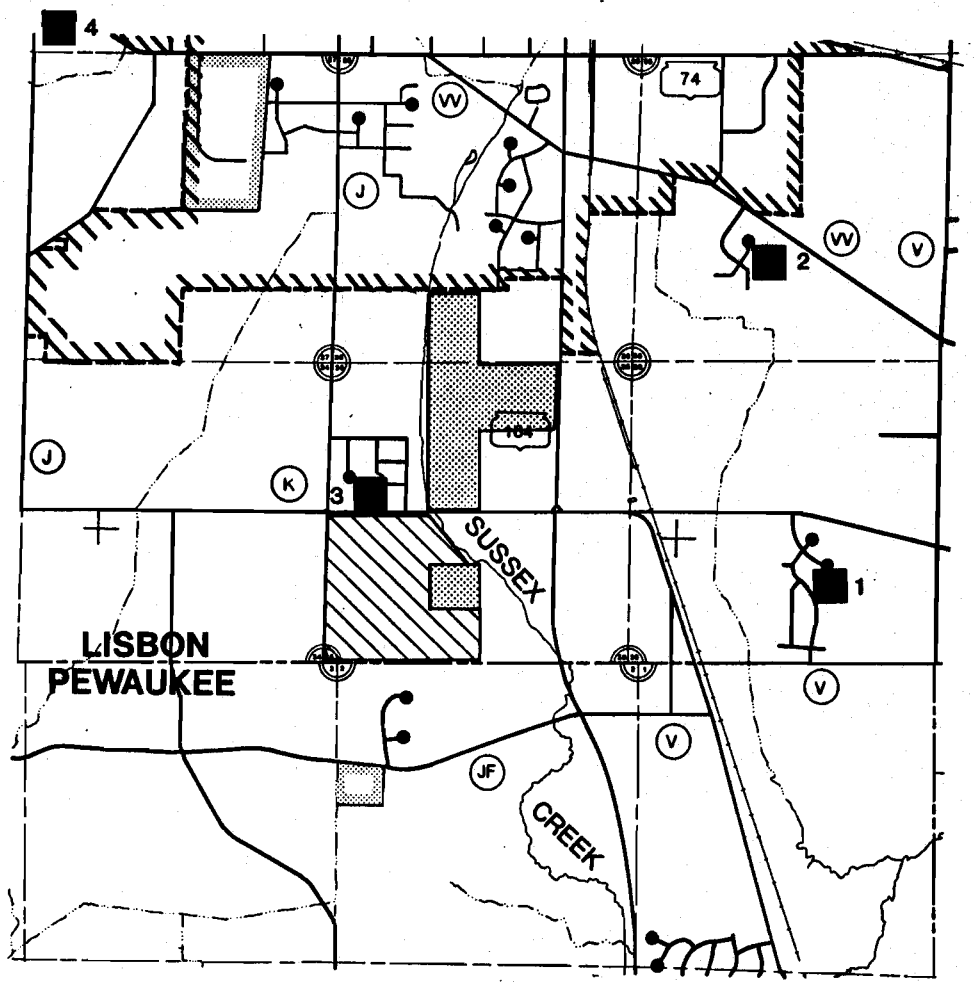
Air Quality

Quarrying operations often emit large quantities of particulate matter to the atmosphere, thereby degrading air quality conditions. Particulate matter may be generated by each phase of the quarrying operation--excavation, processing, storage, and transportation of material--depending on the amount of material processed, the method of processing, the moisture content of the material, the method of transfer of the material, the degree to which the operation is enclosed, and the use of any air quality control measures.

In SEWRPC Planning Report No. 28, A Regional Air Quality Attainment and Maintenance Plan for Southeastern Wisconsin: 2000, 1980, it was reported that quarrying operations accounted for about 6,483 tons of particulate matter emissions, or more than 80 percent of the total fugitive dust emissions identified in the Region in 1977. The regional air quality plan recommended that fugitive dust emissions from quarrying operations be reduced by nearly 70 percent by paving quarry roads, applying water for dust control on all quarry roads, and chemical-water control of dust from all crushing, handling, and storage processes. The plan noted that even with the implementation of these control measures, attainment of the particulate matter ambient air quality standards would not be expected to be met near major quarries, including the Halquist Stone Company quarry. However, further controls were not recommended because the impact of fugitive dust emissions from quarries with controls in place are difficult to predict, and because the area affected by the potential violations was within and immediately adjacent to the quarries and did not include significant concentrations of residential structures. The Wisconsin Department of Natural Resources monitors ambient total suspended particulate levels at four locations near the Halquist Stone Company and Vulcan Materials Company quarries, as shown on Map 9. The sampling data for 1988 are summarized in Table 4. In 1988, four 24-hour composite measurements, ranging from 307 to 670 ug/m^3 of total suspended particulates, exceeded the EPA and DNR primary standard of 260 ug/m^3. As of August 8, 1989, only one measurement in

Map 9

WISCONSIN DEPARTMENT OF NATURAL RESOURCES AIR QUALITY MONITORING STATIONS IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

Halquist Stone Company Inc. Current Site

Halquist Stone Company Inc. Proposed Expansion Site

WDNR AIR QUALITY MONITORING STATIONS

1 W224 N5045 Eastview Drive

2 W227 N5978 Avon Court

3 Halquist Park W239 N53

4 Marchese's Danceland W249 N6424

GRID NORTH

GRAPHIC SCALE

Source: Wisconsin Department of Natural Resources.

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

Table 4

AMBIENT AIR QUALITY MEASUREMENTS TAKEN NEAR THE HALQUIST STONE COMPANY QUARRY: 1988

Location	Civil Division	Number of Samples	Total Suspended Particulates (ug/meter^3 @ 25°C)						
			Maximum 24-House Values				Arithmetic Mean	Geometric Mean	Geometric Standard Deviation
			1st	2nd	3rd	4th			
Halquist Park W239 N53[a]	Town of Lisbon	95	670	442	251	204	70	46	2.4
W227 N5978 Avon Ct.	Town of Lisbon	82	348	307	189	183	58	42	2.2
W224 N5045 Eastview Drive	Town of Lisbon	72	156	152	138	124	51	44	1.7
Marchese's Danceland W249 N6424[b]	Town of Lisbon	90	168	100	99	96	47	40	1.8

[a]Located closest to Halquist Stone Company quarry.

[b]Located farthest from Halquist Stone Company quarry.

[c]EPA and DNR Standard - Primary - 260 ug/m^3
Secondary - 150 ug/m^3

Source: Wisconsin Department of Natural Resources

1989 exceeded the standard.[6] However, that violation has been attributed to natural meteorologic conditions and background pollutant levels and not to the quarry operations.

Air quality monitoring by the Department of Natural Resources also indicated that the EPA and DNR total suspended particulate santards were exceeded on seven days in the spring and summer of 1987. The Department determined from an analysis of the nature of the particulates, wind speed, and wind direction on exceedance days that the Halquist Stone Company quarry was the culpable source of the emissions on six out of seven occasions in 1987.

During a May 25, 1988, site inspection of the Halquist Stone Company quarry, the Department identified several site conditions which were contributing to the air pollution problems. These included unprotected stock piles of material containing fine particles, and a lack of dust control on the primary rock rusher and on conveyor belts moving materials to the stock piles. Reentrainment of rock dust on CTH K in front of the quarry was also noted as a problem. In this case, unpaved road shoulders and high-speed traffic aggravate dusty conditions on the road. The Waukesha County Highway Department is responsible for paving road shoulders, and the Town of Lisbon is responsible for setting speed limits on CTH K. The Halquist Stone Company suggested to the County and Town that the road shoulders be paved and that the speed limits on CTH K be reduced in order to reduce dust and improve safety conditions on the road.

Other conditions and activities in the vicinity of the quarries may have contributed to fugitive dust emissions in 1987 and 1988. Construction work on STH 164, expansion of the Quadgraphics plant in Sussex, and the building of new subdivisions west and north of the Halquist Stone Company quarry all may have contributed dust to the air. Nonetheless, air quality exceedances in the vicinity of the quarries have been traced to both the Halquist Stone Company and Vulcan Materials Company quarries by the Department of Natural Resources.

---

[6]Paul White, Personal Communication, Wisconsin Department of Natural Resources, August 8, 1989.

The Halquist Stone Company has hired a consultant to help bring its dust problem under control and continues to work with the Department to help prevent future violations. The Department is continuing to monitor the air quality in the area.

The Halquist Stone Company has attempted to improve its dust control efforts, and has filed an air quality compliance plan with the Department of Natural resources. Current dust control measures include: 1) use of a street sweeper on CTH K in front of the quarry and on quarry haul roads two times per day, or as conditions require; 2) paving of quarry haul roads; 3) addition of a pressurized watering unit to the primary rock crushing in June 1987; and 4) application of calcium chloride solution to haul roads and the quarry floor. In addition, a new misting system is planned to be installed on the rock crushers.

The Vulcan Materials Company has also been the subject of an air quality monitoring program by the Department of Natural Resources. The Vulcan Materials Company quarry has also been found to contribute to the exceedance of established air quality standards for total suspended particulates. To reduce dust, the Vulcan Materials Company uses a water truck to wet quarry roads and Lisbon Road in front of the quarry. Conveyor belts are also occasionally wet down. Despite these measures, the Vulcan Materials Company quarry has been found by the Department to be one of the likely sources of excessive dust in the area near the quarry on at least one occasion during the 1988 monitoring season.

BIOLOGICAL ENVIRONMENT

Wetlands

Wetlands are natural areas in which the groundwater table lies near, at, or above the surface of the ground and which, therefore, support certain types of vegetation. Wetlands are usually covered by organic soils, silts, and marl deposits. Wetlands support valuable ecological habitats, enhance water quality conditions by trapping pollutants, and stabilize streamflows by storing peak discharges and releasing water during low-flow conditions. Wetlands also have important recreational, educational, and aesthetic values. Any sound evaluation of a major land use change such as the proposed quarry expansion must consider the potential impact on wetlands.

The location and extent of wetlands in the study area are shown on Map 10. In 1985 wetlands in the study area had a combined area of about 540 acres, or about 9 percent of that area. The individual wetlands comprising this total ranged in size from just over 100 acres down to less than one acre in area. Of most significance in the evaluation of the proposed expansion is the wetland location within the limits of the expansion site. The wetlands on and immediately adjacent to the site consist of the lowland hardwood area in the southwest portion of the proposed expansion site, the emergent marsh along Sussex Creek just east of the proposed expansion site, and the lowland shrub-emergent marsh along Sussex Creek just north of the proposed expansion site. As noted above, the wetland areas provide wildlife habitat, with the lowland hardwood area southwest of the quarry expansion site being classified as having a medium value wildlife habitat classification. The wetland of Sussex Creek just east of the expansion site is classified as providing a high value wildlife habitat.

Primary Environmental Corridors and Prime Agricultural Lands

One of the most important tasks completed under the regional planning effort has been the identification and delineation of those areas of the Region in which particularly valuable concentrations of natural resources occur, and which therefore should be preserved and protected. These areas have been termed environmental corridors by the Regional Planning Commission.[7]

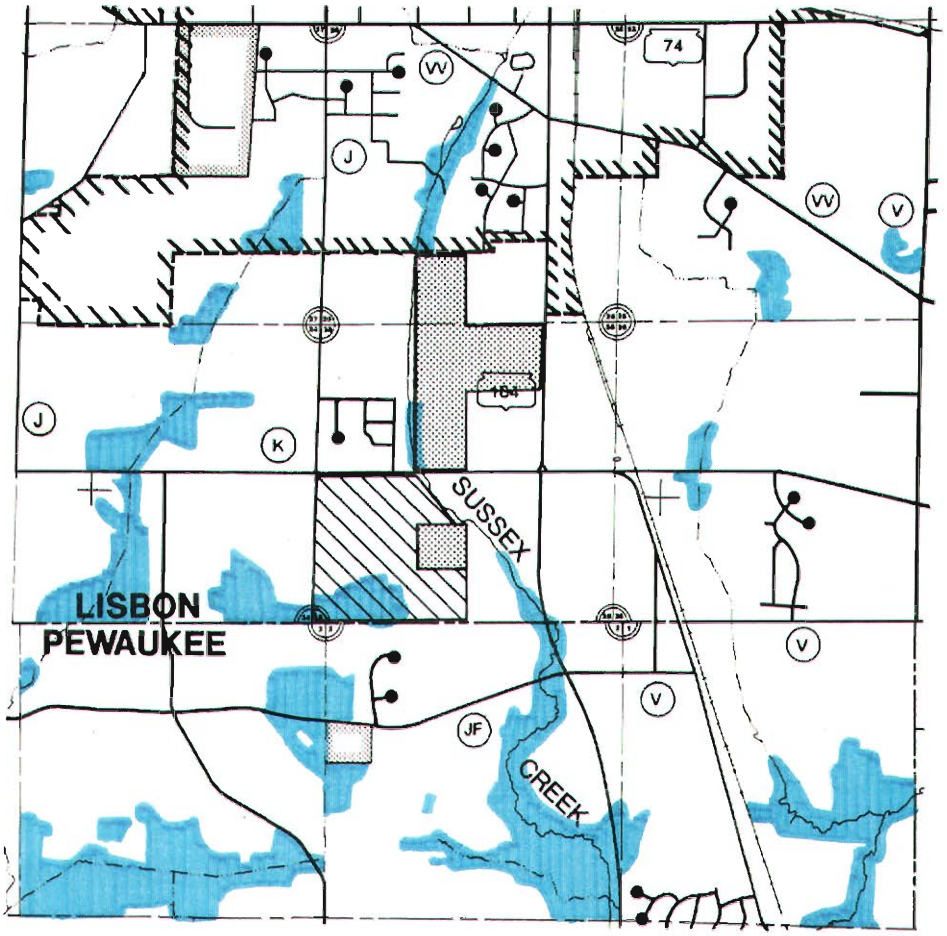
The location and extent of the primary environmental corridors in the study area are shown on Map 11. These corridors contain most of the remaining high-value woodlands, wetlands, and wildlife habitat areas in the study area, and are, in effect, a composite of the best individual elements of the natural resource base. These corridors thus have truly immeasurable environmental and recreational value. The protection of the primary environmental corridors from intrusion by incompatible rural and urban uses, and thereby from degradation and destruction, should be one of the principal objectives of any land use planning effort in the study area. Their preservation in an essentially

---

[7]For a description of the technique used to delineate the environmental corridors, see: SEWRPC Technical Record, Vol. 4, No. 2; March 1981.

Map 10

WETLANDS IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

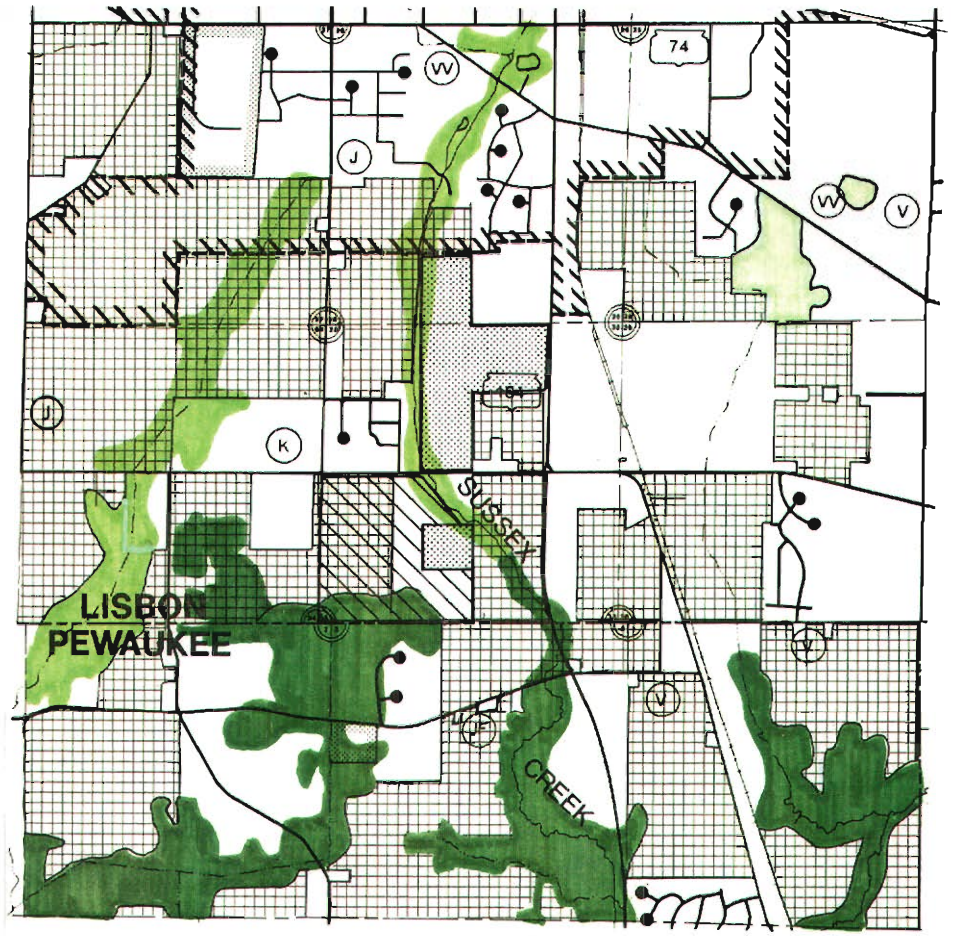
- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- Wetland

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

Map 11

ENVIRONMENTALLY SENSITIVE AREAS AND PRIME AGRICULTURAL LANDS IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Primary Enviromental Corridor
- Secondary Enviromental Corridor
- Isolated Natural Area
- Prime Agricultural Land
- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

open, natural state--including park and open space uses, limited agricultural uses, and country estate-type residential uses--will serve to maintain a high level of environmental quality in the study area, protect its natural beauty, and provide valuable recreational opportunities. As shown on Map 11, about 530 acres, or 9 percent of the total study area, are encompassed within the primary environmental corridors. The primary environmental corridor lands on the site of the proposed quarry expansion include only the lowland hardwoods in the southwestern portion of the site.

For planning purposes, it is useful to distinguish between prime agricultural lands and other farming areas. Prime agricultural lands are those lands which, in terms of farm size and soil characteristics, are best suited for the production of food and fiber. The Waukesha County Park and Planning Commission prepared a preservation plan for farmlands in Waukesha County, including those farmlands in the Village of Sussex study area. This plan, documented in Waukesha County Agricultural Land Preservation Plan, 1981, was adopted by the County in 1984. Prime agricultural lands within the study area identified in this plan are also shown on Map 11. In 1985, these areas encompassed about 2,200 acres, or about 38 percent of the study area. Of these lands, about 55 acres are located within the limits of the proposed quarry expansion site.

Stream Biological Conditions

The aquatic habitat and biological conditions within a stream are in part determined by the overall water quality conditions, and in part by the physical limitations of the stream. Table 5 summarizes a physical description, channel characteristics and ecological conditions of Sussex Creek in 1978. The sampling stations used in the survey are shown on Map 12. The bottom substrate is dominated by sludge deposits contributed in part by the Sussex wastewater treatment plant and fine white silt contributed by quarry operations. Macrophytes and attached algae are more abundant in the lower stream reaches than in the upper stream reaches. As described in the earlier section on surface waters, it should be noted that the Halquist quarry improved its wastewater treatment system in about 1979. Current discharge sampling in 1987 and 1988 indicated that the discharge quality is such that it should not result in significant sediment deposition. The Sussex sewage treatment plant also improved its level of treatment in 1976.

nps5.dbk

Table 5

OBSERVED AQUATIC HABITAT CONDITIONS IN SUSSEX CREEK: AUGUST 1978

Station Number[a]	Physical Description	Bottom Substrate	Land Use Adjacent to Stream Bank	Aquatic Ecology
1	Channel upstream of Sussex wastewater treatment plant outfall. Channel width: 18 feet; maximum depth: 2.0 feet	50 percent silt; 50 percent sand-pea gravel mixed	West bank agriculture (corn); east bank Sussex wastewater treatment plant; upstream residential-commercial land use	Potomageton sp. and Cladophora sp. covering approximately 15 percent of substrate. Acellus sp., Chironomidae, Simulidae and minnows rare.
2	Stream at Sussex wastewater treatment plant discharge outfall; effluent appears high in suspended solids	Sludge deposits cover entire stream substrate at depths up to 1.0 foot	West bank agriculture (corn); east bank Sussex wastewater treatment plant	Extensive shading of substrate by cattails. Oligachaeta abundant.
3	Sussex Creek-Sussex wastewater treatment plant mixzone. Channel width 12 feet; maximum depth 1.5 feet. Stream slightly impounded by culvert located downstream	Sludge deposits cover entire stream substrate at depths up to 1.0 foot	West band agriculture (corn); east bank Sussex wastewater treatment plant	Extensive shading of substrate by cattails. No filamentous algae or macrophytes observed.
4	Channel width approximately 12 feet; maximum depth approximately one foot. Located just downstream (approximately 25 feet) of culvert	Sludge deposits cover entire stream substrate at depths up to 0.5 foot. Bedrock is located below sludge deposits.	Agriculture (corn)	Extensive shading of substrate by cattails. No filamentous algae or macrophytes observed.
5	Channel width approximately 12 feet; maximum depth one foot. Water moderately turbid.	Sludge deposits cover entire stream substrate at depths up to 0.5 foot. Bedrock is located below sludge deposits.	Agriculture (corn)	Extensive shading of substrate by cat-tails. No filamentous algae or macrophytes observed.
6	Channel width approximately 12 feet; maximum depth one foot. Water moderately turbid.	Sludge deposits cover entire stream substrate at depths up to 0.5 foot. Bedrock is located below sludge deposits.	West bank agriculture (corn): east bank mixed grasses and stone quarry.	Extensive shading of substrate by cat-tails. No filamentous algae or macrophytes observed.
7	Channel width 11.5 feet; maximum depth approximately 0.9 foot. Water moderately turbid	Sludge deposits cover entire stream substrate at depths up to 0.5 foot. Bedrock is located below sludge deposits	West bank agriculture (corn); east bank mixed grasses and stone quarry	Extensive shading of substrate by cattails. No filamentous algae or macrophytes observed. Chironomidae and Oligochactae abundant.
8	Channel width approximately 12 feet; maximum depth approximately 1 foot. Stream velocity higher than upstream stations	Sludge deposits covers approximately 30 percent of stream substrate	West bank agriculture (corn); east bank mixed grasses and stone quarry	Cladophora sp. covers approximately 40 percent of stream substrate.

Table 5 (continued)

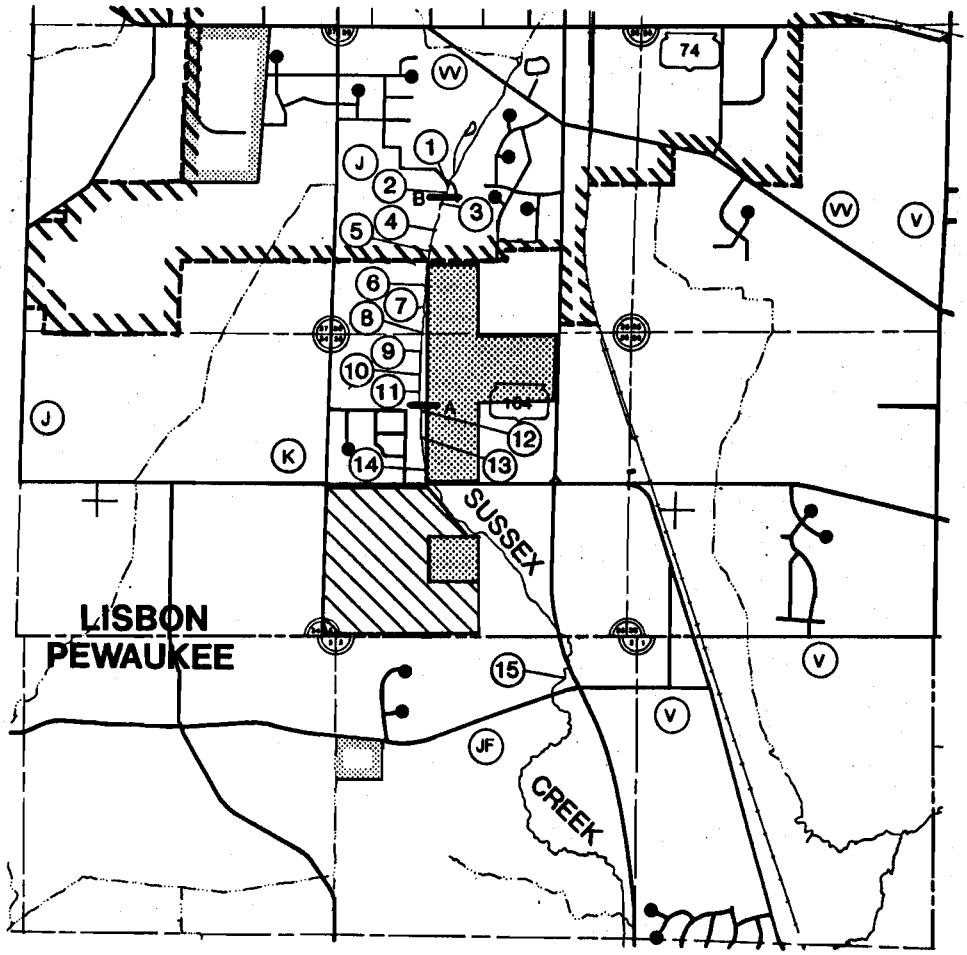
Station Number[a]	Physical Description	Bottom Substrate	Land Use Adjacent to Stream Bank	Aquatic Ecology
9	Channel width 20 feet; maximum depth 1.5 feet. Pool area formed by debris. Water moderately turbid	Sludge deposits cover entire stream substrate at depths up to 2.0 feet	West bank agriculture (corn); east bank mixed grasses and stone quarry	Cladophora sp. covers approximately 60 percent of stream substrate. Lesser amounts of cattails observed, approximately 30 percent of stream is shaded.
10	Channel width approximately 15-18 feet; maximum depth 1.0 foot. Stream meanders through alluvial deposits formed by old quarry washings	Sludge deposits less extensive and found primarily along stream banks. Substrate is up to 0.5 foot, very fine white silt overlying bedrock	West bank light residential with mixed agriculture. East bank is stone quarry	Cladophora sp. covering approximately 80 percent of stream substrate.
11	Channel width approximately 15 feet; maximum depth 0.9 foot. Upstream of quarry washing discharge	Substrate is bedrock overlain by fine white silt. Alluvial deposits from quarry operations causing impoundment of water	West bank light residential with mixed agriculture. East bank is stone quarry	Cladophora sp. covering approximately 80 percent of stream substrate. Numerous minnows observed in quarry discharge and stream mixing zone.
12	Stream at Halquist Stone Company quarry washing discharge. Discharge high in suspended solids. Extensive silt deposition downstream	Substrate is fine, white, shifting substrate	West bank light residential with mixed agriculture. East bank is stone quarry	Cladophora sp. covering approximately 80 percent of stream substrate. Numerous minnows observed in quarry discharge and stream mixing zone.
13	Halquist Stone Company discharge-Sussex Creek mixzone. Water chalky white, very turbid	Bedrock overlain by very fine white silt	West bank light residential with mixed agriculture. East bank is stone quarry	Cladphora sp. covers approximately 75 percent of stream, substrate.
14	Water moderately turbid	Bedrock overlain by very fine white silt	West bank light residential. East bank Halquist Stone Company quarry	Cladophora sp. and Potomogeton sp. covering approximately 80 percent of stream substrate.
15	Channel width 10 feet; maximum depth 0.9 foot. Water relatively clear compared to stations upstream	Bedrock	West bank agriculture (corn); east bank grass meadow	Cladophora sp. covering approximately 75 percent of stream substrate.

[a]As shown on Map 12.

Source: Wisconsin Department of Natural Resources.

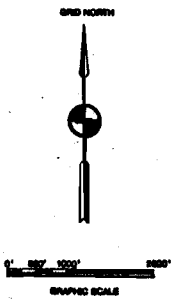
Map 12

SAMPLING STATIONS LOCATION ALONG SUSSEX CREEK



LEGEND

- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- (7) Sampling Station
- A Quarry Main Outfall Location
- B Sussex WWTP Outfall Location



Source: Wisconsin Department of Natural Resources

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

Table 6 presents a habitat rating of Sussex Creek upstream of the Sussex wastewater treatment plant. The rating was prepared by the Department of Natural Resources in 1982. In general, Sussex Creek had little degradation of the stream channel, relatively minor streambank erosion, and modest vegetative cover of the banks. However, the habitat was rated as poor because of shallow water depths and inadequate discharge rates at low-flow conditions, because the stream has few meanders, and because less than 10 percent of the bottom substrate is suitable for desired aquatic life.

A procedure known as the Biotic Index can be used to evaluate the water quality of streams. The biotic index is a numerical value assigned to a stream location based upon the abundance and pollution-tolerance of benthic invertebrates--insects, amphipods, and isopods. The Biotic Index values range from 0.00 to 4.00, depending on the benthic invertebrates identified. The higher the index value, the lower the indicated water quality. The calculated Biotic Index values at five locations in Sussex Creek are presented in Table 7. The Index values, calculated by the Department of Natural Resources in 1982 and 1983, ranged from 3.34 to 5.00. The average Biotic Index values at each station indicated poor or very poor water quality conditions.

The fish species present in a stream provide another indication of water quality conditions. Fish species sampled in Sussex Creek in 1982 are listed in Table 8. A total of five species were identified, with stickleback and white sucker accounting for 84.5 percent of the fish collected. This fish community is typical of forage fish communities found in many southeastern Wisconsin streams. Stickleback, which seldom exceed two or three inches in length, prefer slightly turbid water, but are sometimes found in streams with high turbidity. White sucker are very common and widespread in lakes and streams in Wisconsin and are very tolerant of pollution--including high turbidity. Larger white sucker--which may reach 16 inches in length--are valuable sport fish. White sucker are generally bottom dwelling fish, but production is poor where filimentous algae covers the bottom. As presented in Table 5, filimentous algae--primarily Cladophora, covers 75 to 80 percent of the substrate in the lower reaches of Sussex Creek. Green sunfish, also fished for sport, are more tolerant to turbidity and siltation than are other sunfish species. Mudminnows, which are abundant in marshes, ditches, and small streams, often lie in the mud and plants of stream pools. Mudminnows

nps4.dbk/ib
330-600

Table 6

STREAM HABITAT RATING FOR SUSSEX CREEK UPSTREAM OF THE SUSSEX WASTEWATER TREATMENT PLANT: 1982

Parameter	Rating				Comments
	Excellent	Good	Fair	Poor	
1. Watershed Agricultural Soil Erosion	X	--	--	--	Little evidence of soil erosion. Stable vegetative cover.
2. Nonpoint Sources of Pollution	--	--	X	--	Urban land runoff impacts.
3. Streambank Erosion	--	X	--	--	Infrequent bank erosion.
4. Streambank Vegetative Cover	--	X	--	--	70-90% coverage.
5. Lower Bank Channel Capacity	X	--	--	--	Ample for peak flows. With/depth ratio <7.
6. Lower Bank Deposition	X	--	--	--	Little enlargement of channel or point bars
7. Bottom Scouring	X	--	--	--	Less than 5% of bottom scoured.
8. Bottom Substrate	--	--	--	X	Less than 10% rubble, gravel, or other suitable habitat.
9. Average Water Depth at Low Flow	--	--	X	--	6 - 12 inches
10. Discharge at Low Streamflow Conditions	--	--	--	X	Less than 0.5 cfs.
11. Pool/Riffle and Run/Bend Ratios	--	--	--	X	Ratios greater than 2.5. Primarily a straight stream.
12. Aesthetics	--	--	X	--	Common setting.

Source: Wisconsin Department of Natural Resources.

nps6.dbk
8/8/89

Table 7

CALCULATED BIOTIC INDEX VALUES FOR SUSSEX CREEK: 1982-1983

Station Number[a]	Location	December 1982 Sample 1	December 1982 Sample 2	December 1982 Sample 3	September 1983 Sample 1	September 1983 Sample 2	September 1983 Sample 3	Mean Biotic Index	Indicated Water Quality[b]
1	Upstream of Sussex wastewater treatment plant	4.47	4.89	4.59	3.81	3.70	4.01	4.24	Poor
2	Downstream of Sussex wastewater treatment plant	3.77	3.50	3.71	4.65	4.73	4.64	4.17	Poor
7	Upstream of Halquist Stone Company outfall	--	--	--	4.99	4.90	4.94	4.94	Very poor
11	Upstream of Halquist Stone Company outfall	3.34	3.93	3.59	5.00	4.56	4.97	4.23	Poor
15	Downstream of Halquist Stone Company outfall	3.37	--	--	4.93	4.93	4.98	4.55	Very poor

[a]As shown on Map 12.

[b]

Biotic Index	Indicated Water Quality
0.00-1.75	Excellent
1.76-2.25	Very good
2.26-2.75	Good
2.76-3.50	Fair
3.51-4.25	Poor
4.26-5.00	Very poor

Source: Wisconsin Department of Natural Resources.

Table 8

FISH SPECIES COLLECTED FROM
SUSSEX CREEK: OCTOBER 28, 1982

Species	Fish Collected	of Total
Stickleback.....	26	50.0
White Sucker.....	18	34.5
Green Sunfish....	4	7.7
Mud Minnow.....	2	3.9
Minnow sp.....	2	3.9
Total	52	100.0

Note: Fish sampled by boom-shocking at Station No. 1 on Map 12 located about 300 feet upstream of the Sussex wastewater treatment plant outfall. The stream width was seven feet; the water depth was 1.5 feet; and the substrate was silt with some gravel.
Source: Wisconsin Department of Natural Resources.

prefer clear or slightly turbid water with moderate to dense aquatic plant growth.

SOCIOECONOMIC ENVIRONMENT

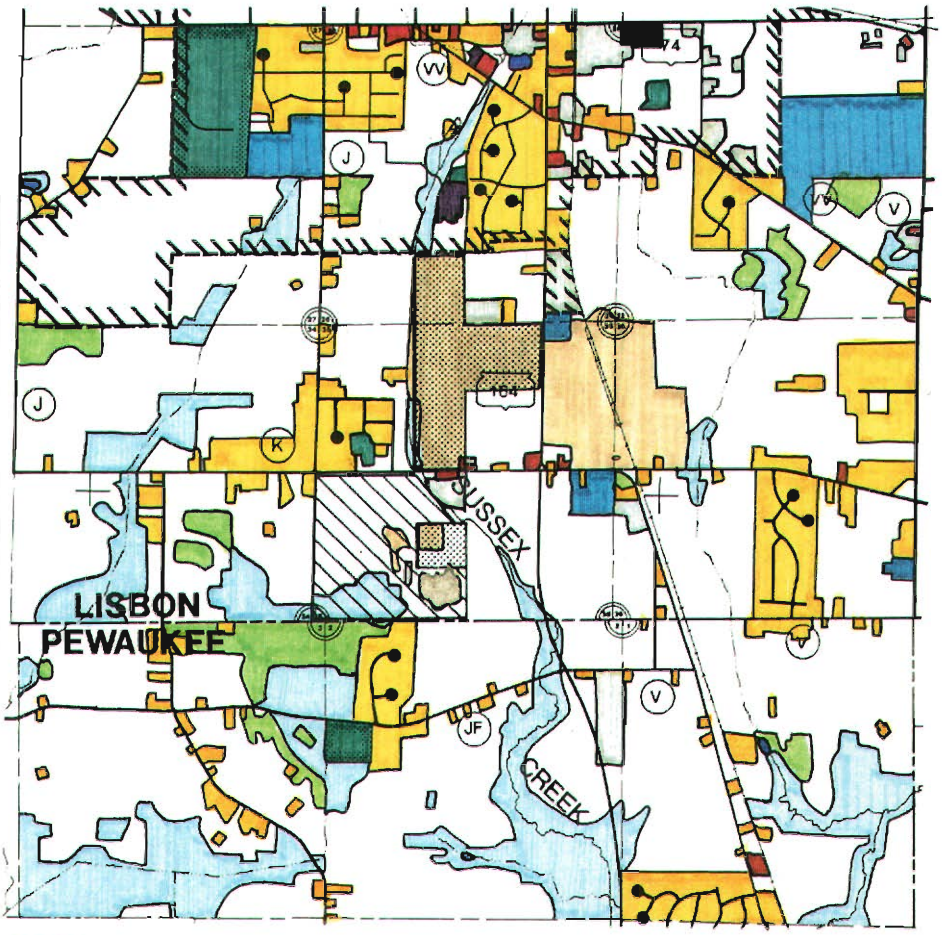
Current and Planned Land Use

The current land use pattern within the study area in 1985, based upon Regional Planning Commission inventory data is shown on Map 13. Quantitative data concerning that land use pattern are provided in Table 9. As indicated in Table 9, under existing conditions about 5,700 acres, or about 78 percent of the study area, is still in rural uses. The most significant rural use is agriculture, comprising 3,200 acres, or about 72 percent of the rural land uses. Currently, extractive, or quarrying, operations, which are included in the rural land use category, comprise about 261 acres, or about 6 percent of that category. About 1,260 acres, or 22 percent of the study area, is devoted to urban uses. The two most significant urban uses are residential, comprising 598 acres, or 47 percent of the urban total; and transportation and utilities, comprising 324 acres, or 26 percent of the urban total.

A recommended future land use pattern for the study area is provided in the adopted regional land use plan for southeastern Wisconsin as refined by local land use plans prepared by the Village of Sussex and the Town of Pewaukee. In order to cope with the major changes in the socio-economic characteristics of the Region that became evident in the 1970s and 1980s, the Regional Planning Commission applied an approach termed "alternative futures" in its areawide planning efforts. Under this approach, the development and evaluation of alternative land use plans is based not upon a single most probable forecast of future socio-economic conditions--the traditional approach to planning in periods of social and economic stability when historic trends can be reasonably anticipated to continue into the future--but rather upon a number of alternative futures chosen to represent a range of conditions which may occur over the plan design period. The purpose of the alternative futures approach is to allow the evaluation of the performance of plans over a variety of possible future conditions in order to identify those that perform well under a wide range of such conditions.

Map 13

LAND USE IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA: 1985



LEGEND

- Residential
- Commercial
- Industrial
- Extractive
- Transportation, Communication, and Utilities
- Government and Institutional
- Recreational
- Woodland
- Wetland
- Surface Water
- Agriculture

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN

T8NR19E LISBON TOWNSHIP | T7NR19E PEWAUKEE TOWNSHIP

Table 9

LAND USE IN THE HALQUIST QUARRY STUDY AREA: 1985

Land Use	Village of Sussex		Town of Lisbon		Town of Pewaukee		Study Area	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
URBAN								
Residential	183	18.5	273	9.6	142	7.4	598	10.4
Commercial	9	0.9	6	0.2	1	0.1	16	0.3
Industrial	46	4.6	23	0.8	20	1.1	89	1.6
Transportation, Communication, and Utilities	110	11.0	138	4.9	76	4.0	324	5.6
Government and Institutional	29	2.9	95	3.3	0	0.0	124	2.1
Recreational	81	8.2	4	0.1	7	0.4	92	1.6
Unused	20	2.0	0	0.0	0	0.0	20	0.4
Urban Subtotal	478	48.1	539	18.9	246	13.0	1,263	22.0
RURAL								
Surface Water	3	0.3	3	0.1	1	0.1	7	0.1
Wetlands	34	3.4	167	5.8	352	18.5	553	9.6
Woodlands	6	0.6	56	2.0	88	4.6	150	2.6
Agriculture	346	34.9	1,678	59.0	1,207	63.5	3,231	56.3
Other Open	127	12.7	141	5.0	5	0.3	273	4.8
Extractive	0	0.0	261	9.2	0	0.0	261	4.6
Rural Subtotal	516	51.9	2,306	81.1	1,653	87.0	4,475	78.0
Total	994	100.0	2,845	100.0	1,899	100.0	5,738	100.0

Source: SEWRPC.

Three alternative future scenarios have been postulated for regional land use planning purposes, with two intended to identify reasonable extremes and one intended to identify a most probable future that lies between the two extremes. Population and employment changes attendant to each future have been projected. A "most reasonably optimistic" future scenario of population and employment change was postulated by combining those socio-economic factors that were internally consistent and would create highly favorable conditions for economic and population growth within the Region. Similarly, a "most reasonably pessimistic" future scenario was postulated by combining those socio-economic factors that would tend to create unfavorable conditions for economic and population growth within the Region. In addition, an intermediate future scenario was postulated. An additional variable was added to the analysis in the preparation of land use plans for each scenario. That variable deals with the degree of centrality of incremental urban land use development as measured by the relative nearness of such new land uses to the major population centers in the Region.[8]

For the purposes of the Halquist Quarry Expansion study, it was determined to present a future land use plan based upon an intermediate-centralized future scenario. This particular alternative future scenario is most consistent with the local land use plans prepared by the Village of Sussex and by the Town of Pewaukee, and furthermore, is the basis upon which recent sewerage system development decisions have been made by the local units of government in the area. In addition, a brief discussion is provided on the potential changes in land use which could be expected should the condition associated with an optimistic decentralized future scenario be realized.

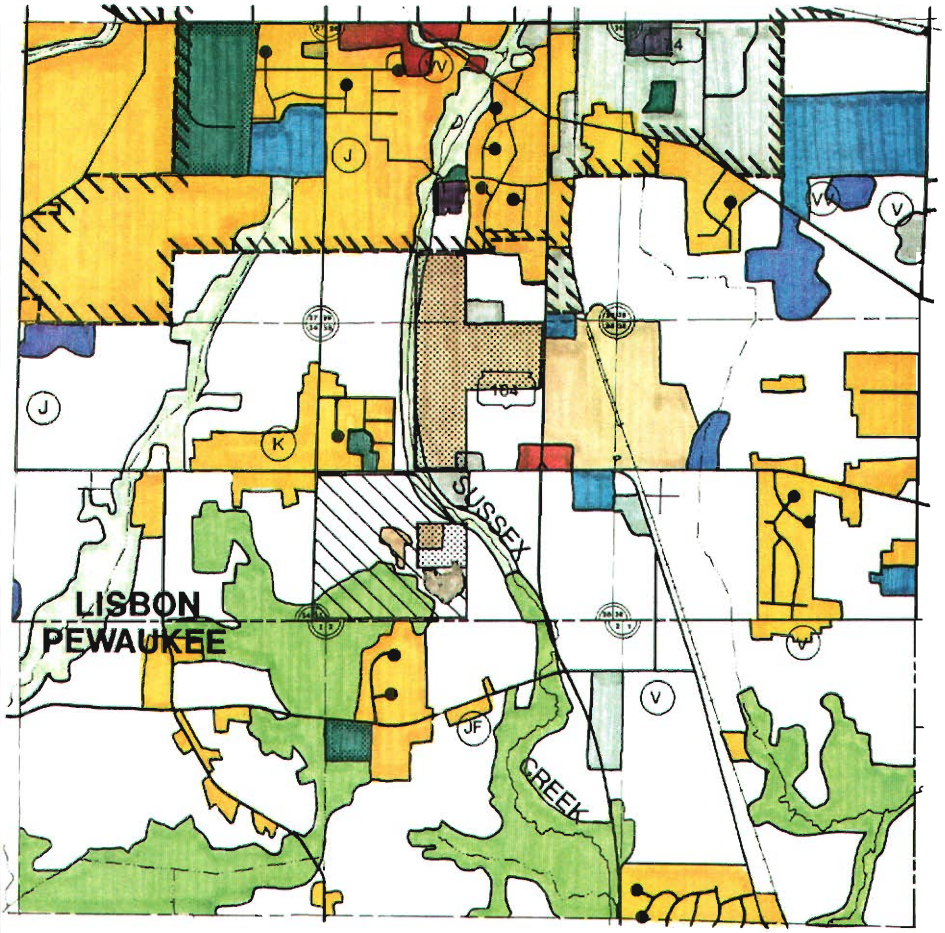
Planned year 2010 land use conditions under the intermediate-centralized scenario are shown on Map 14 and summarized in Table 10. As indicated in Table 10 under this alternative future, about 414 acres of rural land, or

---

[8]For more information concerning the alternative futures technique and its application in southeastern Wisconsin, see SEWRPC Technical Report No. 25, Alternative Futures for Southeastern Wisconsin; SEWRPC Technical Report No. 11 (2nd Edition), The population of Southeastern Wisconsin; and SEWRPC Technical Report No. 10 (2nd Edition), The Economy of Southeastern Wisconsin.

Map 14

LAND USES IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA: 2010



LEGEND

- Residential
- Commercial
- Industrial
- Extractive
- Transportation, Communication, and Utilities
- Government and Institutional
- Recreational
- Primary Environmental Corridor
- Secondary Environmental Corridor
- Isolated Natural Area
- Agriculture

GRID NORTH

0' 500' 1000' 2000'
GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA-
WAUKESHA COUNTY, WISCONSIN

T8NR19E LISBON TOWNSHIP | T7NR19E PEWAUKEE TOWNSHIP

H01a.tb2/noc/ib

Table 10

LAND USE IN THE HALQUIST QUARRY STUDY AREA: 2010

Land Use	1985		Planned Change		2010[a]	
	Acres	Percent of Total	Acres	Percent of Total	Acres	Percent of Total
URBAN						
Residential	598	10.4	247	41.3	845	14.7
Commercial	16	0.3	5	31.3	21	0.4
Industrial	89	1.6	40	44.9	129	2.2
Transportation, Communication, and Utilities	324	5.6	109	33.6	433	7.5
Government and Institutional	124	2.1	8	6.5	132	2.3
Recreational	92	1.6	9	9.8	101	1.8
Unused	20	0.4	-4	-20.0	16	0.3
Urban Subtotal	1,263	22.0	414[a]	32.8	1,677[a]	29.2[a]
RURAL						
Surface Water	7	0.1	0	0.0	7	0.1
Wetlands	553	9.6	0	0.0	553	9.6
Woodlands	150	2.6	0	0.0	150	2.6
Agriculture	3,231	56.3	-349[b]	-10.8	2,882[b]	50.2
Other Open	273	4.8	- 99	-56.9	174	3.0
Extractive	261	4.6	34[c]	13.0	295[c]	5.1
Rural Subtotal	4,475	78.0	-414	-10.2	4,061	70.8
Total	5,738	100.0	0	0.0	5,738	100.0

[a]Planned land use based upon the preliminary year 2010 regional land use plan which assumes an intermediate growth-centralized land use future scenario. Under the extreme optimistic growth-decentralized land use future scenario, an additional 1,500 acres of rural land would be converted to urban uses in the study area.

[b]Under the proposed expansion of the Halquist Quarry, this planned change in agricultural lands is minus 449 acres and the total area of agricultural land in the year 2010 is 2,782 acres.

[c]Under the proposed expansion of the Halquist Quarry, the planned changes in extractive land is a plus 134 acres and the total area in the year 2010 is 395 acres.

Source: SEWRPC

about 7 percent of the study area, may be expected to be converted from rural to urban use over the next approximately two decades. This conversion would increase the amount of land in urban use within the study area by about 33 percent. Of the total area to be converted, about 247 acres, or about 60 percent, would be converted to residential use; about 109 acres, or about 26 percent, to transportation and utilities; and about 40 acres, or about 10 percent, to industrial use.

The Halquist Stone Company and Vulcan Materials Company quarries covered a combined total of about 261 acres in 1985, accounting for 4.6 percent of total study area. Recent and committed extensions of the existing quarries will add about 34 acres to extractive land uses in the study area by the year 2010. As indicated in Table 10, if the Halquist Stone Company's proposed expansion is approved, extractive land use would increase by about 100 acres, to 395 acres, or 6.9 percent of the study area.

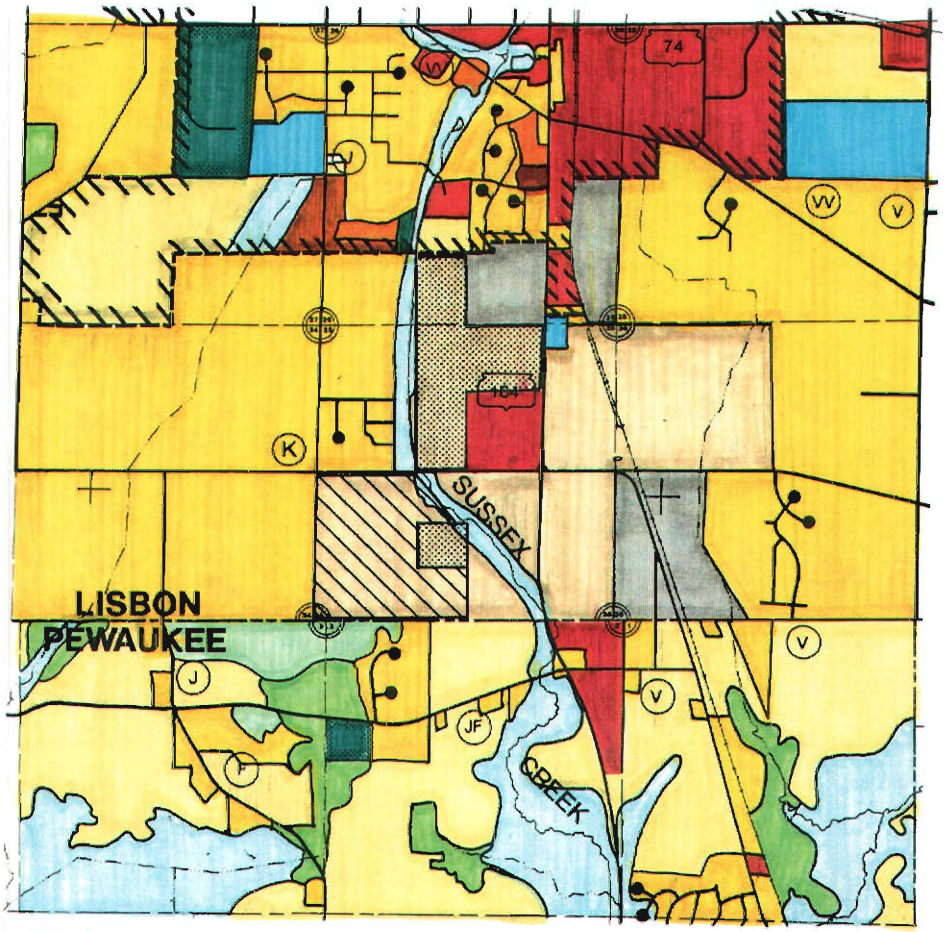
As noted above, other future land use scenarios can be postulated. Under an optimistic-decentralized land use plan, approximately 2.5 square miles of additional rural land would be converted to urban uses in the study area over and above the planned urban areas shown on Map 14 and summarized in Table 10, with the majority of the new urban land being in residential uses. This increase in urban land would occur throughout the study area, excepting U.S. Public Land Survey Sections 34, 35, and the western one-half of Section 36, Township 8 North, Range 19 South, Town of Lisbon, which include the current and proposed quarry operations.

Zoning

The various zoning districts and attendant district regulations within the study area are set forth in the comprehensive zoning ordinances of the Village of Sussex and the Towns of Lisbon and Pewaukee. The zoning districts are shown on Map 15. The shoreland and floodland zoning in both towns are under County jurisdiction. Floodland and wetland zoning in all jurisdictions are jointly exercised with the State. It can be noted that the site of the proposed quarry expansion is zoned as a quarrying district. Areas immediately north and west, and a small area to the south of the proposed expansion site are currently zoned for residential use.

Map 15

EXISTING ZONING IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Floodland
- Upland Conservancy
- Agriculture
- Lowland Conservancy
- Residential-Single Family
- Business/Wholesale
- Residential-Two Family
- Industrial
- Residential-Multi Family
- Quarry
- Park
- Institutional

GRID NORTH

0' 500' 1000' 2000'
GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

It is important to note that the zoning requirements effective in the Town of Lisbon indicate that quarrying operations shall not be permitted closer than 1,000 feet to a residential district unless approved by the Town Board after public hearing, and in no case shall such quarrying operation be permitted closer than 200 feet to any residential district. There is also a requirement for setback distance of 200 feet from street and highway right-of-way. The lands immediately north and east of the proposed quarry expansion site are zoned as A2 in the Town of Lisbon zoning ordinance. The A2 zoning provides for a minimum lot size of 40,000 square feet and provides for single-family dwelling units, public parks, and recreation areas, crop and tree farming, and limited means of keeping poultry and domestic livestock. The land immediately adjacent to Sussex Creek on the east side of the proposed expansion site is zoned Conservancy. The lands immediately south of the proposed quarrying site are zoned primarily in agricultural and conservancy uses by the Town of Pewaukee zoning ordinance, with one area which is an existing subdivision zoned in the R2 District, which provides for single-family residential uses on lots with a minimum size of two acres.

The Village of Sussex has enacted an offensive industry ordinance. Such a provision is provided for under Section 66.052 of the State Statutes and allows the Village to license, regulate, or prohibit certain types of industrial activities within the Village and within one and one-half miles from the Village limits, an area including portions of the Halquist quarry expansion site. The Village's ordinance includes a reference to quarries as one of the industries to be regulated.

Population and Housing Units

The historic, current, and probable future population levels within the study area are set forth in Table 11 by current civil division boundaries. Over the period of 1970 through 1985, the population of the study area increased from about 2,300 persons to 2,700 persons--an increase of about 17 percent. In 1985, nearly one-half of the population of the study area, representing about 1,300 persons, resided in the Village of Sussex portion of the study area, with the remaining 1,400 persons residing in a dispersed pattern throughout the Town of Lisbon and Town of Pewaukee portions of the study area. Probable future population levels within the study area are set forth in Table 11. As noted earlier, these data are based upon the intermediate-centralized future

H01a.tb5/noc/ib
8/3/89

Table 11

POPULATION IN THE HALQUIST QUARRY EXPANSION STUDY AREA: 1985-2010

Community	1970		1985		Increment 1985-2010	2010[a]	
	Population	Percent of Total	Population	Percent of Total	Population	Population	Percent of Total
Village of Sussex	1,161	50	1,255	46	725	1,311	33
Town of Lisbon	911	39	948	35	593	2,210	55
Town of Pewaukee	502	11	502	19	-36	466	12
Study Area	2,344	100.0	2,705	100	3,987	3,987	100

[a]Based upon constant 1988 corporate limits.

Source: SEWRPC

conditions scenario. The resident population of the study area under that scenario may be expected to increase to about 4,000 persons over the 25-year period--1985 through 2010--or by about 45 percent over current levels, with the largest increases occurring in the Village of Sussex and in the Town of Lisbon portions of the study area. The population of the Town of Pewaukee portion of the study area would remain relatively stable under this alternative future.

The number of housing units in the study area for the period 1970 through 1985 and the number which may be anticipated by the year 2010 are shown on Table 12. The number of housing units is expected to increase from about 800 in 1985 to over 1,400 by the year 2010, an increase of just over 70 percent. This is in contrast to the 48 percent increase in resident population levels noted above, and is due to an anticipated continued decline in household size.

Under the optimistic growth-decentralized land use plan future scenario, discussed above under the land use section, the resident population of the study area could reach 11,000 persons, a 400 percent increase over the 1985 population level, with the growth occurring in nearly all portions of the study area. Under this more optimistic growth-decentralized land use pattern, the number of housing units in the study area may be expected to increase from the 1985 level of about 800 to about 3,900 by the year 2010, an increase of almost 400 percent. Growth in housing units, under this scenario, would take place in nearly all of the study area excepting U.S. Public Land Survey Sections 34, 35, and the western one-half of 36, Township 8 North, Range 19 East, Town of Lisbon, which area includes the current and proposed quarry operations.

Employment

Employment levels within the Halquist quarry expansion study area for the years 1972 to 2010 are shown by community in Table 13. The employment level within the study area more than doubled--from about 807 jobs in 1972 to approximately 1,913 jobs in 1985. In 1985, nearly 23 percent of the jobs were located in the Village of Sussex, 76 percent in the Town of Lisbon, and the remaining 1 percent in the Town of Pewaukee. Probable future employment levels within the study area are anticipated to increase to slightly over 2,400 jobs by the year 2010--an increase of about 25 percent over the 1985 level.

Table 12

HOUSING UNITS IN THE HALQUIST QUARRY EXPANSION
STUDY AREA: 1985-2010

Community	1970 Housing Units	1970 Percent of Total	1985 Housing Units	1985 Percent of Total	Increment 1985-2010 Housing Units	2010[a] Housing Units	2010[a] Percent of Total
Village of Sussex...	292	49	422	50	0	496	35
Town of Lisbon.....	226	38	272	33	587	785	55
Town of Pewaukee....	79	13	139	17	6	145	10
Study Area	597	100	833	100	693	1,426	100

[a]Based upon constant 1988 corporate limits.

Source: SEWRPC

Table 13

EMPLOYMENT IN THE HALQUIST QUARRY EXPANSION STUDY AREA: 1972-2010

Community	1972 Employment	1972 Percent of Total	1980 Employment	1980 Percent of Total	1985 Employment	1985 Percent of Total	2010 Employment	2010 Percent of Total
Village of Sussex	242	30.0	536	39.0	444	23.0	464	19.0
Town of Lisbon...	494	61.0	743	54.0	1,445	76.0	1,922	80.0
Town of Pewaukee.	71	9.0	102	7.0	24	1.0	24	1.0
Study Area	807	100.0	1,381	100.0	1,913	100.0	2,410	100.0

Source: SEWRPC.

Traffic

The Halquist Stone Company, Inc., quarry and its proposed quarry expansion site abut CTH K between STH 164 and CTH J. As shown on Map 16, these facilities are part of the arterial street and highway system within the study area. This segment of CTH K is generally constructed as a two-lane rural cross section. However, adjacent to the Halquist property, the pavement is 48 feet wide providing two through-traffic lanes and two turn lanes. In 1988, the traffic volume on this segment of CTH K was 5,940 vehicles per average weekday. Based on a manual turning movement count of the Halquist Stone Company driveway, a substantial portion of the total average weekday traffic is truck traffic. Approximately 20 percent of all traffic east of the driveways and 12 percent of all traffic west of the driveways is truck traffic. The turning movement data are shown in Figure 3.

The current average weekday traffic is below the design capacity of a two-lane rural roadway--7,000 vehicles per average weekday. The traffic into and out of the driveway on the north side of CTH K is moderately heavy but has relatively little impact on CTH K traffic because: 1) the demand is relatively constant throughout the day; and 2) the added lanes at the Halquist property facilitate separation of through traffic and turning traffic.

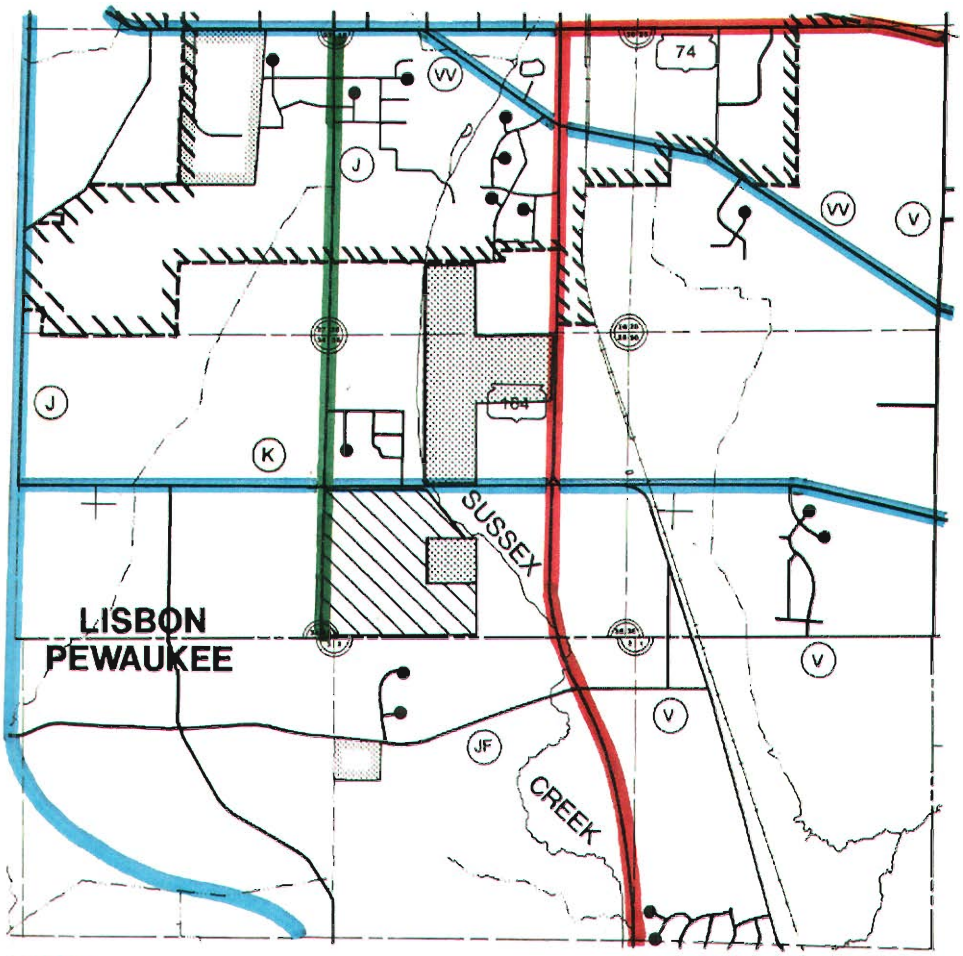
Noise

Noise may be regarded as one of the most directly unpleasant impacts of quarrying operations, especially when located near residential areas. Unlike other potential impacts such as those on water quality or groundwater resources, noise impacts are readily apparent and easily detected. In addition to human impacts, excessive noise may also interfere with wildlife nesting and movement habits.

Noise can be categorized as constant, fluctuating, or intermittent. Constant noises, which do not vary, are the easiest to adapt to and are the least offensive. Fluctuating noises, such as traffic, vary on a somewhat regular basis, and the variation in noise level is not extreme. Fluctuating noises can be irritating, but are generally not considered a serious nuisance. Intermittent noises are sharp, loud sounds which occur at irregular intervals. Intermittent noises can be extremely unpleasant and difficult to adjust to. In general, quarrying operations generate intermittent noises. Examples of

Map 16

ARTERIAL STREET AND HIGHWAY IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

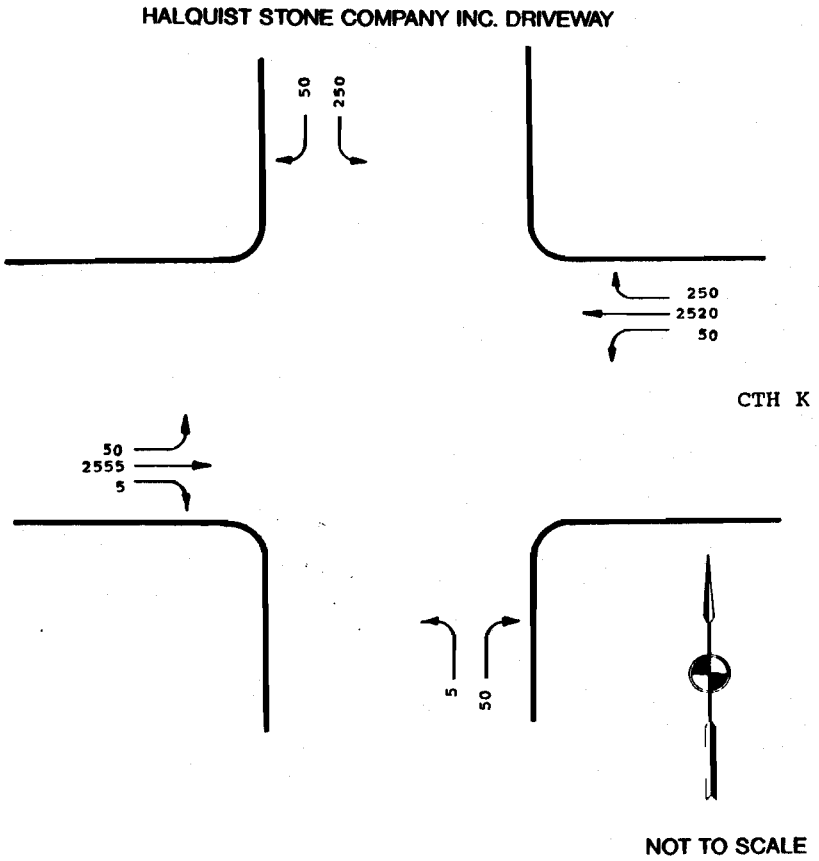
- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- State Trunk Highway
- County Trunk Highway
- Local Arterial

Source; SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP T7NR19E PEWAUKEE TOWNSHIP

Figure 3

AVERAGE WEEKDAY TURNING MOVEMENT COUNTS AT THE HALQUIST QUARRY DRIVEWAY ON CTH "K": 1988



Source: SEWRPC.

such noises are blasting, the use of heavy equipment, and rock crushing operations.

The most widely accepted unit of noise measurement is the decibel (dBA), which is a logrithmic measure of sound pressure. Higher decibel levels are assigned to higher noise intensities. Decibel levels below 20 dBA are difficult to perceive by humans, while levels exceeding 125 dBA frequently cause pain. The effects of decibel levels ranging from 20 to 140 dBA on humans are listed in Table 14.

The effects of noise on the surrounding environment depend on the ambient noise levels, on the land uses, and on the time of day. Table 15 presents the ambient noise levels and the sensitivity of different land uses to noise levels expected from quarrying operations. Residential areas and wildlife habitats can be considered to be moderately to highly sensitive to such noises, while agricultural land, open land, and industrial land would be relatively insensitive.

In general, decibel levels less than 55 dBA are considered to have little impact on residential areas, parks, schools, and churches, which are all sensitive to high noise levels. About 5 percent of the population may be expected to be significantly annoyed by this noise level. However, at 75 dBA, noise levels would have a major adverse impact, generating many complaints and threats of legal action. About 37 percent of the population would be significantly annoyed at a decibel level of 75 dBA. At decibel levels of about 80 to 85 dBA, mammals and birds are usually frightened.

Noise levels for heavy equipment commonly used in quarrying operations are shown on Figure 4. In addition to the noise levels shown on the figure, blasting activities would cause the most intense noise, producing decibel levels ranging up to 150 dBA. The figure indicates that, in the absence of noise controls, quarrying operations would be expected to annoy persons in residential, park, school, and church areas located within at least 500 feet of the site. In general, it can be assumed that noises decrease at a level of 6 dBA for every doubling of distance, plus an atmospheric adsorption rate typically ranging from 0.02 to 0.1 dBA per 100 feet.

Halquist.t14/ib

Table 14

EFFECTS OF NOISE ON HUMANS

dBA Level	Potential Effect
20	No sound perceived
25	Hearing threshold
30	--
35	Slight sleep interference
40	--
45	--
50	Moderate sleep interference
55	Annoyance (mild)
60	Normal speech level
65	Communication interference
70	Smooth muscles/glands react
75	Changed motor coordination
80	Moderate hearing damage
85	Very annoying
90	Affect mental and motor behavior
95	Severe hearing damage
100	Awaken everyone
105	--
110	--
115	Maximum vocal effort
120	--
125	Pain threshold
130	Limit amplified speech
135	Very painful
140	Potential hearing loss high

Source: Jack Golden, et al, Environmental Impact Data Book, and SEWRPC.

Table 15

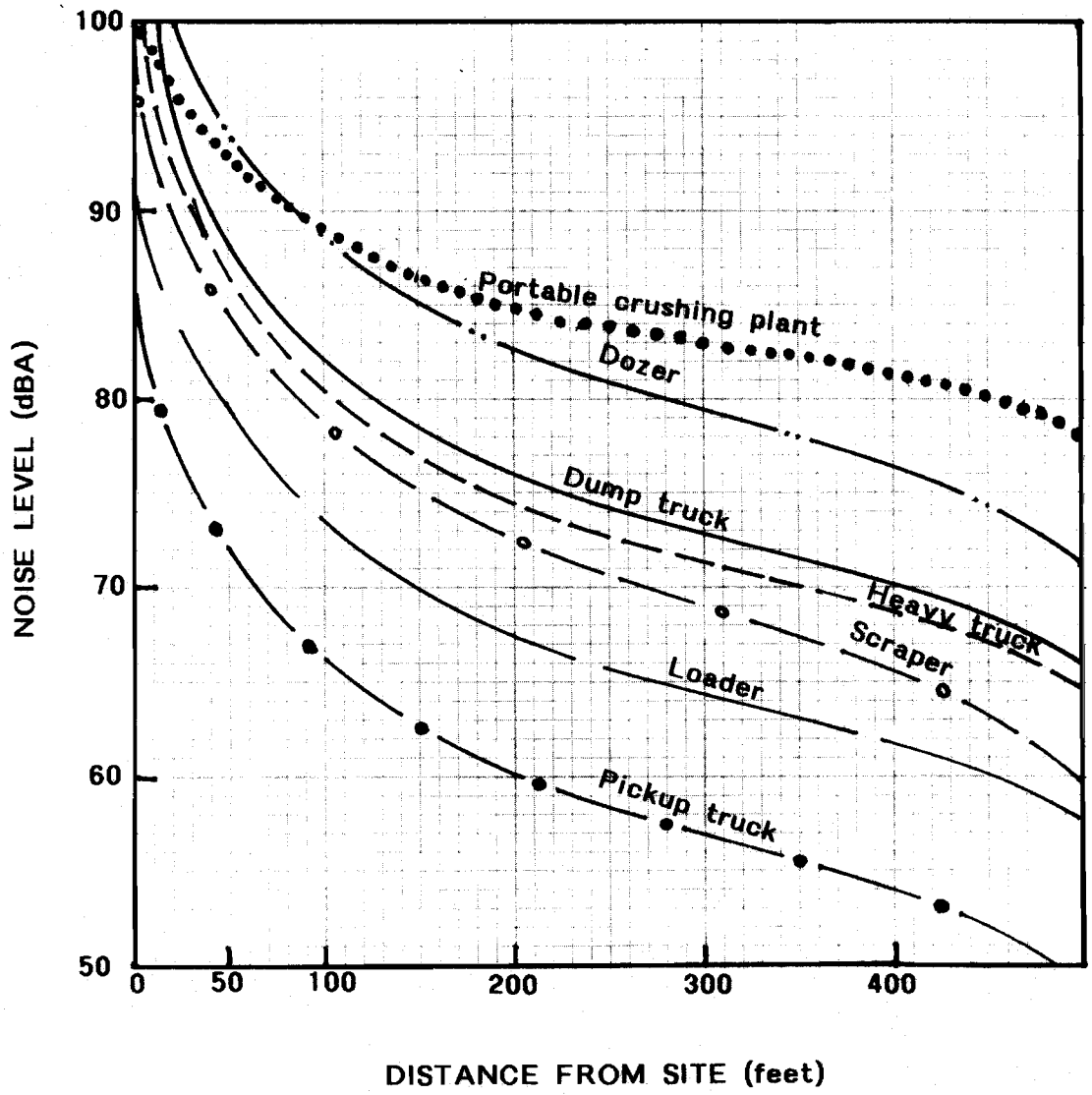
IMPACT OF LAND USE ON SENSITIVITY TO NOISE LEVELS

Land Use	Ambient Noise Levels		Potential Sensitivity To Noise Levels Produce By Quarrying Operations
	Relative	Level (dBA)	
1. Agricultural	Low	30-40	Insensitive
2. Open (No Wildlife Habitat)	Low	25-35	Insensitive
3. Open (Wildlife Habitat)	Low	25-35	Moderately Sensitive
4. Residential	Low-Moderate	40-50	Highly Sensitive
5. Commercial	Moderate	55-65	Slightly Sensitive
6. Industrial	High	60-70	Insensitive

Source: Jack Golden, et al, Environmental Impact Data Book, and SEWRPC.

Figure 4

HEAVY EQUIPMENT NOISE LEVELS



Source: Golden et al, ENVIRONMENTAL IMPACT DATA BOOK, 1979.

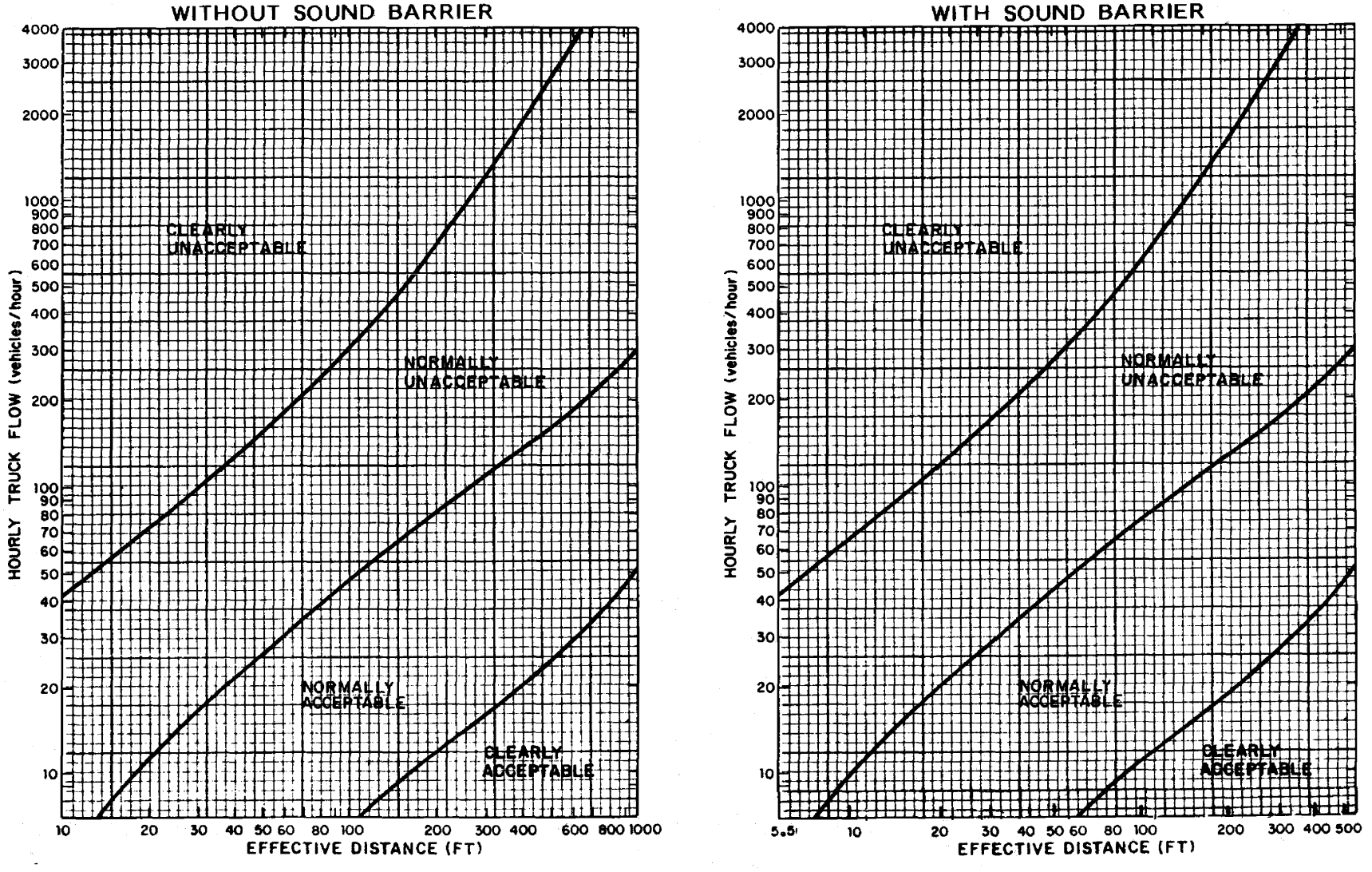
In addition to the noises generated from the quarry itself, truck traffic to and from the site can produce noises which affect the environment located along the transport routes. Figure 5 shows the impact of a 20-foot-high earthen berm on truck noise levels. At the maximum existing truck flow entering and exiting the Halquist Stone Company quarry of 800 trips per day, noise levels would normally be unacceptable within about 260 feet of the street if no berm was present; and within about 150 feet of the street if a berm was present.

The Lisbon Lawns and Winfield Acres subdivisions are located immediately west of Halquist Stone Company quarry. Berms have been constructed by the Halquist Stone Company along most of the perimeter of the main site. The berms, rising 20 to 40 feet above the adjacent land surface, provide a partial barrier to quarry-generated noise. The Waukesha County Health Department has no record of complaints from study area residents of excessive noise from the quarry. However, complaints have been received in the Village of Sussex. The Halquist Stone Company is in the process of constructing berms along the perimeter of the proposed expansion site. The berms are to be constructed along the north and west sides. The southern edge of the expansion site is to remain a natural wooded area.

A second type of impact related to noise is vibration, or the transmission of energy from a source through a medium, such as soil or bedrock. Vibrations can cause annoyance and discomfort in humans, and surficial and structural damage to buildings. Humans can perceive vibrations about one-hundredth of the intensity required to produce structural damage. The most severe and potentially damaging vibrations would be produced by blasting activities. Blasting in quarries, which is regulated under Wisconsin Statute 101.15 and Chapter 7, Subchapter 7 of the Wisconsin Administrative Code through the Wisconsin Department of Industry, Labor and Human Relations (DILHR), is performed by licensed blasters, often on a contractual basis. The blaster is responsible for monitoring and keeping records of the seismic vibrations and noise levels of each blast. In addition, the Town of Lisbon monitors the sound and vibration level of each blast. Vibration and noise levels must be in compliance with standards set by DILHR. The peak noise level allowed in blasting is 133 dBA. Vibration limits are measured in terms of "particle velocity", which is related to the force of the blast which is controlled by

Figure 5

EFFECT OF DISTANCE ON ACCEPTABLE TRUCK NOISE LEVELS WITH AND WITHOUT A 20-FOOT HIGH EARTHERN BERM SOUND BARRIER



Source: NOISE ASSESSMENT GUIDELINES. U.S. Department of Housing and Urban Development.

the amount of explosives used. The particle velocity maximum limit for quarry blasting is two feet per second. There is no record of exceedances of this limit by the Halquist Stone Company.

SUMMARY

In order to properly evaluate the potential environmental impacts of a proposed expansion of the Halquist Stone Company, Inc. quarry operations in the Town of Lisbon, a description of the certain, natural, and man-made features of a nine-square-mile study area have been documented in this chapter.

Two major quarrying operations are located within the study area--those being the operations of the Halquist Stone Company, Inc. and the Vulcan Materials Company. Each of these operations produces crushed limestone of various grades and agricultural lime at sites both of which are located on CTH K (Lisbon Road) in the southeast portion of the Town of Lisbon. The Halquist quarry is located west of STH 164 and the Vulcan Materials Company is located east of STH 164.

The inventory data presented indicates that there are potential negative environmental impacts of the proposed quarry expansion which should be evaluated further in the following chapter. These impacts relate to both onsite and offsite considerations. With regard to the expansion site itself, further consideration will have to be given to floodplain, wetland, environmental corridors, and prime agricultural land, all of which exist within the limits of the expansion site. With regard to offsite impacts, consideration will have to be given to surface water quality, groundwater levels, air quality, biological conditions in Sussex Creek, land use development, traffic, and noise impacts.

With regard to the physical environment of the study area, the existing quarries and potential expansion of the Halquist quarry can be considered to impact surface water quality, groundwater levels, and air quality. With regard to surface water quality, the current quarrying operations discharge treated quarry wastewater and non-contact cooling water to Sussex Creek. The proposed Halquist quarry in the expanded site is also expected to discharge similar wastewaters to Sussex Creek. Historical information has indicated that

the discharge from the current Halquist operation has adversely impacted water quality in Sussex Creek. However, the most recent monitoring information of the Halquist discharge indicates that the concentrations of suspended solids--the primary concern--have been reduced to levels which should not cause any significant adverse water quality impacts if these levels are maintained.

With regard to groundwater levels in the shallow limestone aquifer, quarrying operations have a significant impact in that they result in a drawdown cone of approximately 50 feet vertically extending approximately one-half mile horizontally from the quarry operations. Currently, any new wells in the vicinity of the quarry are drilled into the deeper dolomite and sandstone aquifers and existing wells within the shallow dolomite aquifer are generally well below the elevations of the groundwater table even with the drawdown from the current operations.

With regard to air quality considerations, the quarrying operations do emit relatively large quantities of particulate matter to the atmosphere and have been the cause of air quality standard exceedances in the vicinity of the quarry in the past. The instances of air quality standard violations, however, has been greatly reduced in the past two years with no violations reported due to the quarries during the 1989 monitoring season. In part, this improvement in air quality is due to dust control measures which have been implemented by the quarries.

In addition to these physical environmental considerations, it will also be necessary to take into account floodplain considerations that deal specifically with the proposed expansion site since that site contains floodplain areas.

With regard to the biological environment, there are wetland, primary environmental corridor, and prime agricultural land areas located within and immediately adjacent to the proposed quarry expansion site which will have to be considered further. Stream biological conditions have been impacted by quarrying operations in the past, with evidence of fine white silt sediment in the stream reaches. Sussex Creek, both upstream and downstream of the Halquist quarry is generally considered to have a relatively poor aquatic habitat because of the shallow water depths during low flow conditions and because the

stream has relatively few meanders. Fish species present in the stream were also indicated to be generally tolerant of relatively poor water quality and turbid conditions. However, as noted above, current discharge sampling conducted in 1987 and 1988 has indicated that the discharge quality is such that it would not result in significant sediment deposition.

With regard to the socio-economic environment of the study area, currently about 1,260 acres, or 22 percent of the study area, is devoted to urban uses, with the most significant urban uses being residential. Under the preliminary regional land use plan utilizing an intermediate growth assumption for the Region and a centralized land use plan, it is expected that the urban land within the study area will be increased by just over 400 acres, with the largest areas being converted to residential lands. Under a highly optimistic and decentralized future condition, approximately 2-1/2 square miles of additional rural land would be converted to urban uses, the majority being residential. This increase in urban land would occur generally throughout the study area, excepting the lands of the current and proposed quarrying operations and could present problems with compatible land uses being developed near the quarry operation.

The resident population of the study area under the intermediate growth centralized land use plan is expected to increase from about 2,700 persons to about 4,000 persons, an increase of about 45 percent. Under an optimistic growth and decentralized land use future, a resident population as high as 11,000 persons could be reached within the study area by the year 2010.

Current traffic within the vicinity of the Halquist Stone Company quarry is currently only a small portion of the total vehicle traffic on the roadway. The traffic volume on CTH K is just under about 6,000 vehicles per weekday, with the current traffic design capacity of the roadway being about 7,000 vehicles per day. About 20 percent of all traffic east of the Halquist driveway and 12 percent of all traffic west of the driveway is truck traffic.

Noise levels at the quarrying operation may be regarded as a possible negative impact. Noise can result from blasting, the use of heavy equipment, and the rock crushing operations. Berms generally have been constructed by the Halquist Stone Company along most of the perimeter of the current operations.

The berms rise 20 to 40 feet above the adjacent land surface and provide a partial barrier to quarry-generated noise. The Waukesha County Health Department has no record of complaints from the study are residents of excessive noise from the quarry.

Chapter III

PROBABLE IMPACTS OF THE PROPOSED QUARRY EXPANSION ON THE ENVIRONMENT

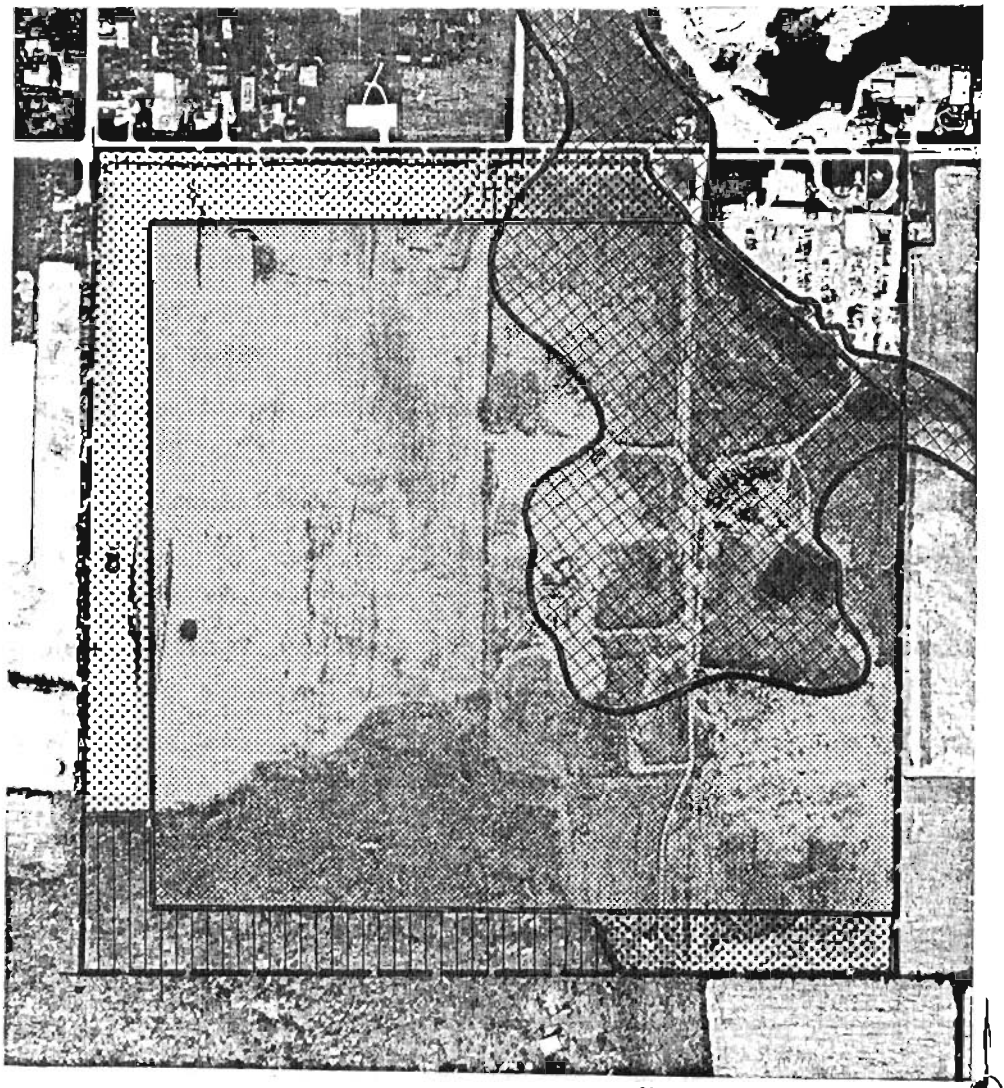
The data presented in Chapter II indicates that further consideration is needed of certain potential environmental impacts resulting from the proposed expansion of the Halquist Stone Company, Inc. quarry. These potential environmental impacts are evaluated in this chapter. More specifically, consideration is given in this chapter to the potential impacts on floodlands, wetlands, environmental corridors, and prime agricultural lands, all of which exist within the limits of the expansion site, as well as to the potential offsite impacts on surface water quality, groundwater levels and quality, air quality, biological conditions, land use development, traffic, and noise levels. This chapter includes a description of the proposed quarry expansion plans, followed by an analysis of the afore-noted impacts which have been categorized under physical, biological, and socio-economic environmental impacts. These sections of the chapter are directed primarily at the impacts of the specific proposal by the Halquist Stone Company to quarry additional lands. However, in addition to the evaluation of this specific proposal, environmental impact information is provided at the end of this chapter on potential future quarry operations in the entire nine-square-mile study area, including both the Halquist Stone Company and the Vulcan Materials Company quarries.

DESCRIPTION OF THE PROPOSED ACTIONS

The Halquist Stone Company, Inc. plans to eventually expand its quarry operations south into the Southwest one-quarter of U.S. Public Land Survey Section 35, Township 8 North, Range 19 East, Town of Lisbon, Waukesha County, as shown on Map 17. The expansion site is bounded on the north by Lisbon Road, on the east by privately-owned agricultural land, on the west by land also owned by Halquist, and on the south by the townline between Lisbon and Pewaukee townships.

Map 17

HALQUIST STONE COMPANY INC. PROPOSED QUARRY EXPANSION SITE



--- EXPANSION SITE BOUNDARY

BERM

100-YEAR FLOODPLAIN

POTENTIAL AREA TO BE QUARRIED

LOWLAND HARDWOODS TO BE MAINTAINED

GRAPHIC SCALE

0 400 800 FEET

Source: SEWRPC.

The entire 160-acre expansion site is zoned for quarrying and the necessary permits have been granted to allow quarrying on the eastern 80 acres of the site, excepting for buffer areas, floodway areas, and the Company's retail sales area. At present there is a small, relatively shallow quarry of about 12 acres on the site being used intermittently by the Halquist Stone Company. This small quarry is activated periodically to provide crushed rock for the Standard Asphalt Company which has a facility located on the site. In addition, stone is taken from this quarry periodically for selected uses in uncrushed form. This quarry was more active than typical during the summer and fall of 1989 when selected stone was being quarried for use in uncrushed form for a Lake Michigan marina project.

Portions of the 160-acre site are proposed to be maintained in their current state and others are proposed to be used for berms and plantings to provide buffer around the planned quarrying activities, as shown on Map 17. Ultimately, in the long-term, about 95 additional acres of land could be quarried.

The site for which the quarrying is proposed was once farmland and was stripped of its topsoil prior to the sale to Halquist in 1983. Halquist Stone Company officials have indicated that the current quarrying operation of its main site north of CTH K (Lisbon Road) will continue to be expanded and deepened. As the economic viability of the main site diminishes, the Company will begin expanding the operations into the proposed expansion site. Company officials indicate that it is likely the major development of this site may not occur for 10 to 20 or more years, depending upon the available material at the current site and market demands for quarry products. The maximum potential depth of both the existing Halquist main quarry and the expansion site is 230 feet--the estimated total thickness of the Silurian dolomite bedrock formation in this area. For the purposes of this report, the maximum depth of the expansion site is assumed to be 120 feet, the same depth as the deepest current excavation of the main site. Given that it will likely take over 50 years to excavate the expansion site to 120 feet, it is reasonable to base an environmental impact assessment on this depth. The depth of the dolomite in this area is about 230 feet. However, at about 120 feet a different rock formation--the Mayville Formation--exists which has somewhat different characteristics, including more fractures, and may not be as desirable for commercial uses. Furthermore, the deeper depths may not be economical to excavate.

Excavation of the Halquist quarry main site and expansion site to substantially lower depths in the distant future may require a further assessment, particularly of potential hydrologic impacts.

Prior to quarrying the expansion site, Halquist has proposed to provide a buffer area about 200 feet wide containing earthen berms along the north and west boundaries, and along a portion of the south boundary, as shown in Figure 6. These berms would be 20 to 30 feet high and planted with mature trees which would add an additional 20 to 30 feet in height to the buffer area. The owner has also indicated that about 12 acres, or about 55 percent of the 22-acre wetland located in the southwest corner of the proposed expansion site would be destroyed. The remaining portion of this wetland would serve as a buffer between the quarry and the residential land uses located immediately to the south of the expansion site boundary. The quarry operator indicates that current plans provide for the possible removal of the northernmost portion of this wetland area to facilitate quarrying and leaving about a 200-foot-wide area in place as a buffer. As noted in Chapter II, this wetland area is classified as a lowland hardwoods area and is part of the primary environmental corridor located partially on the site and extending west and south off the site and thence along the Pewaukee River.

With regard to floodplain areas on the expansion site, current Wisconsin Department of Natural Resources and Waukesha County regulations would essentially preclude filling within the identified floodway limits on the site.

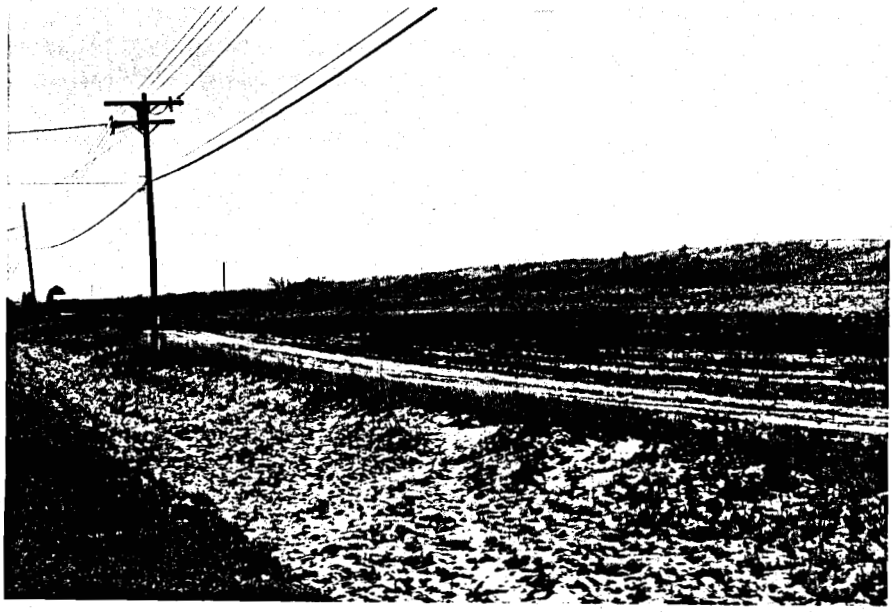
No detailed plan of operation has been developed for the proposed expanded quarry operation. Thus, the following assumptions were made regarding the operation of the expanded Halquist quarry:

1. That the limits of any quarrying activity would be as shown on Map 17;

2. That the rock-crushing plant located in the main quarry north of CTH K (Lisbon Road) would remain at its current location and rock would be transported from the expansion site located south of Lisbon Road to the north side of Lisbon Road via a trucking operation across Lisbon Road for at least some extended period of operation. A tunnel crossing may be installed after an adequate area and depth is excavated. Officials

Figure 6

PHOTOGRAPH OF BERM CONSTRUCTED AROUND PROPOSE QUARY SITE



BERM ALONG CTH "K", NORTH SIDE OF THE
HALQUIST QUARRY PROPOSED EXPANSION SITE

of the Halquist Stone Company indicated that moving the crushing operation would entail a substantial cost and that the quarried material would most likely be transported initially by truck across, and eventually by tunnel under Lisbon Road to the crushing plant at its current location. Trucking of quarry stone from the south side to the north side of Lisbon Road is planned to be carried out for a significant portion of the proposed south side quarry operation.

3. That the total stone output of the expanded facility would be approximately the same as the output of the current facility.

POTENTIAL IMPACTS ON THE PHYSICAL ENVIRONMENT

The primary physical environmental features which may be expected to be impacted by the proposed expansion of the Halquist Stone Company quarry are floodlands, surface water quality, groundwater levels and quality, and air quality.

Floodlands

The 100-year recurrence interval floodplain and floodway limits within the proposed expansion site are shown on Map 6 in Chapter II. The floodplain boundary follows Sussex Creek at a distance varying from about about 150 to about 250 feet from the creek center line up to the location of the existing south quarry, with the floodplain boundary expanding at that location to include all of the quarry area. All of the floodplain is included within the identified shoreland boundary as set forth in the Waukesha County Zoning Ordinance and which includes the lands lying within 300 feet of a navigable stream, or to the landward side of the floodplain, whichever is greater. Development activities such as those associated with the quarry expansion are generally considered conditional uses within the shoreland area and must be approved in accordance with Section 3.07(7) of the County Ordinance. The current Wisconsin Department of Natural Resources and County regulations prohibit the filling in floodway areas which would cause an increase in the 100-year recurrence interval flood stage of 0.01 foot or greater. Such stage increases may be expected from even minor filling within the floodplain area on the subject site. Thus, it may be assumed that there will be no filling within the floodway area as part of the proposed expansion. That limitation

should insure that the proposed operations will not significantly increase downstream flood flows and stages. Additionally, it can be assumed that the development of the site can proceed in such a manner as to maintain the flood storage on the site to the current level in areas outside the floodway and in the floodplain. Consideration of this aspect of the quarry development should insure that no increase in downstream flood flows and stages will occur.

Based upon the foregoing, it may be concluded that, with proper design, the impacts of the proposed quarry expansion on the floodplains and shoreland areas of Sussex Creek should not be significant.

Surface Water Quality

Historically, the primary impact of the existing Halquist Stone Company wastewater discharge to Sussex Creek has been an increase in silt deposition, and in the suspended solids content of the surface waters of Sussex Creek. Sediment deposits in the stream from the quarry operation were substantial in the late 1970s, and water quality data collected as recently as 1982 indicated that the increase in suspended solids and turbidity levels was substantial--on the order of two- to six-fold. However, effluent quality samples collected since 1987 indicate that the solids content of the discharge water is now quite low. In the late 1970s, the Company modified the treatment process to provide for a two-stage settling pond system in lieu of the clarifier which had been used to improve the quality of the effluent. As reported in Chapter II, the suspended solids and turbidity levels measured in the water column in 1987 and 1988 were at a low enough level to have no significant adverse effects on the organisms inhabiting the stream. Groundwater seepage, surface runoff, and quarry wastewater are expected to continue to be treated in settling ponds and then discharged along with noncontact cooling waters to Sussex Creek under the proposed expansion of the quarry. The quality of the discharge may be expected to be similar to existing discharge levels--with maximum quarterly suspended solids levels generally being less than 20 milligrams per liter (mg/l), or one-half of the maximum permitted level of 40 mg/l.

The volume of discharge could increase somewhat since both the existing quarry--which will likely continue to contain the rock crushing operation--and the new expanded quarry would have to be dewatered. However, since the major source of suspended sediment is carried in the wastewater from the rock

crushing and other processing operations, the total amount of solids being discharged should not significantly increase. Thus, it may be expected that discharge of the treated quarry wastewater and noncontact cooling water will not cause a significant adverse impact on surface water quality if the levels of suspended solids are maintained at current levels of a maximum of 20 mg/l. Should the suspended solids levels reach the currently permitted maximum level of 40 mg/l, the summer low flow suspended solids concentration in Sussex Creek could increase by about 40 percent, to about 25 mg/l and the turbidity by about 25 percent, to about 12 Nephelometric Turbidity Units (NTU). These conditions could stress fish and aquatic life in Sussex Creek primarily because the solids content and turbidity would change rapidly at the outfall location. While the fish and aquatic life in the stream are generally considered tolerant to moderate solids loadings and turbidity levels, as discussed in Chapter II, this potential impact can be avoided by limiting the concentrations in the discharge to the maximum levels measured in 1987 and 1988. Upon renewal of the discharge permit, it would be possible to require that level since it is readily achievable under the currently available treatment technology.

Groundwater

As discussed in Chapter II, the groundwater impacts in the vicinity of the proposed quarry expansion are only of concern with respect to the Silurian dolomite or shallow dolomite aquifer. This was concluded since very few wells in the study are finished in the glacial deposits overlying the dolomite because of the shallow depth of these glacial deposits. Furthermore, the deep dolomite and sandstone aquifers are separated from the Silurian dolomite aquifer, in which the quarrying will occur, by the relatively impermeable Maquoketa shale formation. Thus, the deeper aquifers and the Silurian dolomite aquifer can be considered independent of each other.

Both the Halquist Stone Company and Vulcan Materials Company have excavated below the local water table for at least 20 years. In 1988, the quarries were excavated from 40 to 90 feet below the original water table. Groundwater seeps through the quarry walls and accumulates, along with precipitation, on the quarry floors. This water is pooled in sump ponds and then pumped for disposal to nearby streams. Dewatering of the quarries in this manner has led to the development of a steep-sided "cone of depression" in the water table

around the quarries. The "cone of depression" was described in a 1975 U.S. Geological Survey report[9] and has been confirmed by water level measurements made under this current evaluation in wells near the quarries during 1988 and 1989, as discussed in Chapter II. The measured well locations and water level measurements are provided in Appendix B. Water table elevations for 1975 and 1988 are shown on Maps 7 and 8 in Chapter II.

The cone of depression around the quarries is roughly elliptical in shape, with a long axis of approximately 1-1/2 miles and a short axis of approximately one mile. The elliptical shape of the cone is due to the merger of two separate cones of depression associated with the Halquist and Vulcan quarries. Drawdowns within one-half mile of the quarry walls are less than 10 feet below what would be normal water table elevations. Drawdowns within 500 feet of the quarry are about 20 feet.

The quarries drain only the upper portions of the aquifer. Groundwater also flows beneath the quarries through the lower layers of the dolomite, in particular, through the Mayville Formation, as shown in Figure 7. The Mayville Formation--approximately 80 feet thick in the vicinity of the Halquist quarry --is approximately 30 times more permeable than the overlying dolomite formations. The more permeable Mayville Formation conducts and stores more water than the upper parts of the aquifer. Because of these aquifer characteristics, wells located close to the quarry have generally been finished deep in the aquifer and, thus, generally have adequate water supply despite quarry induced drawdowns.

A prediction of the effects of the expanded quarry on groundwater levels requires the establishment of specific assumptions about future land use and aquifer conditions in the study area. The groundwater level impacts analysis was made based upon the following assumptions:

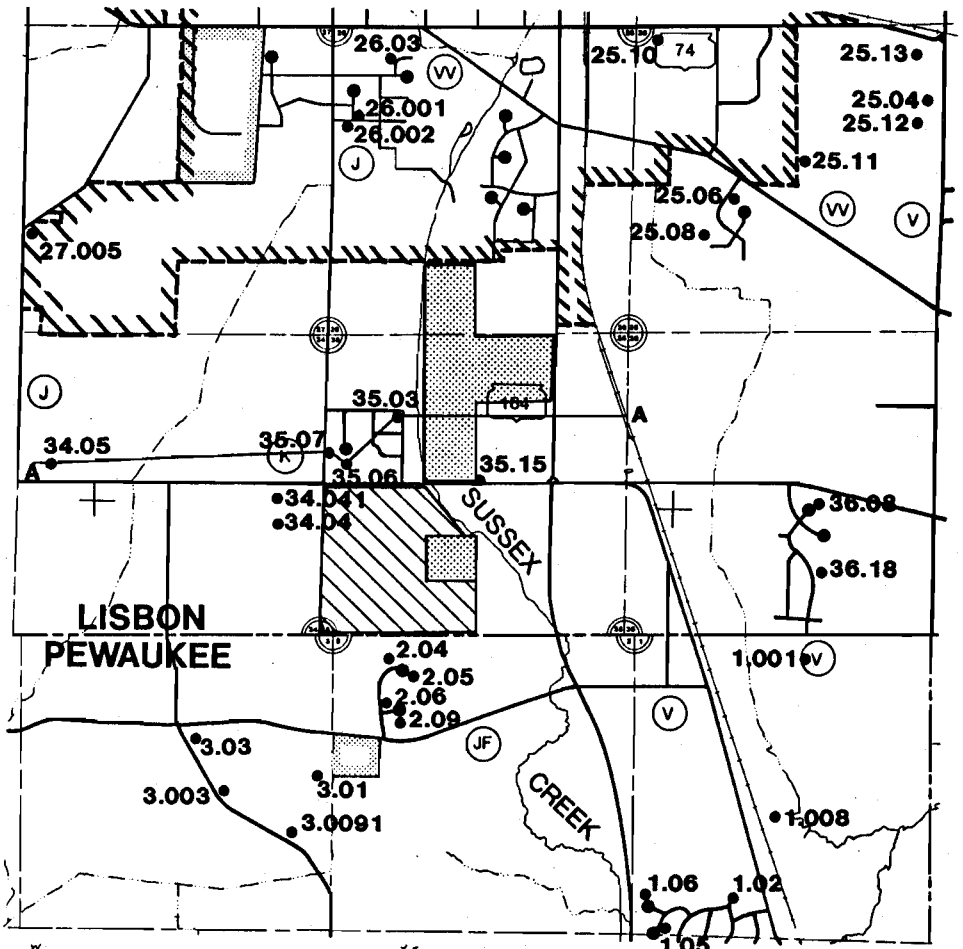
1. For analysis purposes, the Halquist expansion site was assumed to be fully developed. That is, the floor area of the new quarry was assumed

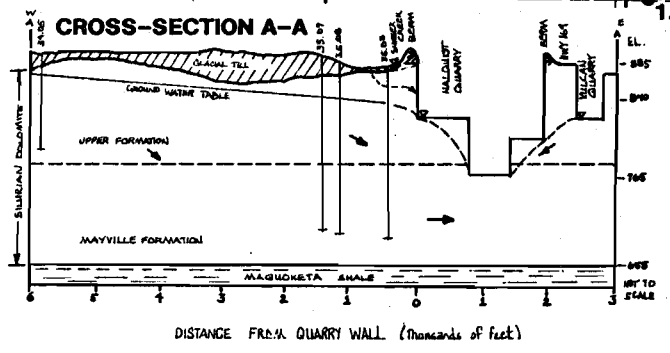
---

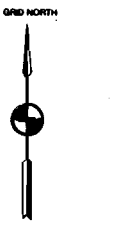
[9]U.S. Geological Survey, Groundwater Resources of Waukesha County, 1985.

Figure 7

LOCATION MAP AND CROSS-SECTION OF GEOLOGICAL CONDITIONS
IN THE TOWN OF LISBON SOUTEAST QUARRY OPERATIONS STUDY AREA







LEGEND

- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- A—A Cross-Section Line
- Well Location
- 25.08 Well ID Number
- Well Bottom
- Water Surface
- Groundwater Flow Direction

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

to be equal to the surface area of the entire potential area to be quarried--about 95 acres--as shown on Map 16. Maximum depth of the fully-developed expansion site was assumed to be 120 feet below surrounding surface elevations--at about elevation 760 feet NGVD--the maximum depth of the Halquist main quarry in 1988. A fully-developed excavation would be expected to have maximum impact on the aquifer and nearby wells. It should be kept in mind that the expansion site will be developed over a relatively long period of perhaps 50 years. Thus, the assumptions stated above relating to full development provides a "worst case" estimate of potential impacts.

2. Residential and other dolomite aquifer uses were assumed to be constant during the analysis period. This approach allows a comparison of the present water table configuration with changed conditions due only to the expanded quarry. While there is a planned 56 percent increase in the population within the study area, it is expected that the new development will occur either in the areas adjacent to the Village of Sussex and will be served by the Sussex municipal water system which utilizes the deep sandstone aquifer as the source of supply, or will be developed in the towns which may rely on either individual wells or in the long term on a new municipal system with both new individual or municipal wells expected to be finished in the deep sandstone aquifer. Should substantial new development occur in the currently rural areas of the Towns of Lisbon and Pewaukee in the areas described in the land use section of Chapter II under the optimistic growth-decentralized future scenario land use plan, a new municipal water supply system would be required which would rely on the deep sandstone aquifer.

3. The hydrogeologic characteristics of the Silurian dolomite into which the expansion site would penetrate are assumed to be the same as at the Halquist main site and the dolomite thickness is about 230 feet at both the main Halquist quarry and the expansion site.

In order to assess the impacts of the proposed quarry expansion on groundwater table levels, two methods were used to predict the groundwater levels under conditions whereby the proposed quarry would be expanded as noted above. The first method used to predict the groundwater table elevations upon development

of the proposed quarry expansion involved projecting the characteristics of the current cone of depression to the expansion site. The cone of depression associated with the current quarries is shown on Map 8. This cone reflects the aquifer response to the current excavation depths, rates of groundwater removal from the quarries, and the hydrogeological conditions in the vicinity of the quarries. The extent of the influence of the current quarrying operation was estimated by comparing the current 1988 groundwater table elevation to the water table elevations which existed prior to the relatively deep quarrying. Well completion reports from the 1940s indicate that the elevation of the groundwater table in the vicinity of the current quarry operation was about 850 feet above National Geodetic Vertical Datum. Thus, the extent of the impact of the quarries was estimated by comparing the current water table elevations to the elevation of the expected water table without the influence of the quarries, as shown on Map 18.

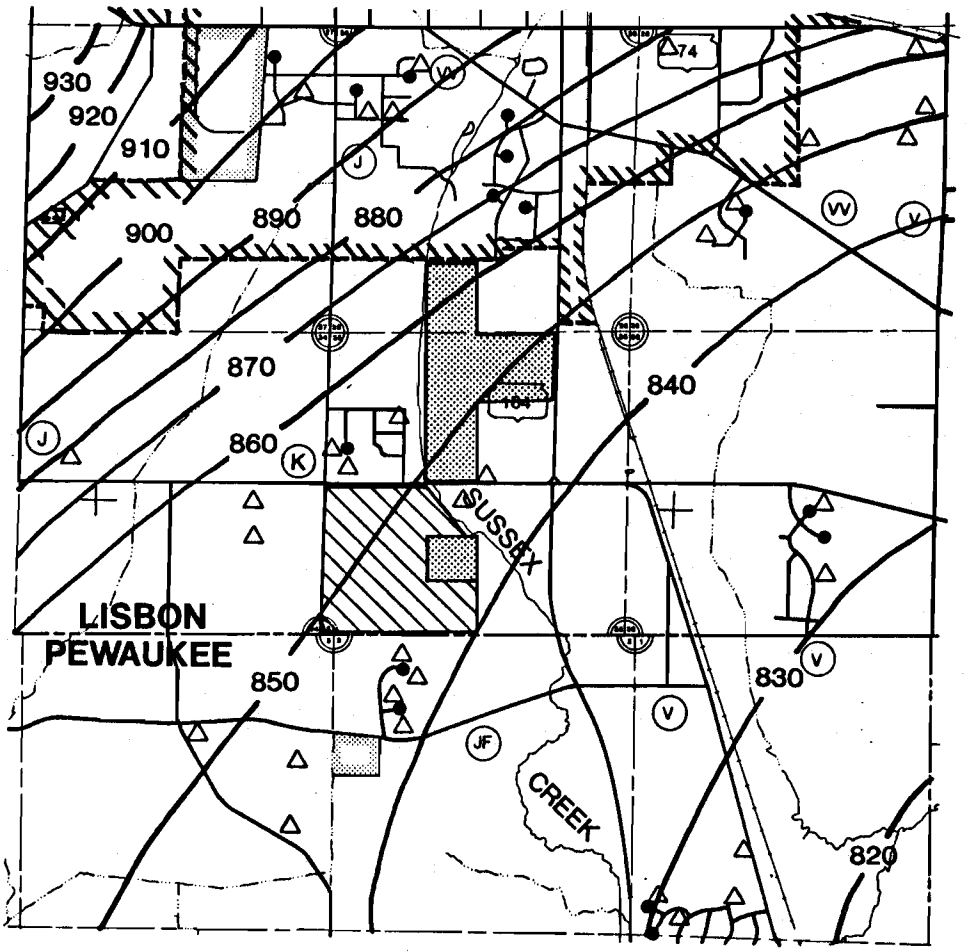
The maximum extent of cone of depression is defined by the maximum radius of influence. Approximately 5,000 feet from the deepest point in the Halquist quarry, the drawdown effects of quarry dewatering become negligible as shown on Map 19. This 5,000 foot distance is the estimated maximum radius of influence of the Halquist quarry.

An approximation of the drawdown cone that may be expected to be caused by a fully-developed expansion site was found by projecting the existing Halquist quarry maximum radius of influence from the approximate center of the expansion site. A circle of influence around the expansion site was drawn to show the probable maximum extent of the cone of depression that would develop around the new site as shown on Map 19. Similarly, the approximate maximum extent of drawdown in five-foot intervals due to the expansion site were drawn as shown on Map 20. Where the two cones of depression overlap, the drawdowns due to both the current site and the expansion site were added together to estimate the total drawdown.

Wells located within the maximum radius of influence of the Halquist quarry have "quarry-related drawdowns" equal to the difference between the observed 1988 head and the 850-foot base-line elevation. These drawdowns are added to the drawdowns predicted to be caused by the expansion site as shown in Table 16. The resultant heads were contoured as shown on Map 21 to illustrate the

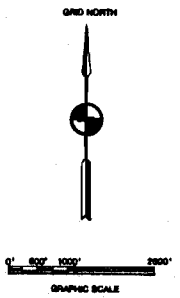
Map 18

APPROXIMATE WATER TABLE ELEVATIONS WITHOUT INFLUENCE OF QUARRIES IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Halqusit Stone Company Inc. Proposed Expansion Site
- Well Location
- 850 Approximate Groundwater Table Contour

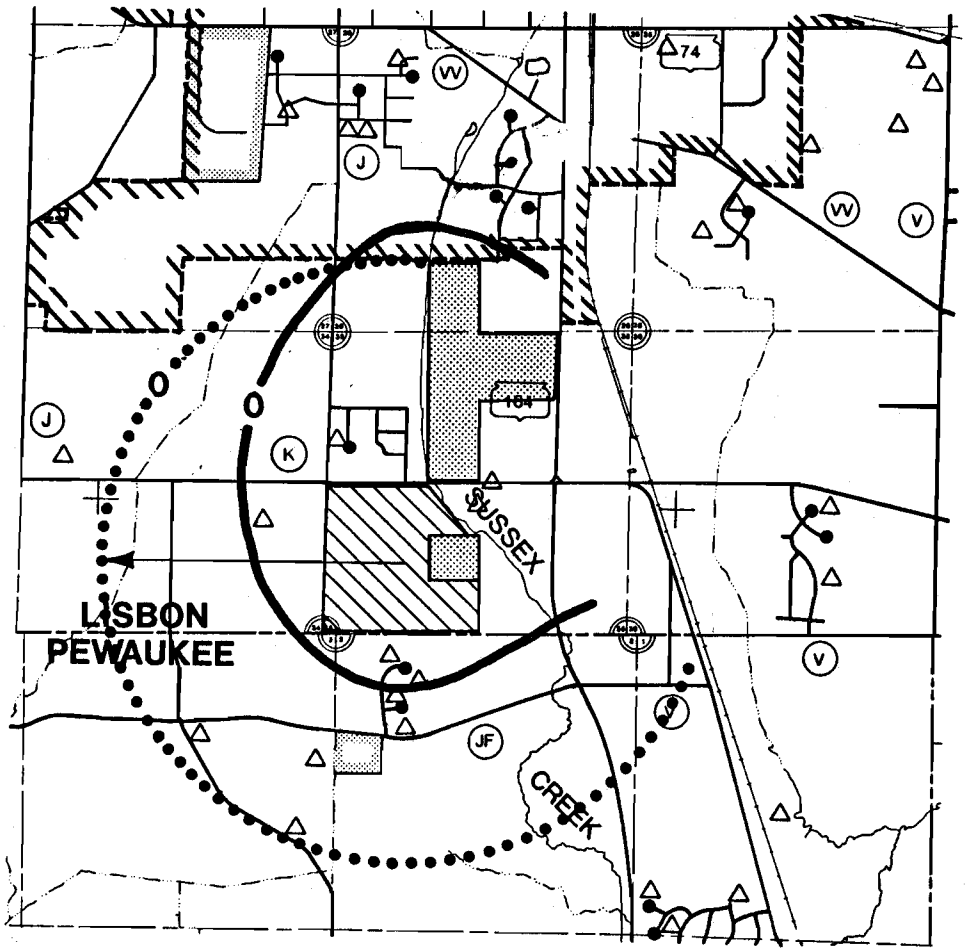


Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP	T7NR19E PEWAUKEE TOWNSHIP

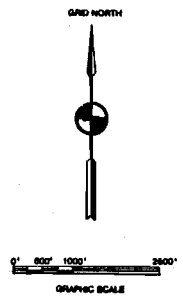
Map 19

ZONE OF INFLUENCE OF CURRENT HALQUIST QUARRY AND PROJECTED ZONE OF INFLUENCE OF EXPANSION SITE IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- 0 — Projected Line of Zero Drawdown Due to Expansion Site Dewatering
- 0 — Line of Equal Drawdown (ft) Due to Current Quarry Dewatering Only
- Well Location
- Maximum Radius of Influence (5000 ft)

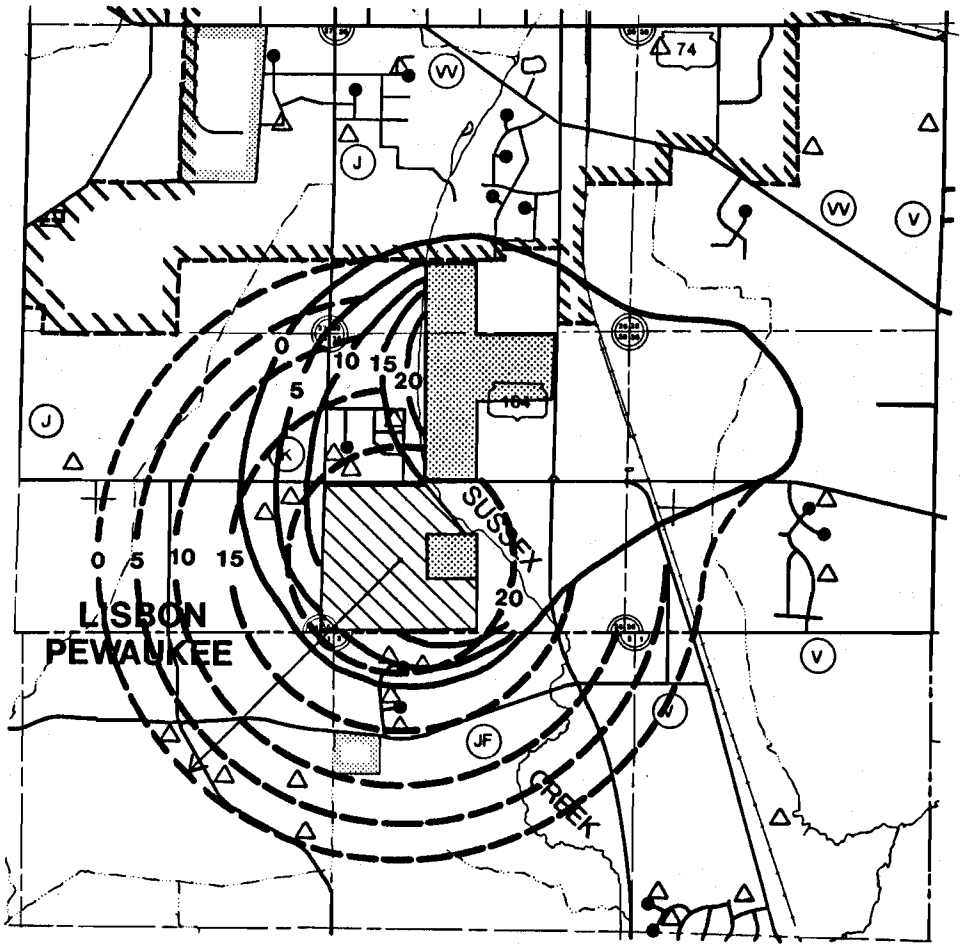


Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

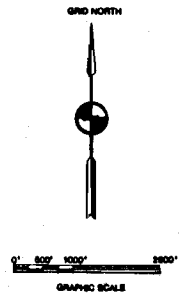
Map 20

ZONES OF DRAWDOWN CAUSED BY QUARRY DEWATERING, INCLUDING EXPANSION SITE IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- Approximate Line of Drawdown (ft) Due to Current Quarry Dewatering Only
- Projected Line of Equal Drawdown (ft) Due to Expansion Site Dewatering
- Well Location
- Maximum Radius of Influence (5000 ft)



Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

Table 16

MAXIMUM RADIUS OF INFLUENCE (MRI) METHOD FOR DETERMINING DRAWDOWNS DUE TO FULLY-DEVELOPED EXPANSION SITE

Ident. No.	Distance From Expansion Site Excavation Floor (feet)	Fall 1988 Observed Heads Elevation (1)	Fall 1988 Quarry-Related Drawdowns (feet) (2)	MRI Predicted Drawdowns (feet) (3)	MRI Total Drawdowns (feet) (4)	MRI Predicted Heads Elevation
35.06	660	835.7	14.3	15	29.3	820.7
35.07	700	839.0	10.6	15	25.6	824.4
2.04	990	848.8	1.6	20	21.6	828.4
35.15	1,140	838.0	12	15	27.0	823.0
34.041	1,200	844.5	5.5	15	20.5	829.5
34.04	1,210	846.8	3.2	15	18.2	831.8
2.05	1,300	841.0	1	20	21.0	829.0
35.03	1,500	833.0	17	15	32.0	818.0
2.06	1,650	852.5	0	17.5	17.5	832.5
2.09	2,300	837.7	0	15	15.0	835.0
3.01	2,500	841.3	0	10	10.0	840.0
3.03	3,100	849.9	0	5	5.0	845.0
3.003	3,300	838.8	0	2.5	2.5	847.5
3.0091	3,420	843.1	0	2.5	2.5	847.5

(1) Fall 1988 observed water levels in domestic water supply wells.
(2) Drawdowns due to current Halquist main quarry; calculated by subtracting observed heads from 850', the elevation of the original water table in the vicinity of the Halquist quarry. Quarry-related drawdown is estimated for well 2.05.
(3) 1988 drawdowns plus estimated drawdowns due to expansion site dewatering.
(4) Projected groundwater table elevations found by subtracting projected total drawdowns from original water table elevation of 850 feet.

Source: SEWRPC.

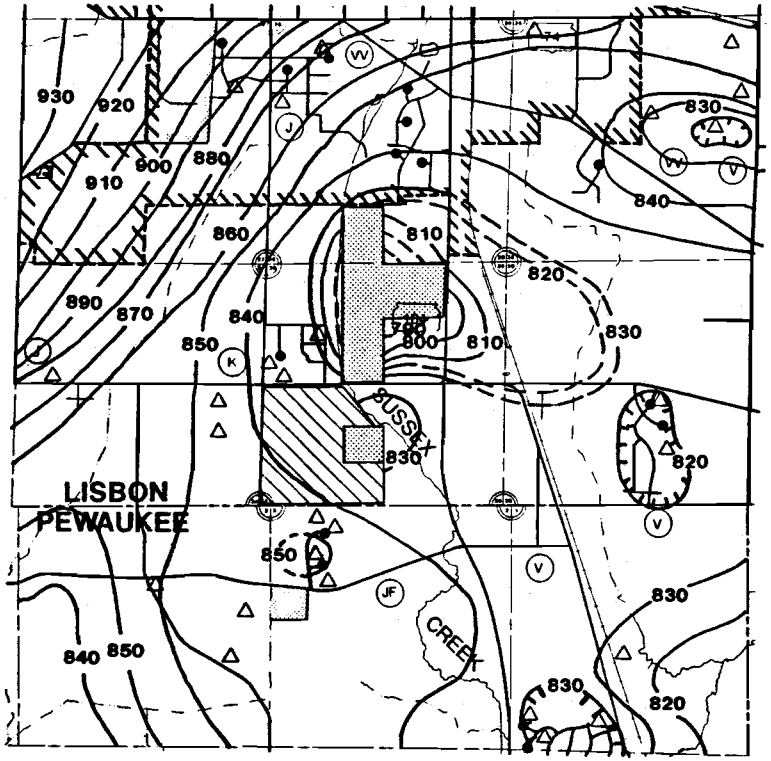
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA-
WAUKESHA COUNTY, WISCONSIN

T8NR19E LISBON TOWNSHIP
T7NR19E PEWAUKEE TOWNSHIP

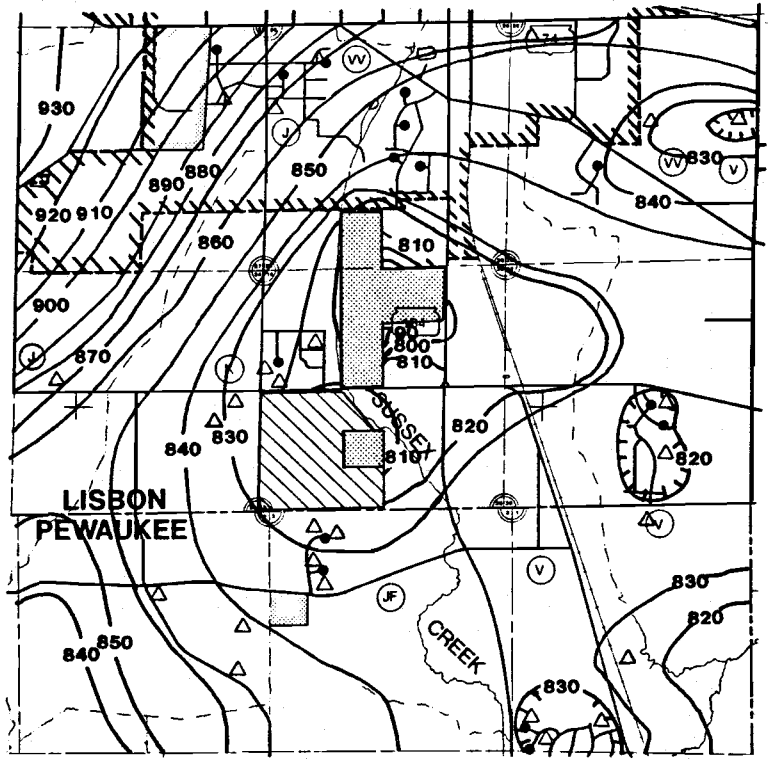
Map 21-A

ELEVATION OF THE GROUNDWATER TABLE IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA: 1988



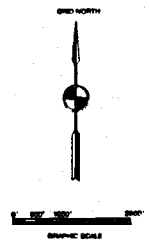
Map 21-B

PROJECTED WATER TABLE ELEVATIONS DETERMINED BY MAXIMUM RADIUS OF INFLUENCE METHOD: EXPANSION SITE FULLY DEVELOPED IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- Well Location
- 840 Projected Groundwater Elevation (NGVD) (Dashed Lines Are Approximate)



Source: SEWRPC

probable configuration of the water table given the influence of a fully-developed expansion site.

It can be noted that the 840 and 830 elevation contours would have moved substantially south and southwest relative to their positions in the 1988 groundwater table, which are also shown on Map 21 for comparison purposes. The migration of these lines reflects the water level decline in the aquifer around the quarries caused by the dewatering of the expansion site. This result indicates that up to a maximum of about 20 feet of additional drawdown can be expected in the wells located outside the quarry site within the radius of influence of the expanded quarry.

In order to provide a check on the estimate of the predicted groundwater table changes due to the quarry expansion, an analytical method was also used to predict the drawdowns due to dewatering of the expanded quarry. This method, known as the Theis analysis, is designed to predict drawdowns caused by a pumping well. In this case, the dewatering from the expanded quarry was treated as a constant withdrawal similar to a groundwater pumping system. The Theis analysis used in this report was solved for drawdown for a given time period according to the standard methods. The calculation leads to a plot of water levels or heads representing the cone of depression induced by the quarry. As a verification that the Theis analysis properly predicts drawdown caused by the expanded quarry, the Theis analysis was used to predict the current drawdown caused by the existing main quarry, and the resulting water table elevations were compared to those measured in the wells in 1988. The resulting heads were compared to those measured in wells in 1988, as shown in Table 17. The maximum error between Theis-predicted heads and observed heads was about plus or minus seven feet, which is considered reasonable given the phenomenon involved.

The Theis method was used to predict quarry-related drawdowns at fourteen wells within 5,000 feet of the expansion site. Several of these wells are located in an overlapping zone of influence of the Halquist main quarry and the expansion site. For these wells, the drawdowns associated with the Halquist main quarry are added to those predicted by the Theis method due to the expansion site. The total drawdowns for all wells are then subtracted from the 850 elevation baseline in order to derive the predicted heads.

Table 17

COMPARISON OF OBSERVED HEADS VS CALCULATED HEADS
IN WELLS NEAR THE HALQUIST MAIN QUARRY

Well Identification No.	Distance to Halquist Quarry Wall (feet) (1)	Fall 1988 Observed Heads Elevation (2)	Theis Calculated Drawdowns (feet) (3)	Theis Predicted Heads (4)	Difference Observed-Predicted
35.15	300	838.0	11.58	838.4	-0.42
35.03	550	833.0	10.53	839.5	-6.47
35.06	1,500	835.7	8.79	841.2	-5.51
35.07	1,800	839.4	8.48	841.5	-2.12
34.041	3,000	844.5	7.59	842.4	2.09
2.04	3,200	848.4	7.48	842.5	5.88
2.05	3,300	848.0	7.43	842.6	5.43
34.04	3,630	846.8	7.26	842.7	4.06

(1) Distance from well to nearest Halquist main quarry wall (feet).
(2) Fall 1988 observed water level elevations (datum is mean sea level).
(3) Solution of Theis equation as explained in text.
(4) Predicted heads found by subtracting calculated drawdown from original water table elevation of 850 feet.

Source: SEWRPC.

Heads predicted by the Theis method in the fourteen wells were compared to those predicted by the maximum radius of influence method, as shown in Table 18. The results of the two methods are relatively close within 2,500 feet of the expansion site, where drawdowns are expected to be the most significant. At distances greater than 2,500 feet, the predicted drawdowns between the two methods begin to diverge. The Theis method predicts about 14 feet of drawdown at wells more than 3,000 feet from the expansion site. The maximum radius of influence method predicts about three feet of drawdown at these same wells. The difference in results may be due to the limitations of the two methods. Because the existing cone of depression is steep-sided and of limited areal extent, it is expected that the drawdown cone caused the expansion site excavation will have similar characteristics. Thus, it is expected that drawdowns beyond 2,500 feet will be 10 feet or less and will decline to zero at about 4,000 to 5,000 feet from the expansion site excavation.

The additional drawdowns expected adjacent to the expansion site are significant and in the order of 15 to 20 feet in areas of current residences. However, a review of the available well logs in the area indicates that many of the wells near the quarry are finished deep enough--greater than 30 feet below the predicted groundwater table elevations--in the dolomite aquifer to be assured of continued water supply despite quarry-related drawdowns. Of 50 wells within 5,000 feet of the proposed quarry expansion site which were inventoried, it appeared that nearly all were at elevations greater than 30 feet below the predicted water levels. It may be necessary, however, for some owners to have their submersible pumps lowered in order to maintain the recommended water column height above their pumps, generally about 30 feet. Wells which are not deep enough to maintain the recommended 30 feet of water above the submersible pump may have to be deepened.

Review of the above analysis indicates that the impacts on wells in the dolomite aquifer may be expected to be minimal. However, it is recommended that there be an agreement reached by the Town of Lisbon with the quarry operator to deal with claims of unforeseen damage caused to private water supplies as a result of the expanded quarry operation.

With regard to groundwater quality, there exists the potential for the accidental spillage of contaminants in an area where large machinery is working.

Table 18

COMPARISON OF MAXIMUM RADIUS OF INFLUENCE AND THEIS-PREDICTED DRAWDOWNS DUE TO FULLY DEVELOPED EXPANSION SITE

Well Identification No.	Distance from Expansion Site Excavation Floor (feet)	MRI Predicted Drawdowns (feet) (1)	Total Theis-Predicted Drawdowns (feet) (2)
35.06	660	29.3	31.5
35.07	700	25.6	27.7
2.04	990	21.6	18.1
35.15	1,140	27.0	28.3
34.041	1,200	20.5	21.7
34.04	1,210	18.2	19.4
2.05	1,300	21.0	17.0
35.03	1,500	32.0	32.8
2.06	1,650	17.5	15.6
2.09	2,300	15.0	15.1
3.01	2,500	10.0	14.9
3.03	3,100	5.0	14.5
3.003	3,300	2.5	14.4
3.0091	3,420	2.5	14.4

(1) Maximum radius of influence drawdowns.
(2) Theis solution plus Halquist quarry-related drawdowns plus seven-foot error factor.

Source: SEWRPC.

It is noted that spillage of certain contaminants, such as fuel oil, should be apparent on the water surface of the ponds which collect surface water runoff in the quarries. Thus, with proper surveillance, the operator could effect a cleanup operation soon as a problem occurred. While the possibility of contamination occurring and impacting on the wells in the area is thus limited, it may be desirable to require that the owner develop as part of the plan of operation, a plan of action which would be carried out if an emergency occurred through spillage of contaminants. Such a plan should include the timely provision of any equipment needed to contain and remove the spilled materials.

Air Quality

Historically, the total suspended particulate levels near the Halquist Stone Company and Vulcan Materials Company quarries have exceeded U.S. Environmental Protection Agency (EPA) and Wisconsin Department of Natural Resources (DNR) primary and secondary standards, resulting in the area being designated as a nonattainment area. The quarries have been identified by the Wisconsin Department of Natural Resources as the primary source of these standard violations. Management measures have been undertaken by both quarries in order to reduce fugitive dust emissions from the quarrying operations. Additional control measures were recommended by the Department in order to further reduce dust emissions. During 1988, four violations of the EPA and DNR particulate standard were reported. As of August 8, 1989, only a single violation of the EPA and DNR standard had occurred in 1989. This violation was attributed to natural conditions and not the quarrying operations. Thus, it appears that proper management measures can be effectively utilized to minimize, and perhaps prevent, any violations of the air quality standards.

The proposed expanded quarry would provide for the same type of quarrying operation as the existing facility, and thus, may be expected to generate similar types and amounts of air pollutants. It is therefore imperative that proper air pollution control measures be applied in the expanded quarry to control fugitive dust. Such measures include sweeping of quarry roads and adjacent public streets, paving of quarry haul roads, water or chemical control of dust at material handling operations, control of dust from storage piles, and application of calcium chloride solution to haul roads and the quarry floor. Table 19 sets forth reasonable available control technology

Table 19

REASONABLE AVAILABLE CONTROL TECHNOLOGY (RACT)
AIR QUALITY CONTROL PRACTICES FOR QUARRY OPERATIONS REQUIRED
BY THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES

Operation	Required Practices
Storage piles having a material transfer greater than 100 tons per year.	1. Material silt content 5-20 percent: Pile to be treated with water, surfactants, stabilizers, or chemicals; draped; or enclosed on three sides. 2. Material silt content greater than 20 percent: Pile to be completely enclosed or draped except any part being worked, loaded, or unloaded. 3. Access areas surrounding storage piles shall be watered, cleaned, or treated with stabilizers as needed to prevent fugitive dust from vehicle traffic.
Handling operations for material with at least a 5 percent silt content: crushing, drilling, blasting, grinding, mixing, screening, compacting, conveying, or loading.	1. To be controlled to 20 percent opacity (a measure of opaqueness) when wind speeds are less than 25 miles per hour except for three minutes in any one hour when fugitive emissions may equal 50 percent opacity.
Process fugitive emissions to the atmosphere.	1. To be controlled to an exhaust concentration equal to less than 0.20 pounds of particulates per 1,000 pounds of exhaust gas. 2. Visible emissions shall not exceed 20 percent opacity except for three minutes in any one hour when fugitive emissions may equal 50 percent opacity.
Trafficable roads (Roads and driveways located within one mile of a nonattainment area for total suspended particulates, are at least 20,000 square feet in area, are on contiguous property under common ownership or control, and are subject, on three separate days during any 14 consecutive day period, to motor vehicle traffic at a rate of at least 10 vehicles per hour).	1. To be paved with asphalt, concrete, or other material approved by the DNR, or to use other approved methods of dust control. 2. If paved, to be kept reasonably free of material through a program of periodic cleaning.

Source: Wisconsin Department of Natural Resources

(RACT) practices which are required by the Wisconsin Department of Natural Resources. With such measures properly and carefully applied, it may be expected that air quality standards would generally be met, although infrequent violations could occur. If violations did occur, additional controls would likely be required. If air pollution control measures are not properly applied to the expanded quarry operation, it is almost certain that the air quality standards relating to total suspended particulates would be violated.

Due to the nature of quarrying operations, it is not practical to capture all of the dust generated. Even with good pollution control, some dust will be dissipated to the atmosphere and tracked on to roadways. The air quality standard currently used is designed to protect human health. A secondary standard is also given consideration which is designed to protect animal and plant life and to prevent property damage, thereby protecting the public welfare. The human health standards should not be exceeded more than once per year. Excessive suspended particulate levels can cause respiratory problems in humans and animals, form a dust layer on plants, corrode materials, reduce atmospheric visibility, and increase cleaning costs for nearby residential, commercial, and industrial property owners.

Based upon the foregoing, it may be expected that the suspended particulate levels resulting from the quarrying operations should not have a significant adverse impact on human or animal health, on vegetation, or on corrosion of materials, assuming that proper air pollution control measures would be utilized at the expanded quarry. However, there could be potential impacts on atmospheric visibility near the quarry, and on increased cleaning costs to remove deposited dust from homes and businesses in nearby urban areas. Overall, atmospheric contributions from the expanded quarry operation may thus be expected to have some impact on the quality of life, and the desire to locate urban land uses, near the quarry.

POTENTIAL IMPACTS ON THE BIOLOGICAL ENVIRONMENT

The biological environment features which may be expected to be impacted by the proposed expansion of the Halquist Stone Company, Inc. quarry are wetlands, primary environmental corridors, prime agricultural lands, and stream biological conditions.

Wetland and Primary Environmental Corridor Lands

As noted in Chapter II, the subject quarry expansion site contains approximately 22 acres of lowland hardwoods, have been identified as a wetland on the State wetland inventory and which are included in the limits of the primary environmental corridors. Those primary environmental corridors are recommended to be maintained in essentially natural open uses. As noted under the description of the proposed quarry expansion, the quarry operator's current plans are to preserve a portion of the primary environmental corridor lands in their current state in order to serve as a buffer along the south side of the expansion site. An approximately 200-foot-wide buffer along the site boundary is proposed to be preserved. Under that proposal, about 12 acres, or 55 percent of the 22-acre corridor area on the expansion site would be destroyed. The loss of the 12 acres of primary environmental corridor land is considered a serious negative impact of the proposed quarry expansion. Because of its importance as a buffer between the quarry and the areas to the south, it is recommended that any permit issued for the expansion of the quarry operations explicitly require preservation of the entire corridor area.

The groundwater levels in the dolomite aquifer are currently substantially below the glacial material in the vicinity of the wetland. Thus, further drawdown of the groundwater levels should not affect the water levels and soil moisture conditions in the wetland area. The wetland area is, however, dependent upon surface water runoff. The quarry expansion will reduce the area draining to the wetland complex, which is located partially on the site, from 150 acres to 100 acres, a reduction of about 30 percent. The effect on the remaining wetland will be limited since a substantial land area lying west and northwest of the wetland now drains and would continue to drain to the wetland. It is recommended that the drainage on the Halquist site, which is not to be excavated and is vegetated, be directed toward the wetland complex, where practical, via grass swales.

Prime Agricultural Lands

Development of the proposed quarry would result in the loss of about 55 acres of lands currently designated in the Waukesha County Agricultural Land Preservation Plan as prime agricultural lands. Although so classified in that plan, the topsoil on the site was stripped prior to the purchase of the site by the Halquist Stone Company, thus limiting its potential as prime agricultural

lands without restoration. The acreage concerned in any case represents less then 0.1 percent of the lands designated as prime agricultural lands within Waukesha County. The prime agricultural lands located in the vicinity of the subject parcel are already somewhat fragmented due to quarrying and residential land uses.

Stream Biological Conditions

The biological conditions in Sussex Creek are currently poor. The shallow, relatively straight stream had, in the late 1970s, a bottom substrate dominated by sewage sludge, quarry silt, and bedrock which was unsuited for supporting a diverse community of benthic organisms. As a result, the Biotic Index values, based on the type and amount of benthic organisms, indicated poor or very poor water quality conditions throughout the stream system. The five fish species identified as present in Sussex Creek are all relatively tolerant of moderate pollution levels.

Expansion of the Halquist Stone Company quarry operations may be expected to have a minimal adverse impact on the biota of the stream if the wastewater discharge rates and concentration of suspended solids remain similar to current levels. As already noted, an increase in sediment loading and turbidity levels over current levels would be expected if the concentrations of suspended solids reach the current maximum permitted levels. This increase could stress fish and aquatic life at low flow conditions because of the rapid change in solids concentration and turbidity. Though occasionally stressed, the biological communities present in the stream would not be expected to change significantly. The species currently present would likely continue to reside in Sussex Creek. The dominant fish species--stickleback and white sucker--could be expected to continue to dominate. The benthic community--already poor--would not be expected to deteriorate further.

The groundwater levels in the dolomite aquifer are currently substantially below the elevation of the bed of Sussex Creek. Thus, further drawdown of the groundwater levels is not likely to reduce the baseflow of Sussex Creek. Treated process and non-contact cooling waters from the quarry operations are discharged to Sussex Creek. The existing outfall, which lies upstream of the expansion site, is expected to remain in operation because the rock crushing operation is to be retained in the existing main quarry pit. This discharge

would serve to increase the baseflow of Sussex Creek. A modest increase in treated water pumped from the quarries is expected since a larger excavation area is anticipated from which groundwater will be pumped. Thus, the likely impacts on stream baseflow should be positive.

It is, therefore, not expected that the expanded quarry operation would significantly change the biological conditions in Sussex Creek. There could be a modest increase in the stream base flow in the future if increased treated water is added to the stream. Stream substrate conditions could improve if sediments deposited by historic wastewater treatment plant and quarry wastewater sources either stabilize or are flushed from the stream channel.

POTENTIAL IMPACTS ON THE SOCIO-ECONOMIC ENVIRONMENT

The primary socio-economic environment features potentially impacted by the proposed expansion of the Halquist quarry are noise level and traffic. In addition, a discussion is presented on the planned land use conditions.

Noise

The intense noise levels which may be generated by quarrying operations have already been noted. Quarry operations such as blasting can produce extremely loud noises which carry thousands of feet. As shown in Figure 4 in Chapter II, nuisance noise levels may exist within several hundred feet of a quarry, especially if noise barriers such as earthen berms, are not constructed.

According to the Halquist Stone Company, earthen berms would be constructed along the northern and western sides and along a portion of the southern side of the expanded quarry operation. In addition, a 22-acre lowland wooded area would be maintained along the remaining portion of the southern boundary. The land to the east is zoned for quarrying. The noise levels which may be expected in the areas surrounding the expanded quarry operation were estimated based upon the following assumptions:

1. The noise level at the quarry pit boundaries under normal quarry conditions would be 90 dBA. This level was calculated using the procedures set forth in Chapter II. To evaluate worst case conditions, it was assumed

that quarry operations would continue within the existing, as well as the proposed expanded, quarry site.

2. The noise level at the existing and proposed expanded quarry pit boundaries under extreme conditions, such as during blasting, would be 120 dBA. This level is consistent with recorded blast noise levels outside the existing quarry pit. Table 20 lists the noise levels actually generated by blasting operations at the Halquist Stone Company quarry over the period from January to August 1989. Inside the quarry pit, the noise levels ranged from 89 to 139 dBA, with a mean level of 120.9 dBA. Outside of the quarry pit, the noise levels ranged from 99 to 140 dBA, with a mean level of 119.3 dBA. Thus, the quarry pit itself does not appear to be very effective in suppressing noise levels from blasts.

3. The earthen berms proposed to be constructed on the northern, western, and a portion of the southern sides of the expanded quarry are to be 20 feet high and located 50 feet from the quarry pit boundaries. The berms would be designed to provide a reduction in noise levels of 15 dBA for normal quarry operations, which were assumed to produce maximum noise levels at a sound frequency of about 500 hertz. However, berms are less effective at attenuating low frequency noises such as blasts, which generally occur at frequencies less than 50 hertz. It was estimated that berms would reduce noise levels from blasting by only 6 dBA.

4. Noise levels could be expected to be decreased at a rate of 6 dBA for every doubling of distance from the quarry, beginning at 100 feet. In addition, noise levels could be expected to be decreased due to atmospheric absorption, the rate varying with the sound frequency and the temperature and humidity of the air, but approximating 0.1 dBA per 100 feet for normal quarry operations, and 0.02 dBA per 100 feet for extreme quarry operations.

5. Trees and shrubs would provide little reduction of noise levels. Although foliage may provide a good visual shield, it provides significant noise reduction only at high sound frequencies, generally greater than 2,000 hertz. As noted above, quarry operations produce maximum noise levels at sound frequencies much less than 2,000 hertz.

Table 20

RECORDED BLASTING NOISE LEVELS IN AND NEAR THE HALQUIST STONE COMPANY QUARRY IN THE TOWN OF LISBON: JANUARY-AUGUST, 1989

Location of Seismograph Reading	Noise Level (decibels)	Distance From Blast (feet)	Date
Inside Quarry Pit			
3rd Bench, Main Pit	129	NA	8/7/89
Main Pit, West Side - 3rd Bench.....	128	NA	8/2/89
2nd Bench, Main Pit	130	NA	7/28/89
Mid Pit 3rd Bench	139	NA	7/21/89
Mid Pit 3rd Bench	139	500	7/21/89
2nd Bench - in front of shot	131	750	7/7/89
2nd Bench Mid Pit	89	800	6/26/89
Main Pit - 3rd Bench North of Shot ...	131	400	6/19/89
2nd Bench South of Shot	128	850	6/5/89
2nd Bench	127	850	5/22/89
2nd Bench	126	850	5/18/89
2nd Bench South of Shot	122	1,000	5/15/89
Main Pit South of Short - 3rd Bench ..	128	800	5/8/89
Main Pit - 3rd Bench	121	1,000	4/24/89
Main Pit - 3rd Bench	117	1,500	4/24/89
Main Pit - 3rd Bench	117	800	4/12/89
Main Pit - 3rd Bench (front of shot) .	127	1,000	4/10/89
Main Pit - 3rd Bench	130	850	4/15/89
Main Pit - 3rd Bench	125	1,000	3/27/89
3rd Bench - North of Blast	128	850	3/20/89
Main Pit - 3rd Bench (front of shot) .	128	800	3/16/89
3rd Bench - North of Pit	128	700	3/8/89
Main Pit - Middle of Pit - 3rd Bench .	127	850	1/6/89
Main Pit - 3rd Bench Middle of Pit ...	135	1,200	1/4/89
Mean Inside Quarry Pit	120.9	--	--
Outside Quarry Pit			
On Driveway South of CTH K	123	NA	8/7/89
On Driveway South of CTH K	115	NA	8/3/89
On Driveway South of CTH K	121	NA	8/1/89
On Driveway South of CTH K	119	NA	7/31/89
On Driveway South of CTH K	121	NA	7/28/89
On Driveway South of CTH K	129	500	7/24/89
On Driveway South of CTH K	118	600	7/17/89
On Driveway South of CTH K	122	1,000	7/14/89
On Driveway South of CTH K	123	1,000	7/12/89
On Driveway South of CTH K	115	750	7/7/89
On Driveway South of CTH K	99	1,000	7/7/89
On Driveway South of CTH K	113	550	7/6/89
On Driveway South of CTH K	118	850	6/27/89
On Driveway South of CTH K	110	1,000	6/27/89
Halquist Shop	113	1,000	6/22/89

Table 20 (cont'd)

Location of Seismograph Reading	Noise Level (decibels)	Distance From Blast (feet)	Date
Outside Quarry Pit (cont'd)			
Standard Asphalt Plant	126	550	6/16/89
On Driveway South of CTH K	126	1,000	5/25/89
Standard Asphalt Plant	133	500	5/24/89
South of CTH K North of Shot on Drive	128	800	5/10/89
On Driveway South of CTH K	119	800	5/5/89
On Driveway South of CTH K	114	900	5/2/89
On Driveway South of CTH K	108	800	5/1/89
On Driveway South of CTH K	125	1,000	4/26/89
Standard Asphalt Plant	113	500	4/20/89
Halquist Shop	110	1,000	4/13/89
Subdivision North of Pit	119	800	3/30/89
Subdivision (Lilac Drive)	116	1,000	3/27/89
Subdivision North of Pit	125	1,000	3/22/89
Standard Asphalt Plant	140	800	3/14/89
Mean Outside Quarry Pit	119.3	--	--

NOTE: N/A - Data Not Available.

Source: Geenen Explosives, Inc.

Maps 22 and 23 show the estimated areas which may be expected to be impacted by noise produced by the expanded quarrying operations. Map 22 shows those areas where the noise levels from normal quarrying operations would be considered to be a severe annoyance--greater than 75 dBA; a slight annoyance--from 55 to 75 dBA; or noticeable--from 45 to 54 dBA. Map 23 shows these areas where the noise levels from extreme operations would be considered a severe annoyance--greater than 90 dBA; a slight annoyance--from 75 to 90 dBA; or noticeable--from 60 to 74 dBA. The duration of quarry operations such as blasting are generally short and the operations occur infrequently--generally one to three times per week. Furthermore, at the same noise level, low frequency noises such as blasts are not generally perceived to be as loud as, and are generally less annoying than, high frequency noises.

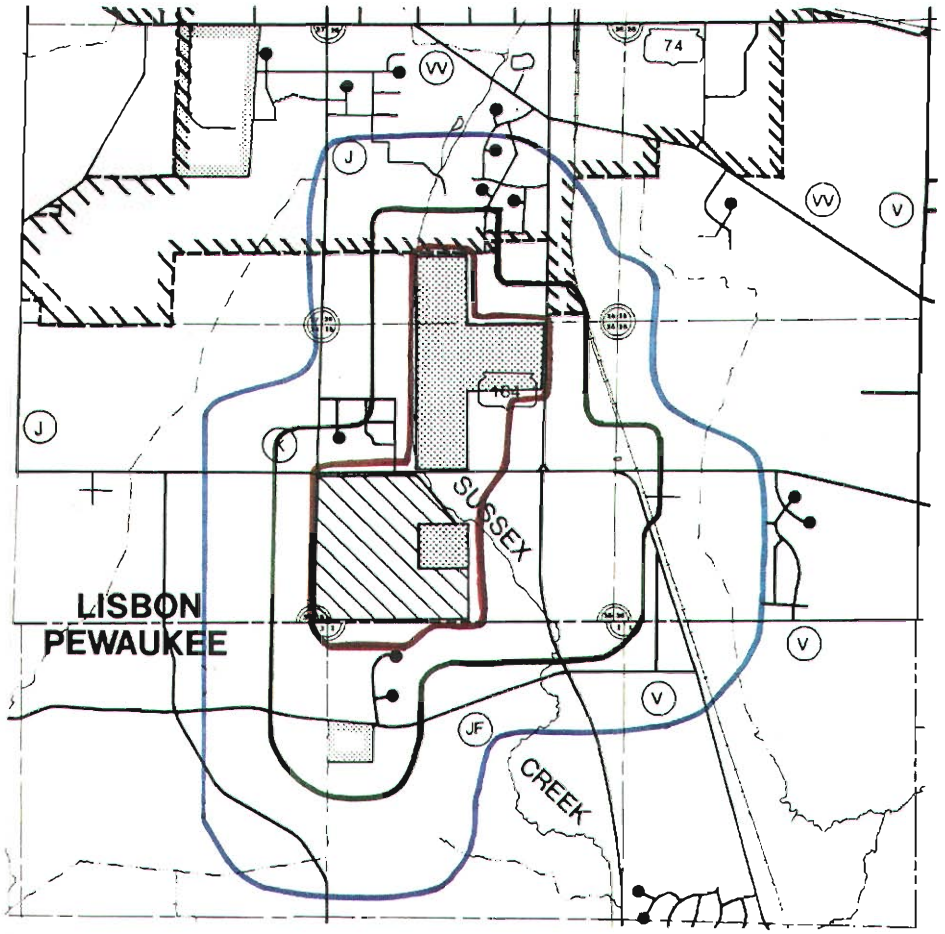
Under normal quarry operations, severely annoying noise levels may be expected to exist only within 100 to 500 feet of the quarry, the distance depending on whether or not an earthen berm was provided. These severely annoying noise levels would be perceived over an area of about 130 acres, excluding the quarry sites themselves. Of this 130 acres, 65 acres are expected to be affected at the same level under the current operation. Thus, the expanded operation would affect an additional 65 acres which are outside of the quarry sites. Slightly annoying noise levels could be expected to exist within 800 to 3,200 feet of the quarry and cover an additional area of about 680 acres, of which 480acres are impacted by the current operation. Thus, about 200 acres of land can be expected to be impacted in this manner by the proposed quarry expansion.

Extreme quarry operations such as blasting may be expected to produce severely annoying noise levels within 1,000 to 1,600 feet of the proposed quarry expansion. These severely annoying noise levels would be perceived over an area of about 650 acres, excluding the quarry itself. Of this area, about 330 acres are currently impacted to this level. Slightly annoying noise levels would extend to a distance of 2,500 to 3,200 feet and cover an additional area of about 1,170 acres, excluding the quarry sites. Of this area, 620 acres are currently being impacted to this level.

Maps 24 and 25 show the probable year 2010 residential, commercial, governmental, and institutional land uses which may be expected to be subjected to

Map 22

ESTIMATED NOISE IMPACTS UNDER NORMAL QUARRY OPERATIONS IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

Halquist Stone Company Inc. Current Site

Halquist Stone Company Inc. Proposed Expansion Site

NOISE LEVEL ESTIMATES BASED UPON IMPACT

Severe Noise Annoyance (75 dBA)

Slight Noise Annoyance (55 dBA)

Noticable Noise (45 dBA)

Normal Operating Conditions (90 dBA at Quarry Boundary)

GRID NORTH

GRAPHIC SCALE

Source: SEWRPC

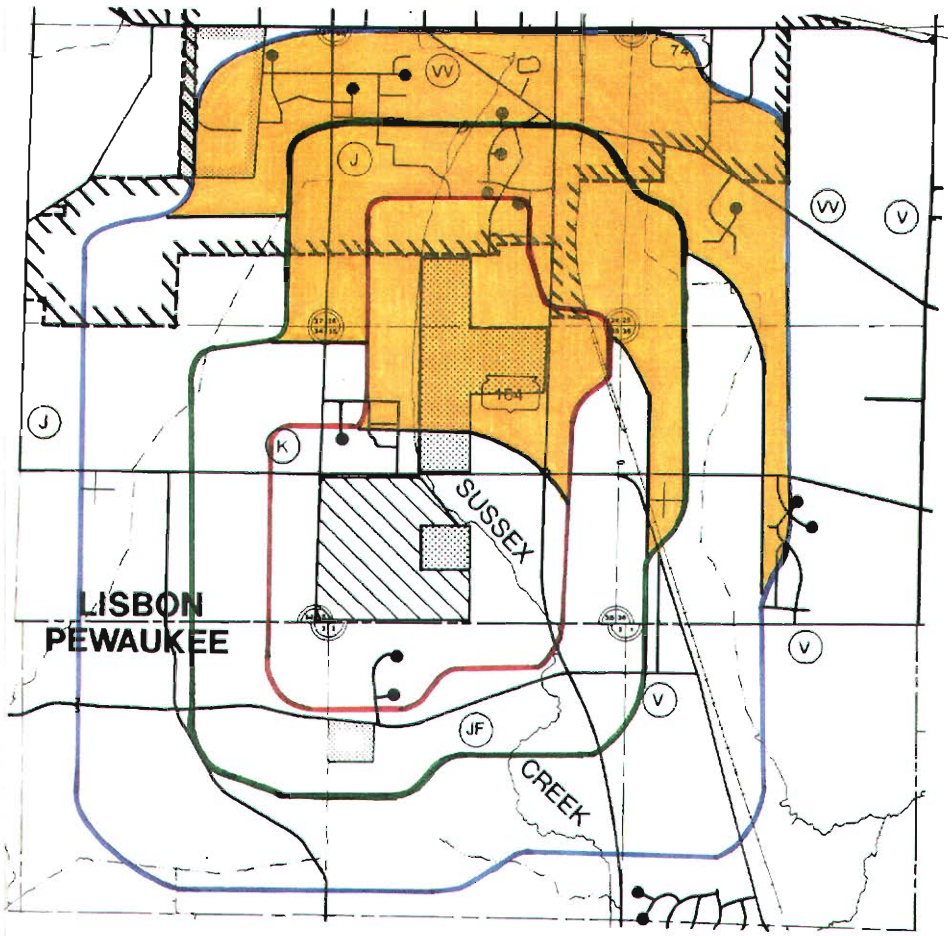
SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN

T8NR19E LISBON TOWNSHIP | T7NR19E PEWAUKEE TOWNSHIP

Map 23

ESTIMATED NOISE IMPACTS UNDER EXTREME QUARRY OPERATION IN THE TOWN OF LISBON QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- Areas Impacted to a Lesser Extent If Blasting is Discontinued in Existing Quarry

NOISE LEVEL ESTIMATES BASED UPON IMPACT

- Severe Noise Annoyance (90 dBA)
- Slight Noise Annoyance (75 dBA)
- Noticable Noise (60 dBA)

Extreme Operating Conditions (I.e. Blasting)
(120 dBA at Quarry Boundary)

GRID NORTH

0' 500' 1000' 2500'
GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T6NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

annoying noise levels. Other urban land uses such as industrial, transportation, and recreational lands were not considered to be as sensitive to noise levels. Under normal quarry operations, shown on Map 24, about four acres of residential land would be subjected to severely annoying noise levels from the proposed quarry. None of this area is already affected to the same level by the current operations. An additional 100 acres of residential land and about 20 acres of commercial, governmental, and institutional land would be subjected to slightly annoying noise levels from the proposed quarry. About 50 acres of this 120-acre area are impacted to the same level by the current operations.

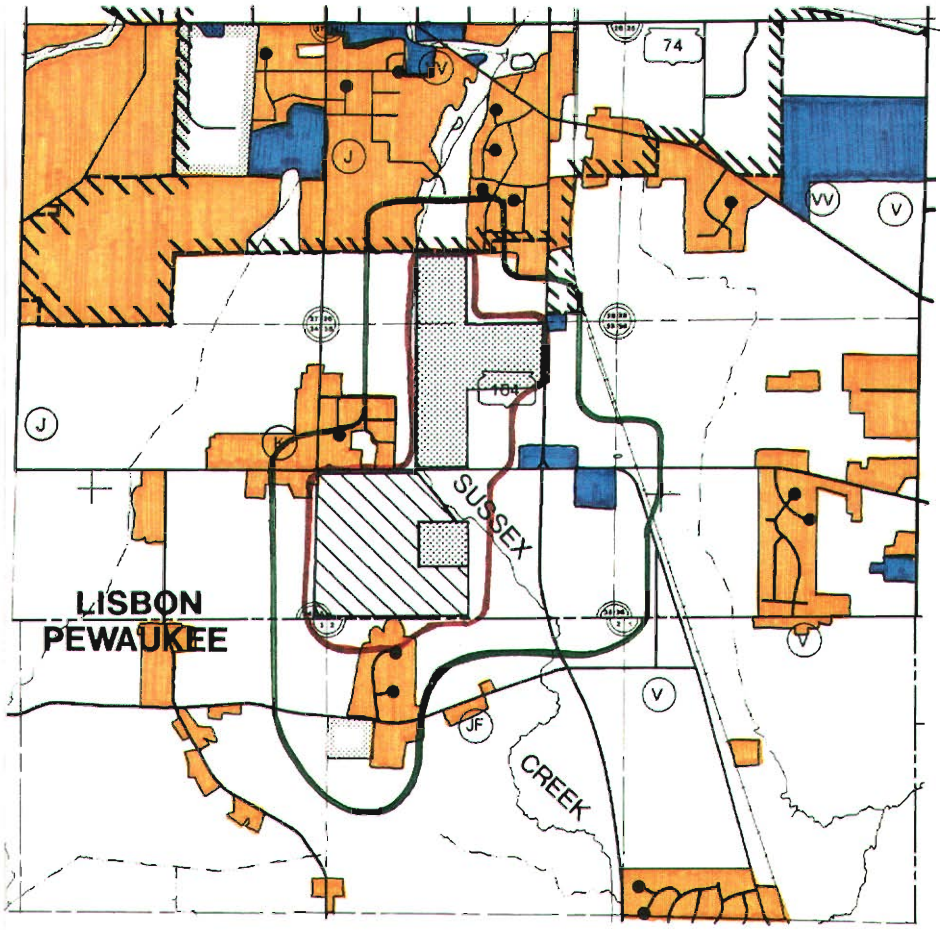
Under extreme quarry operations such as blasting, as shown on Map 25, about 130 acres of residential land and slightly less than 10 acres of commercial, governmental, and institutional land would be subjected to severely annoying noise levels. Of this area, about 60 acres are already affected by the current operation. An additional 230 acres of residential land and 25 acres of commercial, governmental, and institutional land would be subjected to slightly annoying noise levels from the proposed quarry. Of this area, 180 acres are currently affected to this level.

It is important to note that the potentially affected areas shown on Maps 22 through 25 would not be continuously impacted, nor would the entire area be impacted at the same time. The areas affected at any one time would depend upon the particular quarrying activity being undertaken, and upon the location of that activity within the quarry. For example, blasting would occur infrequently and affect only a small portion of the quarry at any one time. Thus, the areas shown on Maps 22 through 25 represent the maximum areas which could be affected by noise impacts on a long-term basis.

In addition to the noise impacts caused by activities within the quarry itself, truck traffic to and from the expanded quarry may be expected to generate noise along the transport routes. At an estimated maximum truck traffic flow of 100 trucks per hour, noise levels would be severely annoying within 20 to 30 feet of the roadway, and slightly annoying within 150 to 250 feet of the roadway. However, as noted below, only about 20 percent of the traffic on CTH K results from the quarry operations. Furthermore, the current level of truck-related noise is not expected to change due to the quarry expansion.

Map 24

PROPOSED YEAR-2010 RESIDENTIAL AND COMMERCIAL LAND USES IMPACTED BY NOISE LEVELS UNDER NORMAL QUARRY OPERATIONS IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- Residential Land Use
- Commercial, Governmental, and Institutional Land Use

NOISE LEVEL ESTIMATES BASED UPON IMPACT

- Severe Noise Annoyance (75 dBA)
- Slight Noise Annoyance (55 dBA)

GRID NORTH

0' 500' 1000' 2000'
GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8N R19E LISBON TOWNSHIP / T7N R19E PEWAUKEE TOWNSHIP

North of CTH K, the noise impacts should not be increased over existing levels, except for potential small increases in the areas immediately northwest of the proposed expansion site. The noise levels for most of the area north of CTH K could actually decrease if quarrying activities decrease at the existing quarry site. It should also be noted that similar noise impacts are generated by the Vulcan Materials Company quarry.

A number of measures could be implemented to mitigate some of the most severe noise impacts. These measures, which include structural facilities, quarry operation procedures, and adjacent area measures, are listed in Table 21. These measures should be carefully considered on a case-by-case basis. If these measures were undertaken, it is likely that while the noise levels would remain at least slightly annoying in the areas impacted, the extent of the impacted area could be reduced. During blasting, severely annoying noise levels would still affect some areas.

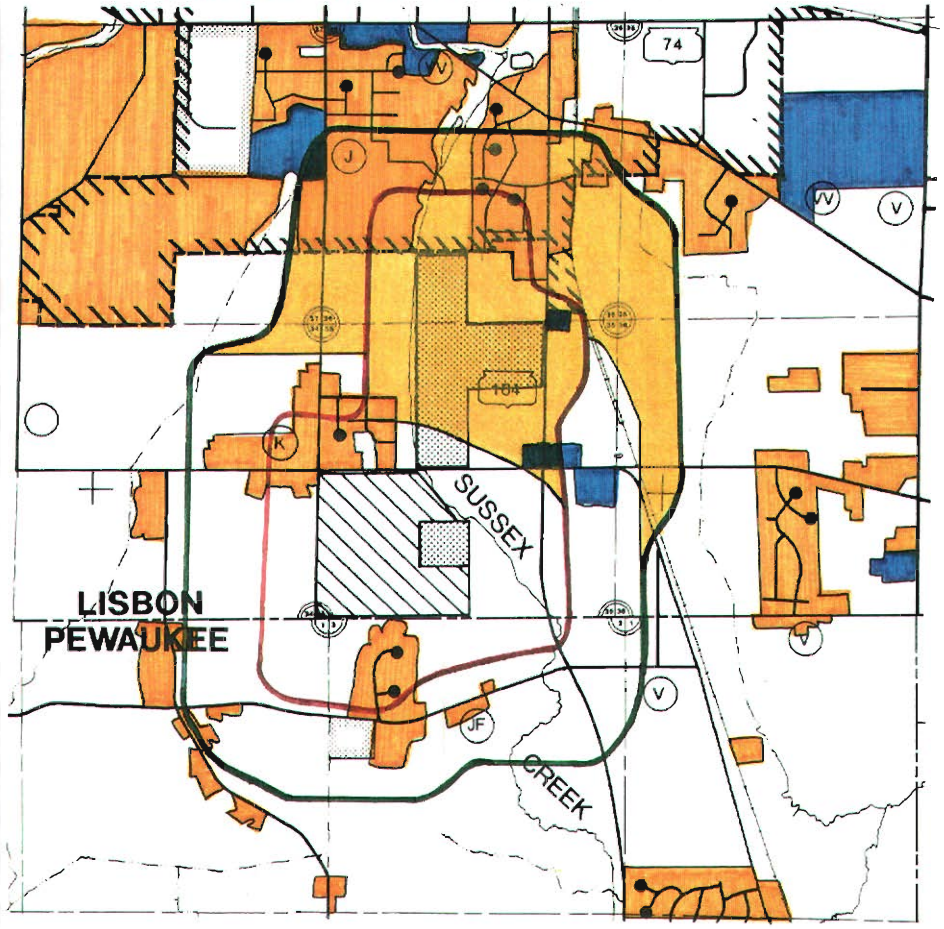
Traffic

As already noted, the 1988 average weekday traffic on CTH K (Lisbon Road)--5,940 vehicles per average weekday--abuts the entrances to the existing, as well as the proposed expanded, quarry facility. The current traffic volume of about 6,000 vehicles per average weekday is somewhat below the design capacity of 7,000 vehicles per day of a two-lane rural roadway. Although the traffic into and out of the quarry driveway on the north side of CTH K is moderately heavy, it was concluded in Chapter II that quarry traffic has relatively little impact on CTH K traffic because the quarry traffic is relatively constant throughout the daylight hours and because added lanes at the Halquist property facilitate separation of through traffic and turning traffic. Quarry traffic has an even lessor impact on traffic flow on STH 164, a four-lane roadway, than on CTH K.

Since, as already noted, the output from the expanded quarry facility is assumed to remain approximately the same as the output from the existing facility, it may also be assumed that the volume of truck traffic traveling along CTH K would be about the same in the future as it is today. Thus, the impact of the expanded facility on traffic to and from the quarry should not be significant. However, as already noted, the quarry owner plans to initially convey quarried stone from the south quarry to the north quarry by truck

Map 25

PROPOSED YEAR-2010 RESIDENTIAL AND COMMERCIAL LAND USES IMPACTED BY NOISE LEVELS UNDER EXTREME QUARRY OPERATION IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Halquist Stone Company Inc. Proposed Expansion Site
- Residential Land Use
- Commercial, Governmental, and Institutional Land Use
- Areas Impacted to a Lesser Extent If Blasting Is Discontinued in Existing Quarry

NOISE LEVEL ESTIMATES BASED UPON IMPACT

- Severe Noise Annoyance (90 dBA)
- Slight Noise Annoyance (75 dBA)

GRID NORTH

0' 500' 1000' 2000'
GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP	T7NR19E PEWAUKEE TOWNSHIP

across CTH K for some significant period of time. This could result in large trucks crossing CTH K from 100 to 250 times per day or about 12 to 25 times per hour, if the operation is limited to normal working hours. The truck sizes would be large and could have slow start and stop characteristics. Such a trucking operation would both impede and be impeded by traffic on CTH K, and would create a serious safety hazard. The current traffic volume of about 6,000 vehicles per average weekday on CTH K is nearing the roadway capacity of about 7,000 vehicles per average weekday. It may be expected that there will be a tendency to limit the waiting time of the trucks crossing CTH K at the risk of impeding normal through traffic. This aspect of the proposed operation can be considered as having potentially severe negative impacts. Thus, the expansion of the quarry operation should be conditioned upon a tunnel under Lisbon Road being provided for the transport of materials across Lisbon Road as the initial construction phase of the expanded operated.

Another potential traffic-related impact is damage to the roadways caused by heavy trucks. As shown on Figure 3 in Chapter II, quarry-related traffic--mostly trucks--accounts for about 10 percent of the total westbound traffic on CTH K just east of the quarry driveway and for about 2 percent of the total eastbound traffic just west of the driveway. Although CTH K and STH 164 were designed to accommodate truck traffic, the heavy weight of the loaded trucks will accelerate pavement deterioration and increase long-term road maintenance costs. Vehicle loads can lead to fatigue cracking, permanent deformation, and rutting of bituminous concrete roadways, such as those on CTH K and much of STH 164. Fatigue cracking results from repeated tension occurring at the underside of the stabilized pavement layers. Fatigue cracking of bituminous concrete pavement is typically manifested by the common "alligator" cracking pattern. Permanent deformation of bituminous concrete pavement results from compression and shear occurring in the various layers of pavement. Rutting is a type of pavement distress where longitudinal grooves or ruts are worn into the bituminous concrete pavement surface by heavily loaded vehicles, especially when accelerating or decelerating.

The portion of STH 164 near the intersection with CTH K has a Portland cement concrete pavement. Vehicle loads on concrete pavement can lead to fatigue cracking and erosion. Fatigue cracking is caused in the same way as for bituminous concrete pavements except transverse cracks--rather than

"alligator" cracks--typically occur. Pavement "pumping" can result from excessive pavement deflection at the slab edges, joints, and corners, and causes loss of subbase and subgrade materials with eventual cracking and faulting of the pavement.

Currently, there is little indication of road damage by quarry-related truck traffic. Indeed, both CTH K and STH 164 near the quarry site appear to be in good condition. Nevertheless, a study conducted by the American Association of State Highway and Transportation Officials found that a single passage of an 80,000 pound truck causes as much pavement damage as the passage of 9,600 automobiles.[10] The truck traffic generated by the quarry operation can be expected to entail higher road maintenance and repair costs and/or higher reconstruction costs in order to accommodate the truck traffic, than the maintenance, repair, and reconstruction costs which would be entailed if the truck traffic did not exist. The road damage caused by traffic loads should not, however, be greater than under existing conditions.

Some measures could be taken to abate related impacts of traffic associated with the quarries. First, reduced traffic speeds and paving of roadway shoulders near the quarry site would help reduce fugitive dust emissions from the quarry operation. Second, reduced traffic speeds and construction and maintenance of smooth pavements would reduce noise levels generated from the operation. Third, there is a need to develop a traffic plan to illustrate the means by which truck traffic conveying stone across CTH K will be handled.

Future Land Use Impacts

As can be noted by review of Maps 13 and 14 in Chapter II, that land uses immediately adjacent to the proposed quarry expansion site are primarily open space type uses and quarrying operations, with the exceptions of the residential land uses currently in place to the north and northwest of the proposed site in the Town of Lisbon, and to the south of the proposed site in the Town of Pewaukee. The impacts on these current residential land use areas are

---

[10]American Association of State Highway and Transportation Officials, "AASHO Road Test", Highway research Board Special Report 61, National Academy of Sciences, 1962.

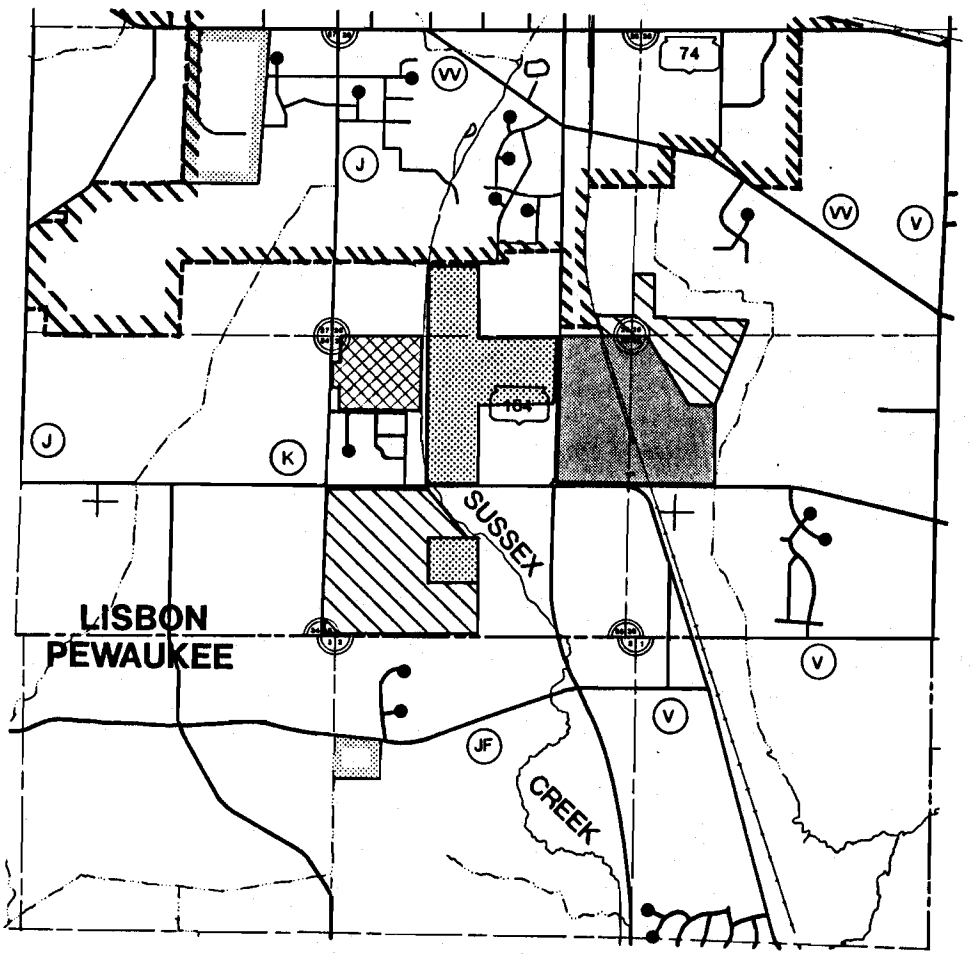
primarily related to traffic, noise, and air quality. However, conditions under the expanded operation should not be substantially different than under current conditions for the residential land uses in the Town of Lisbon. However, increased noise and air quality impacts could be expected in the existing and partially developed residential land in the Town of Pewaukee north of CTH JF and immediately south of the expansion site.

As already noted, the impacts on the existing and planned land use pattern considered have been those based on an intermediate growth centralized land use future scenario developed as part of the year 2010 regional land use plan, presently under preparation by the Regional Planning Commission. A more optimistic growth decentralized land use scenario would result in considerable additional residential development in the vicinities of the quarries. In addition, since the quarry operations are expected to be in place for a relatively long period of time--significantly greater than the 20-year plan period--it is likely that the areas surrounding the quarries may eventually be strongly considered for residential purposes. Because of this possibility, it may be desirable for the Towns of Lisbon and Pewaukee to seek to preclude, to the maximum extent practicable, the establishment of additional residential subdivisions within approximately one-quarter mile of the boundary of the proposed quarry operation should the expansion be approved as proposed.

While such an action would be a positive step in reducing the socio-economic impacts of the quarry operation, it may not be agreeable to the local units of government and the land owners concerned. For example, the Village of Sussex is currently considering a proposed development of the Robert Stier property, the eastern limits of which are within 400 feet of the current Halquist quarry operation, as shown on Map 26. A detailed site plan for the proposed development has not yet been prepared. However, a representative of the Village of Sussex indicated at the public informational meeting on this environmental impact evaluation that the Village was not interested in owning or maintaining additional park and open space land on the south side of the Village. Thus, the Village may not be in favor of additional open space land use zoning in this area. Preliminary plans call for low density residential development. Such a plan will likely result in increased nuisance complaints related to the quarries, due to continued residential encroachment into areas impacted by air and noise pollution. It is therefore recommended that any proposed

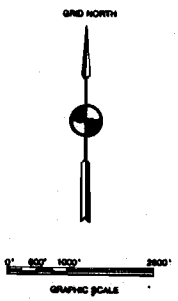
Map 26

SPECIFIC POTENTIAL DEVELOPMENT AREAS IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Vulcan Materials Company Current Site
- Proposed Quarry Expansion Site
- Robert J. Stier Property



Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP	T7NR19E PEWAUKEE TOWNSHIP

residential subdivision plan be denied by the Village of Sussex pending the purchase of the quarry operator of the lands within 1,320 feet of the limits of the existing and proposed quarry operation; or the dedication of the lands concerned for public open space purposes. The land could be developed for purposes compatible with quarry use, such as industrial, public utility, or certain institutional uses.

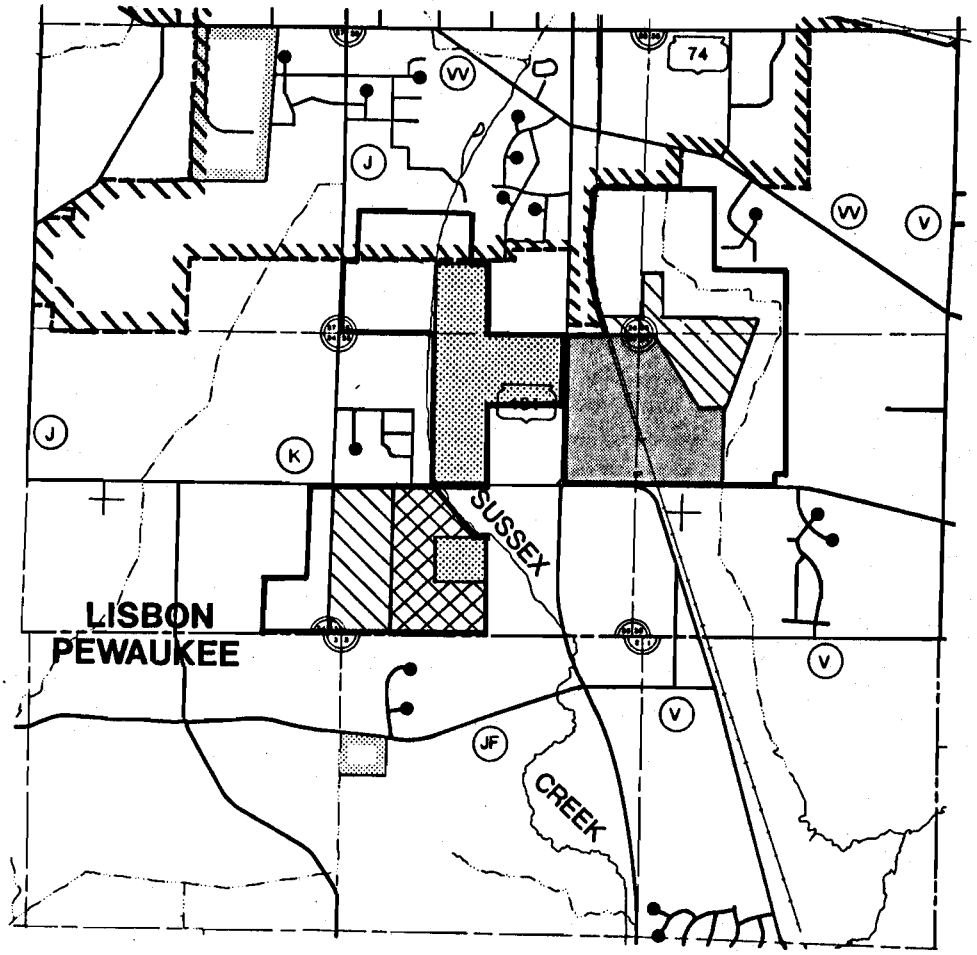
AREAWIDE QUARRY OPERATION IMPACTS

The previous section of this chapter has dealt primarily with the environmental impacts of a specific quarry expansion proposed by the Halquist Stone Company. In addition to consideration of the potential local impacts of that specific expansion, it is important to consider the potential areawide impacts of that expansion as well as other quarrying operations in the study area. Thus, this section of the report describes areawide environmental considerations assuming the long term expansion of both quarries in the study area--the Halquist Stone Company quarry and the Vulcan Materials Company quarry. For purposes of this analysis, the Halquist quarry is assumed to be expanded to the full size within the 160-acre expansion site south of CTH K, as described earlier in this chapter. This expansion will provide for about 107 acres of active quarry. Furthermore, the Vulcan Materials Company quarry is also assumed to be expanded significantly.

Vulcan Materials Company owns approximately 400 acres of land in the northeast one-quarter of U.S. Public Land Survey Section 35 and the Northwest one-quarter of Section 36, Township 8 North, Range 19 East, Town of Lisbon, Waukesha County, as shown on Map 27. The quarry operations are now limited to approximately 140 acres in the southwest portion of that property. Eventual expansion could take place to the northeast, up to 200 feet of the tributary to Sussex Creek, and up to about 1,000 feet of all current residential areas. While it may be possible to reroute the tributary to Sussex Creek to the east and north to gain additional quarry capacity, this would reduce the buffer area required to protect existing and proposed residential areas. Thus, it was assumed that the expansion limits on the east and north for the foreseeable future would be limited by the location of the tributary to Sussex Creek. Under these assumptions, an additional approximately 70 acres could be quarried at the Vulcan Quarry site.

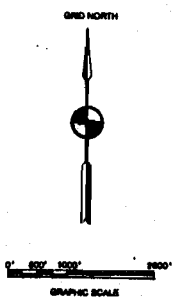
Map 27

CURRENT AND POTENTIAL QUARRY OPERATIONS IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Vulcan Materials Company Current Site
- Proposed Quarry Expansion Site
- Halquist Stone Company Inc. Property South of CTH "K" Currently Approved For Quarrying
- Quarry Property Boundary



Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

Detailed plans of this expansion were not available for the Vulcan Materials site. However, the assessment in the following sections assumes that eventually about 210 acres will be quarried. For purposes of this report, the following assumptions were made with regard to the future Vulcan Materials quarry operations:

1. That the limits of any quarrying activity would be as shown on Map 26.

2. That the quantity of material quarried on a daily basis would remain constant at about 600,000 to 700,000 tons per year.

3. That the depth of the quarry would remain at the maximum current depth--about 110 feet to approximately elevation 765 feet above NGVD--with expansion to be accomplished by extending this depth laterally.

4. That the current rock crushing and limestone production facilities would remain west of the Wisconsin Central Ltd. railway line.

5. That no additional berms would be constructed on the sides of the expanded quarry operation.

The eventual development and expansion of the Halquist Stone Company and the Vulcan Materials Company quarrying operations located within the study area can be expected to have potential areawide impacts on groundwater levels, noise levels, air quality conditions, and land use development. These environmental impacts are considered to be the most significant associated with the quarrying operations based upon the detailed analyses for the specific Halquist expansion as discussed in the previous section. Because these impacts can be areawide in nature and in part cumulative, further discussion of these impacts considering both quarrying operations in the study area is provided in this section.

Groundwater Supply

The analyses conducted for the Halquist quarry expansion, as documented in a previous section of this chapter, indicate that groundwater drawdowns resulting from the quarry operations may approximate 10 feet at a distance of about 2,500 feet, decreasing to zero at about 4,000 to 5,000 feet from the quarry

excavation. Maximum drawdown levels are expected to be about 20 feet at a distance of about 500 feet from the quarry excavation. Review of the data presented eaarlier indicates that drawdowns are expected in the order of between 10 to 20 feet in areas of current residential development. In addition, as noted earlier in this report, a review of the available well logs in the area indicates that most of the wells within the groundwater drawdown zone of influence of the potential quarry limitations are finished deep enough--greater than 30 feet below the predicted groundwater table elevations--in the dolomite aquifer to be assured of continued water supply despite quarry-related drawdowns. Specific information on well depths is provided in Appendix B. In some cases, it may be necessary for some homeowners to have their submersible pumps lowered in order to maintain an adequate water column height above the pumps. Thus, analyses which have been conducted indicate that the impacts on wells in the dolomite aquifer may be expected to be minimal, even under the ultimate quarry development. However, it is recommended that there be agreements reached between the Town and the quarry operators to deal with unexpected damage caused to private water supplies as a result of expanded quarry operations, including the need to lower and modify pumping systems. Such agreements are not uncommon and have been effected in the Town of Lisbon and in the adjacent Town of Pewaukee at other locations. With such agreements in place, homeowners will be largely protected from quarry related groundwater impacts.

Air Quality

As noted in the earlier section of this report, historically, total suspended particulate levels near the two quarrying operations in the study area have exceeded U.S. Environmental Protection Agency (EPA) and Wisconsin Department of Natural Resources (DNR) air quality standards resulting in the area being designated as a nonattainment area. Management measures which have been undertaken by both companies to reduce fugitive dust emissions have been relatively successful based upon the number of violations which have occurred in the last two years--four violations occurring in 1988 and only one violation occurring in 1989, the latter violation being attributed to natural causes rather than the quarrying operations. Since the proposed quarry expansions would provide for the same type of quarrying operation as the existing facilities, they may be expected to generate similar types and amounts of air pollutants. Due to the nature of the quarrying operation, it is not practical

to capture all of the dust generated. Even with good pollution control systems, some dust will be dissipated to the atmosphere and tracked on to roadways. Thus, it is important that proper air pollution control measures be applied to control fugitive dust to the extent possible. Measures which have been designed to control fugitive dust emissions are listed in Table 19 in the previous section. With the application of these measures, it may be expected that air quality standards will generally be met, although some infrequent violations may occur.

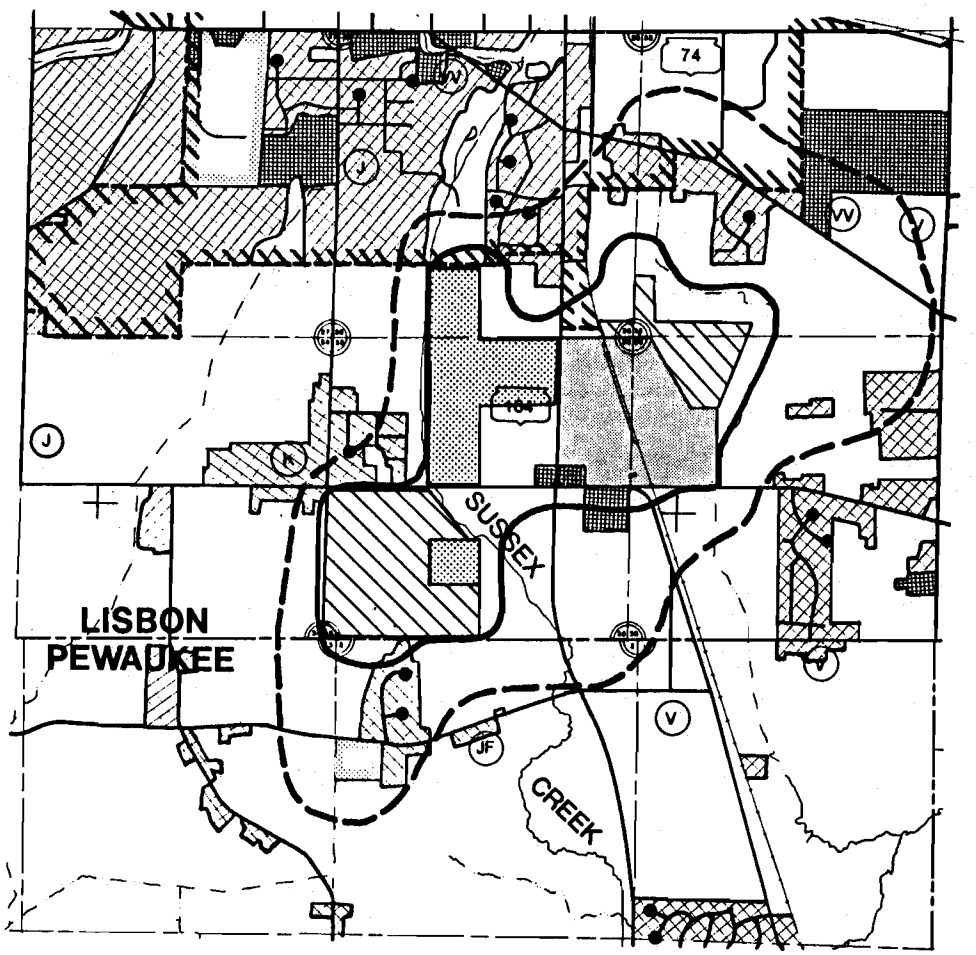
Testimony from area residents and field observation indicates that nuisance air quality problems do in fact exist. There can be expected to be impacts on the areas adjacent to the quarry due to somewhat degraded atmospheric visibility and increased cleaning costs to remove deposited dust from homes and business vehicles and other property. Overall, atmospheric contributions are expected to be similar to those experienced in the immediate vicinity of the quarries at this time, with those same impacts expected to be experienced in areas adjacent to the expanded operations. Such atmospheric contributions from the expanded quarry may be expected to have an impact on the quality of life and the desire to locate urban land uses near the quarry, as is the case with the present quarries. Upon ultimate quarry development, existing residential areas including the Circle Crest and Country Club Estates subdivision in the Town of Lisbon and the development along Lindsay Road in the Town of Pewaukee may be expected to be adversely impacted by nuisance air quality conditions under further conditions unless air quality controls at the quarries are improved.

Noise Levels

A detailed evaluation of the noise levels expected to be associated with the existing and proposed expansion of the Halquist quarry was presented in the previous section. The same type of analyses were also conducted for the study area assuming the expansion of both the Halquist and Vulcan quarry operations. Maps 28 and 29 show the estimated areas which may be impacted by noise produced by the expanded quarrying operations. Map 28 shows the areas where noise levels from normal quarrying operations would be considered to be a severe or slight annoyance, while Map 29 shows those areas where noise levels from extreme operations, such as blasting, would be considered a severe or slight annoyance. Maps 28 and 29 also show the probable year 2010 resi-

Map 28

PROPOSED YEAR-2010 RESIDENTIAL AND COMMERCIAL LAND USES IMPACTED BY NOISE LEVELS UNDER NORMAL COMBINED QUARRY OPERATIONS IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Vulcan Materials Company Current Site
- Proposed Quarry Expansion Sites
- Residential Land Use
- Commercial, Governmental, and Institutional Land Use
- Slight Noise Annoyance (55 dBA)
- Severe Noise Annoyance (75 dBA)

GRID NORTH

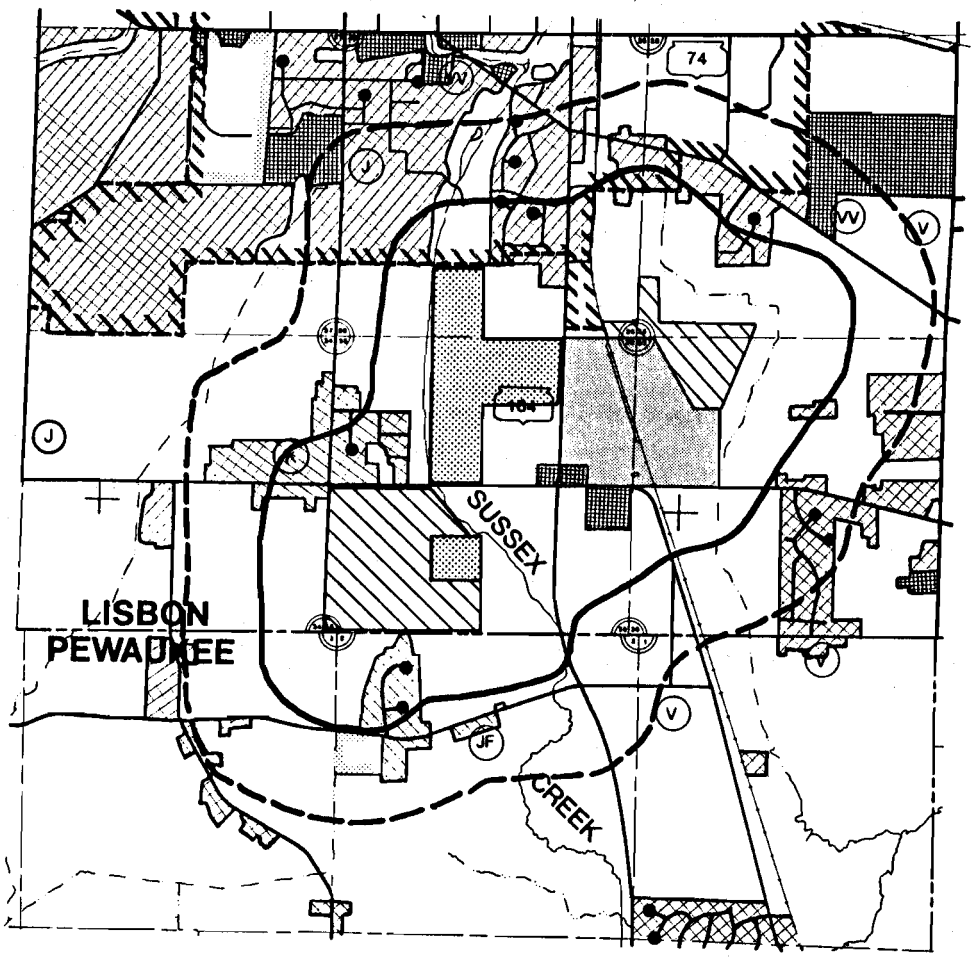
0' 600' 1000' 2000'
GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP	T7NR19E PEWAUKEE TOWNSHIP

Map 29

PROPOSED YEAR-2010 RESIDENTIAL AND COMMERCIAL LAND USES IMPACTED BY NOISE LEVELS UNDER EXTREME COMBINED QUARRY OPERATION IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Vulcan Materials Company Current Site
- Proposed Quarry Expansion Sites
- Residential Land Use
- Commercial, Governmental, and Institutional Land Use
- Slight Noise Annoyance (75 dBA)
- Severe Noise Annoyance (90 dBA)

GRID NORTH

0' 500' 1000' 2000'
GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA-
WAUKESHA COUNTY, WISCONSIN

T8NR19E LISBON TOWNSHIP | T7NR19E PEWAUKEE TOWNSHIP

dential, commercial, and governmental and institutional land uses which may be expected to be subjected to annoying noise levels. As shown on Map 28, about six acres of residential land and about 22 acres of commercial, governmental, and institutional land would be subjected to severely annoying noise levels from normal quarry operations. About 22 acres of this 28-acre severely impacted residential, commercial, governmental, and institutional area are impacted to the same level by the current operations. An additional 246 acres of residential land and about 25 acres of commercial, governmental, and institutional land would be subjected to slightly annoying noise levels from the normal quarry operations. About 176 acres of this 271-acre slightly impacted residential, commercial, governmental, and institutional area are impacted at the same level by the current operations.

Under extreme conditions, such as blasting, as shown on Map 29, about 83 acres of residential land and about 25 acres of commercial, governmental, and institutional land would be subjected to severely annoying noise levels. Of this 108-acre severely impacted residential, commercial, governmental, and institutional area, about 76 acres are already affected by the current operation. An additional 483 acres of residential land and about 28 acres of commercial, governmental and institutional land would be subjected to slightly annoying noise levels from extreme conditions at the proposed quarry. Of this 511-acre slightly impacted residential, commercial, governmental, and institutional area, 365 acres are currently affected at the same level.

As noted earlier, a number of measures can be implemented to mitigate the most severe noise impacts. These measures include structural facilities, modification to quarry operational procedures, and adjacent area measures, and are listed in Table 21. Even if these measures were undertaken, it is likely that the noise levels would remain at least slightly annoying in the areas impacted, while the extent to the impacted area could be reduced somewhat. During blasting, annoying noise levels would still affect most of the area.

Future Land Use Impacts

As can be noted by review of Maps 13 and 14 in Chapter II, the land uses immediately adjacent to the proposed quarry expansions are primarily open space type uses and quarrying operations. However, as shown on Map 30, there are a number of residential land uses currently in place to the north and

h01A12.TBL/ib

Table 21

MITIGATIVE MEASURES WHICH MAY REDUCE THE ADVERSE IMPACTS OF EXCESSIVE NOISE FROM QUARRY OPERATIONS

Type	Description
Structural Facilities	1. Earthen Berms (or similar noise barriers) 2. Enclose certain quarry operations, such as rock crushing.
Quarry Operation Procedures	1. Schedule noisiest activities for mid-day and rush hour periods. 2. Utilize blasting techniques which produce less noise. 3. Reduce truck traffic and truck speed. 4. Construct smooth, gently-sloped haul roads, where possible. 5. Require noise control features on heavy equipment and comply with vehicle codes and regulations concerning noise emissions from heavy equipment.
Adjacent Area Measures	1. Develop setbacks from the quarry for new urban development and only allow land uses in impacted areas which are compatible with the expected noise levels. 2. Soundproof buildings in impacted areas. 3. Reduce speed limits on, and carefully maintain, roadways used by trucks and heavy equipment.

Source: SEWRPC

northwest of the proposed Halquist site in the Town of Lisbon and to the south of the proposed Halquist site in the Town of Pewaukee. In addition, there is current residential development located immediately to the north of the proposed Vulcan Materials expansion site.

As noted in the previous sections, there are concerns about potential environmental impacts with regard to air quality and noise levels in the areas adjacent to the existing and proposed quarry sites, and the creation of nuisance conditions for the existing development. As noted earlier in this chapter, there may be considerable pressure to develop lands in the vicinity of the quarries for residential uses by the year 2010. In addition, the quarry operations as currently planned are expected to remain in place for a relatively long period of time--significantly greater than the 20-year plan period for current land use planning. The Towns of Lisbon and Pewaukee and the Village of Sussex should preclude to the maximum extent practical, the establishment of additional residential development within an approximate one-quarter mile of the boundary of the proposed quarry operations as delineated on Map 30. This area covers about 1,100 acres outside of the ultimate quarry development areas.

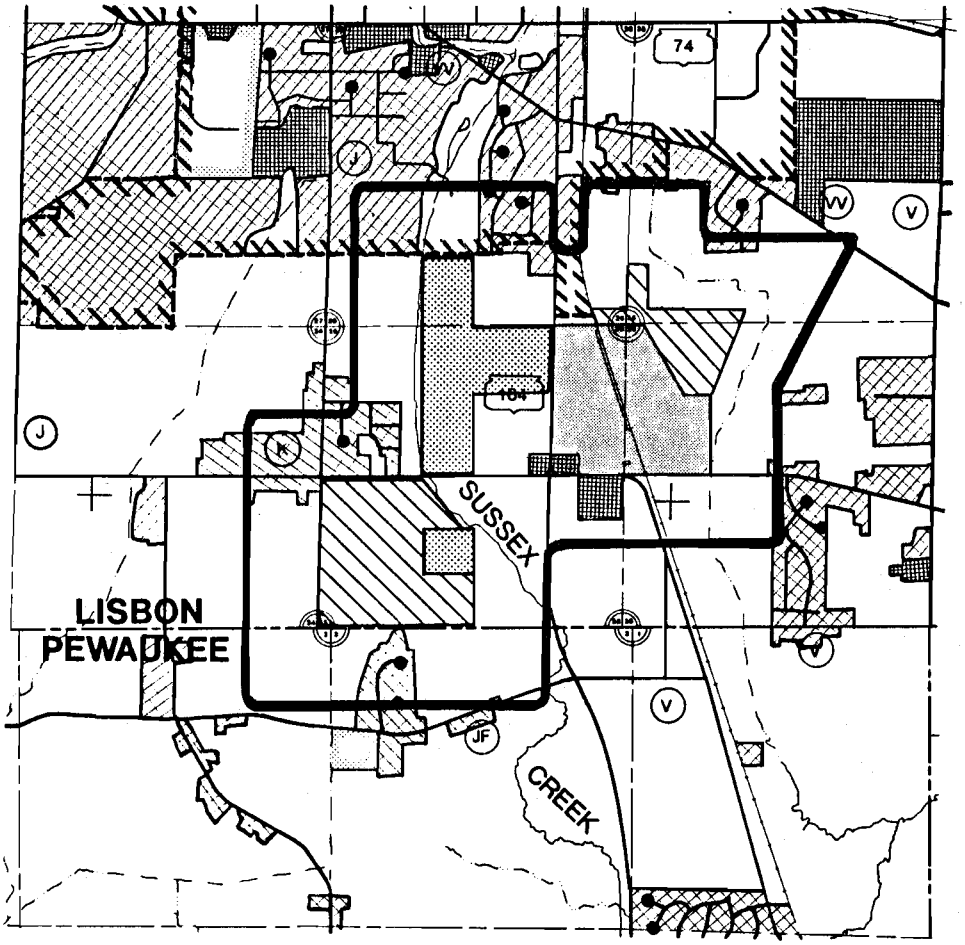
SUMMARY

In the analyses of the potential environmental impacts of the proposed expansion of the Halquist Stone Company, Inc. quarrying operations in the Town of Lisbon, it was assumed that the size and production levels of the expanded site would be similar to the size and production levels of the existing main Halquist quarry operation. It was also assumed that the existing quarry would remain in partial operation in that some processes, such as rock crushing, would continue to be located within the existing quarry pit. It was also assumed that the expansion site would not be quarried extensively for 10 years or more. Once quarrying began, it was estimated that the facility would have an economic life of 50 years or more.

The proposed expansion of the Halquist Stone Company, Inc. quarrying operations is not expected to have a significant adverse impact on surface water quality, stream biological conditions, private water supply wells, groundwater contamination, floodlands, or prime agricultural lands. While all of these

Map 30

QUARRY IMPACT AREA FOR LIMITING RESIDENTIAL DEVELOPMENT IN THE TOWN OF LISBON SOUTHEAST QUARRY OPERATIONS STUDY AREA



LEGEND

- Halquist Stone Company Inc. Current Site
- Vulcan Materials Company Current Site
- Proposed Quarry Expansion Sites
- Residential Land Use
- Commercial, Governmental, and Institutional Land Use
- Quarter Mile Development Boundary

GRID NORTH

0' 500' 1000' 2000'
GRAPHIC SCALE

Source: SEWRPC

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION	TOWN OF LISBON SOUTHEAST AREA QUARRY OPERATIONS STUDY AREA- WAUKESHA COUNTY, WISCONSIN	T8NR19E LISBON TOWNSHIP / T7NR19E PEWAUKEE TOWNSHIP

factors would be affected to some degree, the anticipated impacts are considered to be relatively minor, with some readily achievable mitigative measures being required in some cases.

The proposed expansion of the Halquist Stone Company, Inc. quarrying operations could have more significant adverse impacts on air quality conditions, noise levels, traffic, and a wooded lowland located south of and in the southern portion the proposed expansion site. Mitigative measures, including the construction of structural and pollution control facilities; the monitoring of air quality, noise, and water level conditions; and modifications in the operation and construction of the expanded quarry could minimize these adverse impacts. A more detailed discussion of the effectiveness of these mitigative measures is presented in Chapter IV.

An evaluation was conducted of the areawide impacts of the ultimate quarry expansions at the Halquist Stone Company, Inc. and the Vulcan Materials Company quarry sites. Areawide impacts in the study area are expected for groundwater levels, noise levels, air quality conditions, and land use development. Groundwater table impacts are expected to be significant with drawdowns of up to 20 feet. However, the impacts of this drawdown on wells should be minimal and can likely be readily mitigated. Upon ultimate quarry development, a large undeveloped area currently zoned residential, current residential areas including the Circle Crest and Country Club Estates subdivision in the Town of Lisbon, and the development along Lindsay Road in the Town of Pewaukee may be expected to be impacted by nuisance noise and air quality conditions to at least the same and possibly worse levels under future conditions than under current conditions unless noise and air quality controls are improved.

Chapter IV

CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

This report, requested by the Town of Lisbon, assesses the potential environmental impacts of the proposed expansion of the Halquist Stone Company, Inc. quarrying operations in the Southwest one-quarter of U.S. Public Land Survey Section 35, Township 8 North, Range 19 East. This analysis, conducted in 1988 and 1989, describes the existing quarry operations, the existing environment, the proposed future expansion and use of the quarry, and the potential environmental impacts of that expansion.

The existing 130-acre main Halquist Stone Company, Inc. quarry located north of CTH K and west of STH 164, produces 400,000 to 500,000 tons of crushed limestone and agricultural lime per year. The quarry, which has been in operation for about 55 years, has been excavated to a depth of about 120 feet below the surface elevation, that is to an elevation of about 770 feet above mean sea level. A second, smaller quarry, located south of CTH K, covers about 12 acres of a total of 80 acres which has been granted the necessary permits for quarrying. This smaller quarry is about 30 feet deep and produces about 30,000 tons of product per year. This quarry was more active in 1989 when it was used as a source of large rock for a marina project along Lake Michigan. A nearby quarry, slightly larger than the Halquist main quarry, is owned and operated by the Vulcan Materials Company. This quarry is located just east of STH 164 and north of CTH K.

CONCLUSIONS OF ENVIRONMENTAL IMPACT ANALYSIS

Inventory data presented in Chapter II of this report addressed floodlands, wetlands, environmental corridors, and prime agricultural lands within the expansion site itself. Offsite conditions were described and assessed for surface water quality, groundwater levels and quality, air quality, biological conditions in Sussex Creek, land use development, traffic, and noise. Those environmental factors which may be impacted by the proposed quarry expansion were identified.

The environmental impact analysis presented in Chapter III indicated that the proposed expansion of quarrying operations, with proper design and operational procedures, should have only relatively minor impacts on surface water quality, stream biological conditions, private water supply wells, groundwater quality, floodlands, and prime agricultural lands. Only monitoring and certain mitigative and precautionary measures would be required to ensure that these environmental factors are not significantly affected.

The expansion of the quarry may substantially impact air quality conditions and noise levels. Also, changes in the proposed expansion proposal and the method of operation are needed to minimize impacts on wetlands and environmental corridor lands and on traffic. Groundwater levels may be expected to be drawn down by up to 20 feet by the quarry dewatering, with the groundwater levels being affected for up to 4,000 to 5,000 feet from the site. The declines in groundwater levels are not expected, however, to significantly affect private water supply wells in the area since the well depths in the area of impact are generally substantially below the expected future condition water levels. A description of the two major impacts, air quality and noise, along with potential mitigative measures, follows. In addition, the changes in the expansion layout and operation plans needed to mitigate wetland/environmental corridor and traffic impacts are discussed.

Air Quality

In the absence of mitigative measures, the fugitive dust emissions from the proposed quarry expansion site would be expected to cause significant exceedances of both the EPA primary and secondary standards for total suspended particulates. Based on historical records, those standard violations could be expected to extend for a minimum of 2,000 feet around the quarry sites in the study area. Total suspended particulate levels which violate the primary and secondary standards may cause respiratory problems in humans and animals, form a dust layer on plants which may reduce their growth rates, corrode materials, reduce atmospheric visibility, and increase cleaning costs for nearby urban areas.

Mitigative measures to reduce fugitive dust emissions from quarry operations are listed in Table 19. Because some of these measures have recently been implemented by the quarries in the study area, standard violations have been

reduced, with only four violations reported in 1988 based upon Wisconsin Department of Natural Resources monitoring data. Only a single violation of the secondary standard was recorded during the first seven months of 1989. This violation, however, was not attributed to dust emissions from the quarry, but to meteorological conditions and background particulate levels. It thus appears that the mitigative measures listed in Table 19 can effectively control fugitive dust emissions to meet regulatory levels.

Even with these mitigative measures, however, total suspended particulate levels may still exceed ambient levels typical of rural and urbanizing areas. It is therefore expected that, within up to about one-half mile of the quarry, atmospheric particulate matter pollution would be noticeable and urban cleaning costs would be expected to increase.

Noise

If no special measures are undertaken to reduce noise levels, annoying noise levels would exist within up to 3,200 feet of the expanded quarry site during normal quarry operations and during activities such as blasting. Severely annoying noise levels would exist within up to 1,600 feet of the quarry site, depending upon the location and the type of quarrying activity. Severely annoying noise levels from the existing and expanded quarry could affect up to 130 acres of residential land and up to 10 acres of commercial, governmental, and institutional land. Of this 140-acre area, about 60 acres are affected by the existing quarry operation. Slightly annoying noise levels could affect up to 230 acres of additional residential land and up to 25 acres of additional commercial, governmental, and institutional land. Of the 255 acre total, about 180 acres are affected by the existing quarry operation.

Mitigative measures which may reduce noise impacts are listed in Table 21. Even if these measures are implemented, it may be expected that annoying noise levels would affect some residential areas, especially the two residential areas located northwest, and just south, of the expansion site.

Wetland and Environmental Corridor Lands

The current proposal for the Halquist Stone Company quarry operation south of Lisbon Road includes a proposal to destroy 12 acres, or 45 percent of the 22-acre corridor area on the expansion site. This area is a lowland hardwood

wetland. Because of the local importance and its importance as a buffer between the quarry and the areas to the south, it is recommended that any permit issued for the expansion of the quarry operations explicitly require preservation of the entire corridor area.

Traffic Impacts

The proposed quarry operations of the Halquist Stone Company south of Lisbon Road include plans to initially convey quarried stone from the south quarry to the north quarry by surface trucking across CTH K for some significant period of time. This could result in large trucks crossing CTH K from 100 to 250 times per day or about 12 to 25 times per hour, if the operation is limited to normal working hours. The truck sizes would be large with slow start and stop characteristics. Such a trucking operation would both impede and be impeded by traffic on CTH K, and would create a serious safety hazard. The current traffic volume of about 6,000 vehicles per average weekday on CTH K is nearing the roadway capacity of about 7,000 vehicles per average weekday. This aspect of the proposed operation can be considered as having potentially severe negative impacts. These impacts can be mitigated by providing a tunnel under Lisbon Road as one of the first steps upon initiation of the expanded operation.

Areawide Impacts

An evaluation was conducted of the areawide impacts of the ultimate quarry expansions at the Halquist Stone Company, Inc. and the Vulcan Materials Company quarry sites. Areawide impacts in the study area are expected for groundwater levels, noise levels, air quality conditions, and land use development. Groundwater impacts are expected to be severe but can likely be mitigated. Upon ultimate quarry development, a large undeveloped area currently zoned residential, current residential areas including the Circle Crest and Country Club Estates subdivision in the Town of Lisbon, and the development along Lindsay Road in the Town of Pewaukee may be expected to be impacted by nuisance noise and air quality conditions to at least the same or possibly worse levels under future conditions than under current conditions unless noise and air quality controls are improved.

Conclusions

Four conclusions may be drawn from this evaluation of the potential

environmental impacts of the proposed expansion of the Halquist Stone Company, Inc. quarry operation and the other quarry operations in the study area. First, the quarry operations may be expected to have relatively minor impacts on all but four of the environmental factors considered. These minor impacts are either insignificant or readily mitigated.

Second, the environmental impacts associated with the wetland-environmental corridor land impacts and the traffic impacts can be mitigated by changes in construction and operation of the proposed quarry.

Third, the two environmental factors which may be significantly impacted are air quality and noise levels. These impacts would require extensive mitigative measures to control--and total control is probably impractical. Both of these major impacts may be considered a serious nuisance by persons residing or working within up to about one-half mile of the quarry expansion site, although distance impacted by nuisance conditions could be reduced by mitigative measures. Human health and the ecological resources within the study area are not expected to be significantly affected, although the overall quality of life and the desirability of the area for urban development could be affected. These impacts could be manifested in ways such as potentially lower property values, a reluctance to enjoy the outdoors and participate in outdoor recreational activities, increased cleaning and maintenance requirements, and occasional disturbance of sleep and relaxation periods.

Fourth, the areawide impacts listed above resulting from the current and future operations of the two quarries in the study area indicate a need to limit new residential development in near proximity of the quarries' current and future operations.

Because of the shallow depth to bedrock, quarry operations represent an important element of the industrial economy of the Town of Lisbon, and the Villages of Lannon and Sussex. The stone products provide a resource needed for construction in and for agricultural uses of a much larger area. Because of the importance of the bedrock resource to the continued economic development of the greater Milwaukee area; and because of the historic location of the quarry and of quarry-related activities, it may be concluded that, if measures are

taken to minimize the adverse noise and air quality impacts, expansion of the Halquist Stone Company quarry would be an acceptable use of the subject site.

RECOMMENDATIONS

The following recommendations are offered for consideration as means to minimize the potential environmental impacts of the proposed expanded Halquist Stone Company quarry operation and to enhance the acceptability of the operation by existing and future nearby residents and by the local communities concerned.

Towns of Lisbon and Pewaukee

1. To minimize noise and air quality impacts, it is recommended that the local zoning ordinances be amended to restrict new residential land uses within 1,350 feet of an existing quarry or proposed quarry site which has been approved by the Town. This distance could be decreased somewhat where the quarry owners provide information which demonstrates, to the local municipalities' satisfaction, that the fugitive dust emissions and noise levels would be controlled to an extent that annoying conditions would not occur.

2. It is recommended that the 37-acre area west of the proposed quarry expansion site and owned by the Halquist Stone Company, Inc., be rezoned to preclude residential development and provide for open space or other types of use suitable for a buffer area. This land, which is currently zoned for residential use, should be used to provide a buffer for the proposed expanded quarry.

3. The Halquist Stone Company will require special approval from the Town of Lisbon, under Section 3.08(M)3.A.(1) of the Town Zoning Ordinance, to operate a quarry at the proposed expansion site because the site is located less than 1,000 feet from a residential zoning district. It is recommended that such approval be conditioned upon the Halquist Stone Company providing to, and the Town approving, a site use and operations plan for the expanded quarry. The site use and operations plan should include at least the following information:

- o A description of the nature of all proposed future quarrying activities, including the precise location and extent of the areas to be quarried, the amount of materials to be removed, and the depths to which such removal are expected to occur.

- o Identification of the specific means to be employed to mitigate environmental impacts. In this regard, particular emphasis should be given to mitigative measures relating to: preservation of the wetland area south of the site; noise; groundwater quantity and quality; air quality; and traffic problems caused by trucks crossing Lisbon Road.

- o Operations descriptions that would, for example, identify where unused materials quarried on the site, if any, are to be deposited, and describe the hours and methods of operation.

- o Provisions for a survey of existing groundwater levels prior to major quarrying, including the installation and monitoring of at least three groundwater observation wells on or near the proposed expansion site, and the taking of water level measurements from all private water supply wells located within one mile of the proposed expansion site, if the well owners permit. At a minimum, and where allowed by the well owners, quarterly readings should be taken for a one-year period prior to the initiation of the new quarrying operations. This baseline water level information would be useful for evaluating and verifying future reports on lowered water levels due to quarry dewatering.

- o An erosion control plan by which soil erosion would be controlled during the development of the quarry site, and the associated water quality impacts reduced.

4. It is recommended that the Towns of Lisbon and Pewaukee establish a program to compile and record complaints from citizens related to quarry operations, to coordinate corrective actions by the quarry owners and operators, and to forward complaints to the appropriate regulatory agencies when necessary. Monitoring records collected by

the quarry owners and various governmental agencies should be filed with the Towns.

Waukesha County

1. It is recommended that Waukesha County in cooperation with the Halquist Stone Company, Inc. pave the shoulders of CTH K near the Halquist Stone Company quarry to reduce fugitive dust levels. This action may also prolong the economic life of the roadway by reducing erosion of the shoulder and loss of subgrade material. Cost-sharing arrangements between the County and the Halquist Stone Company should be agreed-upon between the two parties.

2. Waukesha County should work with the Town of Lisbon and the State of Wisconsin to reduce speed limits on CTH K and STH 164 near the existing and proposed quarry operations. Such speed restriction should be designed to reduce fugitive dust emissions and noise levels near the quarry.

Halquist Stone Company, Inc.

1. It is recommended that the Halquist Stone Company prepare a site use and operational plan for the proposed expanded quarry, as described above, and submit the plan for approval to the Towns of Lisbon and Pewaukee.

2. It is recommended that the Company change the site use and operation plans to provide for maintenance of the 22-acre wetland/primary environmental corridor at the south side of the expansion site and to include provision for a tunnel under Lisbon Road to eliminate significant truck traffic across Lisbon Road.

3. It is recommended that the Company survey existing groundwater levels near the expansion site prior to major quarrying operations, as described above, and submit copies of the data to the Towns of Lisbon and Pewaukee.

4. It is recommended that the Company implement the noise control measures listed in Table 21, and air quality control measures listed in Table 19.

5. It is recommended that the Company upon start-up of major quarrying operations at the expansion site carefully monitor groundwater levels, and provide fair and adequate compensation to owners of any private water supply wells which are impacted by the quarry dewatering.

6. Construction activities associated with the initial efforts to begin operation of the quarry at the expansion site, including access road construction, removal of overburden, stockpiling of remaining topsoil, berm construction, and processing area construction, may, in the absence of erosion control measures, result in an increased rate of soil erosion on the project site, and in increased sediment loadings to Sussex Creek. It is recommended that the Company develop in cooperation with, and subject to the approval of, the County Land Conservation Committee construction erosion control measures to be implemented during the development of the quarry.

7. It is recommended that the Halquist Stone Company agree not to actively quarry or otherwise develop the 37-acre site located just west of the proposed expansion site, which is owned by the Company. That site, which has been herein recommended to be rezoned to the Quarry District, should be maintained as a buffer area to reduce noise and aesthetic impacts.

Private Property Owners

1. It is recommended that private property owners located in the vicinity of the quarry carefully record a description, the date, and time of annoying or nuisance conditions related to the quarry operation. Complaints should be forwarded to the appropriate town or village.

2. It is recommended that private property owners with water supply wells located within one mile of the proposed quarry cooperate with the local units of government and the Halquist Stone Company by allowing water levels in their wells to be measured on a once-per-quarter basis for at

least a one-year period prior to the time any major proposed new quarrying activity begins active operation. These water-level measurements will provide baseline data from which to assess groundwater drawdown levels once the quarry is dewatered. Additional measurements may be requested once the proposed quarry is in operation.

SUMMARY

The proposed expansion of the Halquist Stone Company, Inc. quarry and other quarries in the study area would be large operations involving heavy equipment and the excavation and movement of tremendous volumes of rock material over a long time period. The overall environmental impacts of such an operation would be widespread and varied. However, this analysis indicated that most of the environmental impacts could expected to be relatively minor, with the exceptions being impacts on air quality, noise, and to a lesser extent, groundwater levels.

A number of administrative measures, monitoring programs, and mitigative measures are recommended to minimize the impacts from the proposed quarry operation and to promote public and local governmental acceptance of the operation. Those measures are summarized in Table 22. Even if the recommendations listed in the table are implemented, there are several unavoidable impacts which would be caused by the expansion of the Halquist Stone Company, Inc. quarry. First, some of the noise, fugitive dust, and groundwater impacts of the existing quarry operation would persist for a long time--perhaps 70 years--rather than abating when it is no longer economically feasible to quarry the current facility. These existing impacts will persist because some of the quarrying operations for the expansion site, such as rock crushing, will be located within the existing pit. Second, air quality conditions, although expected to meet State and federal standards, would be worse than ambient conditions for areas not affected by quarry operations. Reduced atmospheric visibility and increased dust accumulation would be the impacts which would likely be noticed by area residents. Third, noise levels would likely be occasionally annoying to some area residents, especially those located within 1,000 feet of the existing or expanded quarry operations. Some residents would likely be subjected to severely annoying noise levels during activities such as blasting. Residential areas most likely to be affected by noise levels from the expanded

Table 22

RECOMMENDED MEASURES TO MINIMIZE THE ENVIRONMENTAL IMPACTS OF THE PROPOSED EXPANDED HALQUIST STONE COMPANY, INC. QUARRY

Recommended Measures	Town of Lisbon	Town of Pewaukee	Waukesha County	Halquist Stone Company, Inc.	Private Property Owners
Administrative Measures					
1. Amend zoning ordinances to limit residential and related development near quarries	X	X	--	--	--
2. Rezone 37-acre area west of expansion site	X	--	--	--	--
3. Require preparation of site use and operations plan, survey of existing groundwater levels, and preparation of a construction erosion control plan	X	--	--	--	--
Mitigative Measures					
1. Implement noise control measures (see Table 21).	--	--	--	X	--
2. Implement air quality control measures (see Table 19)	--	--	--	X	--
3. Prepare and conform with site use and operations plan	--	--	--	X	--
4. Prepare and conform with construction erosion control plan	--	--	--	X	--
5. Agree to not actively quarry buffer area just west of existing expansion site	--	--	--	X	--
6. Pave shoulder of CTH K near quarry	--	--	X	X	--
7. Reduce speed limits on CTH K and STH 164 near quarry	--	--	X	--	--
Monitoring Programs					
1. Survey existing groundwater levels	--	--	--	X	--
2. Cooperate with survey of existing groundwater levels and subsequent surveys of water level drawdowns	--	--	--	--	X
3. Carefully record nuisance conditions and forward complaints to local units of government	--	--	--	--	X
4. Establish program to compile complaints, coordinate corrective actions, and forward complaints to regulatory agencies as needed	X	X	--	--	--

Source: SEWRPC

quarry operation are those located to the northwest, and to the south, of the expansion site. Avoiding an increase in these noise and air quality impacts will likely require some limitations to land use development near the quarry expansion site. Fourth, dewatering of the existing and the expanded quarry sites may be expected to drawdown the groundwater elevations within about 5,000 feet of the quarry sites. However, this drawdown would be expected to have minimal impacts on existing private water supplies.

An evaluation was conducted of the areawide impacts of the ultimate quarry expansions at the Halquist Stone Company, Inc. and the Vulcan Materials Company quarry sites. Areawide impacts in the study area are expected for groundwater levels, noise levels, air quality conditions, and land use development. Groundwater impacts are expected to be significant but can likely be mitigated. Upon ultimate quarry developments, a large undeveloped area currently zoned residential and current residential areas may be expected to be impacted by nuisance noise and air quality conditions to at least the same levels under future conditions as under current conditions unless noise and air quality controls are improved. To minimize these concerns, it is recommended that residential land uses in the vicinity of the existing or proposed quarry operations be limited.

Beneficial impacts of the expanded quarry operation would include continued employment for about 50 persons, primary economic benefits to the Halquist Stone Company, Inc. and secondary economic benefits to the local communities, and the provision of needed rock materials for construction and agricultural purposes in the greater Milwaukee area. The Lisbon area is one of the most productive areas for limestone quarrying in the State of Wisconsin.

APPENDICES

(This page intentionally left blank)

H01a.app/rpb/kwb/ib
10-23-89
300-100

Appendix A

TOWN OF LISBON SOUTHEAST AREA QUARRY EXPANSION
ENVIRONMENTAL IMPACT EVALUATION

Summary Notes from the October 19, 1989
Public Information Meeting

A public information meeting on the preliminary environmental impact evaluation was held on October 19, 1989, by the Town of Lisbon Plan Commission. The public information meeting was conducted in two phases--the first being a presentation of the preliminary findings of the environmental impact evaluations, and the second being a period for questions and comments by the members of the Town Plan Commission and the public. Officials from the Town of Pewaukee and Village of Sussex were provided with copies of the draft report by the Town of Lisbon and asked for comments. The following summarizes the comments received at the public information meeting:

1. Mr. William Krigg, a Plan Commission member, asked what means would be used to transport the materials excavated in the proposed quarry expansion south of Lisbon Road to the north side where the crushing operation would be located. Mr. Biebel indicated that the Regional Planning Commission staff assumption was that the majority of the material would be conveyed under Lisbon Road, with the initial excavation being made in the vicinity of the crossing in order to provide the depth needed to tunnel under the roadway. Mr. Krigg asked the representatives of the Halquist Stone Company in attendance what their intentions were. Those representatives indicated that they presently do cross the road with trucks to convey material from the existing smaller quarry and that that practice would likely be continued for some time until an adequate depth and area was reached on the south side to allow for tunnelling under the roadway. It was indicated that there could be a relatively long period of time when surface truck transport would be used. Mr. Biebel indicated that the report would have to be revised in that light.

2. Mr. Holt asked the representatives of the Halquist Stone Company if they had other comments. Those representatives indicated that the report was well done and represented a substantial work effort. Three additional comments were provided.

   The Halquist representatives stated that the report indicated that the lowland hardwoods wetland area located on the expansion site was intended by the owners to be maintained in its current state and undisturbed. The Halquist quarry representatives reported that it was intended to maintain at least a portion of that woods but not necessarily the entire wooded area. It was agreed that the report would be changed in this regard.

   The quarry operators also noted that the report indicates that there is a current 12-acre quarry located south of Lisbon Road. They requested that this be clarified since there are 80 acres of land in that vicinity which could be quarried under present permit conditions. While only about 12 acres are currently being mined, the size of the quarry should be considered to be 80 acres.

   Finally, the Halquist Stone Company representatives noted that the report indicated potential noise problems due to the expanded quarry operation. They indicated that at the present time they had not had any significant problems from neighbors complaining about noise and suggested that the same condition would exist should the quarry expansion take place.

3. Ms. Jean Stadler noted that the encroachments within the study area by residential land uses were becoming more significant. She cited the Steir property which had recently been discussed with the Village of Sussex as an area which could be potentially provided with public sewer as one example. She asked Mr. Zellmer to comment on that property later in the meeting. She also suggested that the impacts which had been cited for the proposed Halquist quarry expansion could potentially exist in other areas, such as the Vulcan Materials quarry and another Halquist quarry in the township.

4. Mr. Holt noted that other quarry operations in the study area may need to be evaluated for future condition impacts. He asked that the report be revised in that respect. Mr. Biebel indicated that the study had been designed from its onset to deal specifically with the Halquist site and that the Commission had suggested a relatively large study area be considered to be sure the impacts would be fully evaluated in the surrounding area. He indicated that the same type of detail as provided for the Halquist site could not be provided for the remainder of the area since that would involve substantial additional work effort over and above that envisioned. He did, however, indicate that the Commission staff would review the report and see what information dealing with other quarries in the study area could be provided.

5. Mr. Redford, Chairman of the Town of Pewaukee, indicated that he had a number of comments. First, he indicated that he would strongly urge the Town to require that the entire lowland hardwood area located at the south end of the proposed expansion site be preserved and that, in addition, a berm also be constructed north of that area to restrict noise levels. He suggested that the Town Board be assured of the arrangements needed in writing as part of the permitting process for the quarry.

   Mr. Redford also asked if the the impact of the quarry expansion on property values had been considered in the evaluation. Mr. Redford referred particularly to open lands which could be considered for urban uses. He questioned whether or not more value could be obtained from encouraging development in the area without the quarry operations. Mr. Biebel indicated that impacts of property values of the implied conversion of the quarry sites to residential or other urban uses had not been considered as a practicable alternative.

   Mr. Redford also noted that at a quarry operation located in the Town of Pewaukee, the Town had periodically measured water table levels and well water depths of all potential impacted properties. That work is done by the Town but is paid for by the quarry operator in order to protect the property owners from potential water supply

problems. He noted that there are agreements on the means to resolve any identified problems. He suggested that that such an arrangement also be included in the expanded Halquist quarry operation if it is approved.

Mr. Redford also asked that the restoration plans for the quarry be developed and carefully reviewed by the Town. He further asked that the Town, if it considers the proposal further, should have assurances that the crushing operation would in fact remain north of Lisbon Road, as opposed to being moved to the south side of Lisbon Road.

Mr. Holt indicated that all those items could be considered further in negotiating the potential approval permits with the quarry operator.

Mr. Redford also indicated that it was his understanding that the quarrying operations would not be allowed within 1,000 feet of Town lines. Mr. Holt indicated that also would be an item which should be negotiated with the quarry operator.

6. Mr. Krigg indicated that he had been under the impression that no intensive quarrying would be required south of Lisbon Road by the Halquist Stone Company for about 20 years, in that they had still significant remaining viable areas to quarry north of Lisbon Road. He indicated that at the present time, there appears to be substantial activity in the south side of Lisbon Road and noted that as opposed to the discussion in the report, the south quarry appeared to be actively operated as opposed to very small, intermittent uses. He and Mr. Anhalt asked what had changed the timetable for that operation and asked if the approvals for the new proposed expansion were now more important to the quarry owner.

Mr. Perry Halquist responded that the quarry in the south side had been operated more actively recently since they were providing stone for a Lake Michigan marina development in Kenosha which had been found at a suitable quality in the south quarry at levels of

approximately 16 feet, thus the overburden material was being removed and used in order to reach the material to be provided for the Kenosha marina now under construction.

7. Mr. Bruce Zellner, Village Engineer for the Village of Sussex, indicated that he was surprised to note the relative elevation of the water table in the vicinity of Sussex Creek. He noted that an earlier report provided by SEWRPC for the Village of Sussex treatment plant had suggested the possibility of requiring an outfall sewer be constructed to a point downstream of Lisbon Road to avoid potential groundwater contamination from the Creek. He noted that the vertical distance between the water table and the Creek appeared to be significant and thus the expense of that outfall pipe may not be warranted. A letter to this affect was subsequently provided to the Regional Planning Commission. That letter and a response is attached to these minutes. Mr. Zellner also reported that the Steir property has recently been discussed by the Joint Planning Commission of the Village of Sussex and the Town of Lisbon and noted that that Committee had recommended that the Steir property be used for low-density residential land use. He noted that the Village of Sussex already had a substantial amount of open space land under its ownership and that they would not likely be in favor of providing for a buffer open space between the Steir property development and the quarry.

8. A citizen who lived near the quarry indicated that many of the environmental impact concerns raised in the report were in fact real concerns for the residents. He cited particularly the noise and dust factors as being severe problems. He reported that the asphalt plant located on the quarry property south of Lisbon Road had in fact been operated at longer hours than were allowed. Mr. Holt replied that this had been reported to the Town earlier and was in the hands of the Town Attorney at the present time. The citizen also suggested that air quality and dust control were major issues. He suggested that all trucks carrying lime should be required to cover the trucks. He suggested that starting times at the quarry were too long. Mr. Holt indicated that these items would be considered in the negotiations on the quarry expansion permit.

There being no further comments, Mr. Holt indicated that he felt the report was well done and asked that consideration be given to the comments received tonight, particularly to trying to address the other quarrying operations in the study area.

APPENDIX B

WATER LEVELS IN WELLS IN THE HALQUIST EXPANSION STUDY AREA

TOWN OF LISBON, WAUKESHA CO.
WISCONSIN

Characterization of the dolomite aquifer in the study area included mapping the current ground water table, particularly around the Halquist and Vulcan quarries. According to Gonthier (1975), the water table of the dolomite aquifer is coincident with its saturated thickness and may be determined from water levels in wells finished in the aquifer. With the cooperation of over 50 well-owners in and around the study area, water level measurements were obtained in October and November, 1988. Water level measurements in wells outside the study area were taken in order to establish a regional picture of the ground water table.

Well locations and owners were determined from DNR well completion reports, tax records and large-scale contour maps. Ground surface elevations at well heads were determined from land survey contour maps of the study area. Water level measurements were taken using a nylon measuring tape and "plopper", a metal cup that makes a slapping sound when hitting the water surface. The simple measuring device proved to be quick and accurate, with duplicatable results in most cases. Measurements were made to within 1 cm. Water levels were measured only when the well pump was not running and, therefore, represent the static water level at that time (Table I).

Table I.

MEASURED WATER LEVELS IN WELLS IN STUDY AREA

Well I.D. Number	OWNER	Total Depth of Well(ft)	10/88 Depth to Water (ft)	10/88 Water Level Elevation
36.18	LaCroix	161	46.80	819.2
36.08	Kwarciany	153	45.85	814.2
35.15	Halquist	284	55.49	838.0
35.07	Schlei	216	48.60	839.4
35.06	Ratelle	212	45.26	835.7
35.03	Edquist	216	46.96	833.0
34.05	Lembke	102	30.13	864.9
34.041	Osterman, J.	178	50.54	844.5
34.04	Osterman, R.	108	44.24	846.8
33.003	Martin	220	127.77	946.2
31.005	Burki	140	67.01	827.0
31.003	Konkol	n/a	11.99	830.0
31.002	Goergen	n/a	69.76	828.2
30.003	Findler	n/a	24.19	837.8
30.002	Gullickson	n/a	22.81	839.2
28.003	McAleavey	214	120.94	962.1
28.002	Ruhbusch	225	126.42	966.6
27.005	Pulbermacher	115	29.70	928.3
26.03	Wollin	147	35.68	880.8
26.002	Boettcher	201	41.61	862.4
26.001	Manegold	201	39.43	864.6
25.13	Lied's	173	17.04	858.0
25.12	Hamilton HS	300	94.00	779.0
25.11	Templeton MS	290	45.00	830.0
25.1	Mindeman	100	41.25	853.7
25.08	Flaeschel	135	27.82	847.2
25.06	Maahs	149	34.54	841.5
25.04	Thierfelder	130	13.46	850.5
23.001	Rose	73	32.64	908.4
22.003	Janichek	139	15.71	952.8
22.001	Erdmann	147	14.81	945.2
21.004	Current Owner	160	23.70	955.3
21.002	Schlei, T.	81	20.47	939.5
19.001	Larscheidt	n/a	16.99	863.0
18.001	Affeldt	n/a	66.66	n/a
12.001	St. P & P Church	240	53.61	812.4
7.002	Capitol Airport	n/a	15.93	829.1
7.001	Schlieper	151	23.11	804.9
6.001	Zaretzke	142	16.45	823.5
4.003	Teuteberg	83	13.14	846.9
3.03	Perschon	82	30.08	849.9
3.01	Anderson	142	23.72	841.3
3.0091	Freyer	122	31.87	843.1
3.003	Beck	81	31.25	838.8
2.09	Michor	112	32.26	837.7
2.06	Prager	205	17.53	852.5
2.05	Ruiz	167	39.02	841.0
2.04	Fox	200	31.57	848.4
1.06	Olson	142	13.04	829.0
1.05	Kierstyn	147	17.91	828.1
1.02	Guidinger	156	21.27	832.7
1.008	Harland	100	21.96	822.0
1.001	Flitsche	n/a	36.10	828.9

APPENDIX C

ESTIMATION OF HYDRAULIC CONDUCTIVITY OF THE SILURIAN DOLOMITE AQUIFER

Hydraulic conductivity (K), a measure of the ability of earth material to transmit water, was estimated according to a method presented by Bradbury and Rothschild (1985). With a Lotus 123 spreadsheet, well completion data from forty-one wells in and around the study area were analyzed. The well data included total depth of well, well radius, screen length, static and pumping water levels, time length of pump test and pumping rate. Other parameters included aquifer thickness, storage coefficient and well loss coefficient. A sample spreadsheet print-out and the equations used in the analysis are given in Table I. The spreadsheet used an iterative technique to solve for transmissivity (T). Hydraulic conductivity was found by dividing T by aquifer thickness (b).

Aquifer thickness varies from nearly 300 feet to 174 feet in the study area. Aquifer thickness for each of the analyzed wells was found from the dolomite thickness isopach map (Appendix C). Storage coefficient and well-loss coefficient were taken from the article by Bradbury and Rothschild, which analyzes wells in the same aquifer.

The reliability of the estimate by this method is highly dependent on the quality of information provided on well completion reports. These reports are filled out by well drillers after installation of a well, as required by the State of Wisconsin. In order to increase confidence in the results, only wells with reported completion tests of six or more hours and drawdowns greater than zero were analyzed.

The average K (ft/day) for the aquifer was found by taking the inverse log of the geometric mean of the estimated K's. By this method, the average K of the dolomite aquifer is 6.2 ft/day (Table II).

A PROGRAM TO ESTIMATE AQUIFER TRANSMISSIVITY
AND HYDRAULIC CONDUCTIVITY FROM SPECIFIC CAPACITY TESTS

WELL DATA:		STND. DRILLERS UNITS	IN CONSISTENT UNITS (FT,SEC)
ID NUMBER	0.00		
DIAM (IN.)	6	INCHES	0.5 FEET
TOTAL DEPTH	216	FEET	216 FEET
CASING DEPTH	185	FEET	185 FEET
SCRN LENGTH	31	FEET	31 FEET
STATIC LVL	32	FEET	32 FEET
PUMP LVL	35	FEET	35 FEET
TIME LENGTH	6	HOURS	21600.00 SECONDS
PUMPING RATE	10	GPM	0.022 FT3/SEC
AQ.THICKNESS	230	FEET	230 FEET
DRAWDOWN(s)	3	FEET	

STORAGE COEF	2.0000E-04	SPECIFIC CAPACITY	7.4278E-03
WELL LOSS(Sw)	1.6237E-02	TRANSMISSIVITY	4.6955E-02
s-sw	2.984	HYDRAULIC CONDUCT.	2.0415E-04
G(L/B)	2.1521E+00		
Sp	2.9993E+01		
Radius	0.25		
W. LOSS COEFF	32.70		

TRANSMISSIVITY	
INITIAL T VALUE:	
ITERATED T VALUES	
4.3299E-02	1
4.6907E-02	2
4.6954E-02	3
4.6955E-02	4
4.6955E-02	5
4.6955E-02	6
4.6955E-02	7
4.6955E-02	8
4.6955E-02	9
4.6955E-02	10

EQUATION:

$T = [Q/4\pi(s-sw)] * \ln(2.25Tt/r^2S + 2sp)$

$sp = [(1- L/b)/(L/b)] * [\ln(b/r) - G(L/b)]$

$G(L/b) = 2.948 - [(7.363 * (L/b)) + (11.447 * (L/b)^2) - (4.675 * (L/b)^3)]$

$sw = C * Q^2$

Terms:

T = Transmissivity (square feet per second)
Q = Pumping rate (cubic feet per second)
s = drawdown (ft)
sw = Well loss (ft)
t = time length of pump test (seconds)
r = inner radius of well
S = Storage coefficient (unitless)
sp = partial penetration factor (unitless)
L = length of well screen (ft)
b = aquifer thickness (ft)
C = well loss coefficient (32.7)

Source: Bradbury and Rothschild, 1985, A computerized technique for estimating the hydraulic conductivity of an aquifer from specific capacity data: Ground Water, V. 23, No. 2, pp. 240 -246

Table II.

CALCULATED HYDRAULIC CONDUCTIVITY FOR 41 WELLS IN STUDY AREA
(Wells with completion tests of 6 or more hours, drawdowns > zero)

WELL ID NUMBER	Total Depth of Well (ft)	Length of Screen (ft)	Static Water Level (ft)	Pumping Water Level (ft)	Pump Test Hours	Pumping Rate GPM	Aquifer Thickness (ft)	Hydraulic Conductivity (ft/day)	Log K (ft/day)
36.16	172	72	37	42	12	10	200	5.62	7.49E-01
36.11	168	96	20	23	6	10	200	7.49	8.75E-01
36.09	160	90	25	35	24	15	200	3.61	5.58E-01
36.03	210	130	45	50	18	12	200	4.42	6.46E-01
36.02	135	63	50	70	20	10	200	4.42	6.46E-01
35.16	175	135	20	30	6	65	230	1.21	8.26E-02
35.15	288	88	75	100	12	22	290	2.00	3.02E-01
35.09	184	83	49	50	9	10	230	26.01	1.42E+00
35.07	216	31	38	39	6	10	230	54.26	1.73E+00
35.06	212	108	60	65	6	10	230	3.94	5.95E-01
35.05	223	38	29	33	6	10	230	11.21	1.05E+00
35.04	228	128	35	40	8	12	230	4.21	6.24E-01
35.03	216	31	32	35	6	10	215	17.54	1.24E+00
34.02	271	86	38	40	6	10	263	11.99	1.08E+00
31.101	121	70	62	65	10	10	246	9.91	9.96E-01
31.009	227	144	95	100	6	20	246	6.38	8.05E-01
30.105	102	42	73	75	6	20	246	43.21	1.64E+00
30.103	69	27	15	20	8	17	246	20.17	1.30E+00
30.102	91	48	10	15	12	12	246	8.75	9.42E-01
30.101	83	40	9	15	14	10	246	4.38	6.41E-01
27.103	108	44	28	32	14	10	271	10.04	1.00E+00
27.102	141	71	52	55	14	10	271	9.93	9.97E-01
27.101	309	208	15	78	15	155	271	3.09	4.90E-01
27.03	163	56	19	55	40	12	271	1.16	6.58E-02
27.005	115	67	38	70	6	10	271	0.87	1.00E-02
26.03	147	47	28	34	6	8	271	4.95	6.95E-01
26.002	201	101	41	53	40	12	295	2.09	3.20E-01
26.001	192	90	17	39	48	12	295	1.23	9.08E-02
25.12	300	149	40	200	24	200	295	1.98	2.97E-01
25.11	290	140	21	50	24	201	295	15.25	1.18E+00
25.09	131	71	16	50	6	15	295	1.15	5.93E-02
25.08	135	77	12	16	6	12	295	7.64	8.83E-01
19.101	118	55	11	21	9	40	246	13.26	1.12E+00
12.001	240	104	53	55	12	10	246	10.65	1.03E+00
4.003	83	41.5	12	55	10	10	246	0.91	-4.01E-02
2.10	112	71	30	35	12	15	210	8.61	9.35E-01
2.06	205	120	20	35	18	20	210	2.52	4.01E-01
1.07	126	10	6	11	14	156	210	40.18	1.60E+00
1.06	142	102	6	16	8	106	174	29.65	1.47E+00
1.05	147	101	12	90	18	14	174	3.65	5.63E-01
1.02	156	96	15	23	8	45	174	13.87	1.14E+00

MEAN LOG K:
0.79
INVERSE:
6.166

Source: Well completion records on file with the Department of Natural Resources