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CUT-AND-COVER TUNNELING TECHNIQUES

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16. Abstract

This study of cut-and-cover tunneling techniques in urban areas considers environmental quality, geotechnical investigation and analysis, ground support, ground water control, permanent structure, restoration, cost considerations and major problems. Both United States and Foreign techniques are reviewed.

This volume consists of summaries of significant articles, summaries of recent noise-control legislation, and the Ontario, Canada, expropriations act.

The other volume of this report is FHWA-RD-73-40, entitled "A Study of the State of the Art".

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PREFACE

The material in this volume is explanatory and supportive material for the state-of-the-art report Cut-and-Cover Tunneling Techniques submitted by Sverdrup & Parcel and Associates, Inc., Engineers-Architects-Planners to the Federal Highway Administration Department of Transportation in full compliance with Contract No. DOT-F-H-11-7803 dated June 30, 1971.

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LITERATURE REVIEW

PREFACE

A literature review was made to obtain a general understanding of the present state-of-the-art in tunnel construction by the cut-and-cover method. The problems of cut-and-cover construction in congested urban areas are shared by other construction activities; for example, the problem of groundsupport is in many respects similar to what is encountered in basement excavations, and the details for slurry construction techniques may be obtained from dam construction. The total scope of the articles covers a much wider area than was of immediate interest for the study.

The review summaries presented in the following section were, therefore, slanted toward the subject matter that is pertinent to the study. The summaries may therefore not be a true precis of the complete article.

Bugge, W. A. and Irvin, L., "Designing the San Francisco Bay Area Rapid Transit System", Civil Engineering, October, 1964, p 58.

This article, written before construction, notes the magnitude of the undertaking and outlines it in two words BIG and NEW. The bigness and new concepts for the 75-mile system are discussed.

Highlights of the Development Program are briefly described under the titles vehicle stability, sound and vibration, transit - vehicle trucks, track support, propulsion equipment and power supply, automatic train control, fare collection, and test track.

The article also gives the background to planning and designing subways, aerial structures, and passenger stations. Other paragraphs contain information on surveying and mapping, soils exploration, scheduling, and cost control.

"Brussels Subway Runs Obstacle Course", Engineering News-Record, August 5, 1971, p 17.

Brussels soils are a mixture of sand and clay with limestone deposits. Much of the two-track tunnel runs through water-laden soils and underground rubble of towns dating from the Middle Ages. Cut-and-cover construction and slurry-trench method were used where water was a problem.

Maintaining traffic at all times in the downtown area where tunnels crossed a maze of sewer lines, utility cables, and pipelines was a principal consideration in selecting the construction method. Solidifying the subgrade by freezing was selected as the most economical method.

Freezing was done by sinking piles on 3-ft centers below the obstacles and circulating a brine solution. The surrounding soil was frozen after about four weeks, using a solution with temperatures as low as -10°F. Once the soil was frozen, excavation was made by hand equipment and front-end loaders.

Areas with fewer utilities and less rubble were shield-driven.

"Deep Excavation and Tunneling in Soft Ground", Proceedings of the Seventh International Conference of Soil Mechanics and Foundation Engineering - Mexico 1969, State-of-the-Art Report by Ralph B. Peck, State-of-the-Art Volume, p 225; Ch. 2, "Deep Excavations", p 259.

Only excavation with vertical sides requiring lateral support are discussed. Base-failure and bottom-heave phenomena are also considered.

The settlement of adjacent ground depends upon soil properties, general procedure of excavation, bracing employed, and also on the workmanship. The ground subsidence around the excavation is caused both by bottom heave (because the overburden pressure is removed) and inward lateral movement of the side walls.

The volume of settlement around the structure is about equal to the volume of lost ground associated with the inward movement of the vertical walls. The latter volume is directly related to the volume of heave of the bottom of the excavation between the limits of the vertical walls. Those volumes may not be equal for soils other than saturated clays.

Settlements can best be minimized by reducing the lateral wall movements. The stiffness of soldier beams and sheet piles, even of heavy section, is usually not enough to reduce the wall movements. Struts with close vertical spacing may give a substantial reduction in movement. Other more-rigid wall-types may require less support, but the benefit of the rigid walls may not always be as great as the designer anticipates. The soil characteristics are more important than the wall stiffness.

SECTION 2.2.2. SUMMARY OF LATERAL MOVEMENTS OF VERTICAL EARTH SUPPORT

Examples:

Cohesionless Sand. Thirty-seven-ft deep excavation, 18-ft loose sand overlying dense sand and gravel. Walers at third points. H-pile tiebacks prestressed to 50 percent of working load give 2 inches of maximum movement. Prestressed to 110 percent of load gave only 0.2-inch movement.

Cohesive Granular Soil. Sixty-ft-deep excavation in clayey sands and very-dense to dense sands. Struts at four elevations. It was evident after excavation was completed that a substantial part of the deformation took place before the depth of excavation had reached that particular level. All struts were prestressed. Maximum movement on the order of .25 inch.

Soft and Medium Clays. Examples from Chicago, Oslo, and Mexico City show that the lateral movements associated with very soft-to-medium plastic clays substantially exceeds those in cohesive granular or cohesionless soils. Large and often excessive movements develop if excavation proceeds too deeply before the upper strut is placed. It appears to be confirmed that the top strut should be installed before the excavation exceeds the depth equal to $\frac{Zsu}{\gamma}$. If the top strut is installed above this level, most of the deformation will occur below the excavation level prevailing at any given time. This will cause loss of ground and settlement in spite of good workmanship.

If berms are used to stabilize the retaining wall, the movement of the wall may be excessive because of deflections of the berm.

Stiff Clays. An example was a 60-ft excavation in clay with undrained shear strength of 3 ksf. The side walls consisted of 3- by 3-ft concrete cylinders 75-ft deep, spaced at $4\frac{1}{2}$-ft centers. Struts were placed at 20- and 50-ft below surface. Three-quarter-inch and $\frac{1}{4}$-inch movements were noted at the top and at mid-height, while the bottom remained fixed.

SECTION 2.2.3. SUMMARY OF SETTLEMENT

Cohesionless Sands. The settlement of loose sand or gravels may be as much as 0.5 percent of the depth of the cut. Large erratic and damaging settlements caused by the flow or migration of sands into the cut are not uncommon where ground-water has not been brought under complete control. The actions of cohesionless sands are somewhat unpredictable and the construction methods must be carefully selected.

Because of the increased possibility of settlement, the upward flow from below the cutoff walls toward the excavation bottom is much more critical than seepage through slots into horizontal sheeting.

Cohesive Granular Soils. Movements in cohesive granular soils are generally small. The cohesion greatly reduces the sensitivity to seepage pressures. Excavation is commonly a straight-forward operation, but lateral support cannot be eliminated because the material often tends to spall.

Saturated Plastic Clays. Settlements within plastic clays are likely to be greater than in most other soil. Consolidation may cause delayed settlement. The magnitude of the settlements and their

distribution as a functional distance from the cut are of practical importance. In soft clays settlement as great as .2 percent of the depth for the cut may be encountered at distances equal to 3 or 4 times the depth of the cut. Peck has based this upon measurements made in Chicago and Oslo. Buildings on piles can also be affected. The tendency of the soil to settle near the cut can develop negative skin-friction-loads on the piles. These loads in turn cause penetration of the piles. It is important to have a tight fit between the lagging and the well-trimmed clay surface.

Stiff Plastic Clay. The rise in the excavation bottom caused by elastic response to the removal of overburden may be a more predominant feature than settlement. Excavation wall-support may also rise.

SECTION 2.2.4. SETTLEMENTS DUE TO REMOVAL OF STRUTS

When excavation has been carried out to-grade, and all struts have been placed, one or more of the intermediate struts can often be removed without causing large enough inward deflection of the sheeting to produce significant settlements.

SECTION 2.3. BASE FAILURE BY HEAVE

2.3.1. Soft Clays. The danger of a bearing-capacity failure of the base arises only when the soil beneath the excavation level behaves essentially as a frictionless material under undrained conditions. The degree of stability may be expressed by the dimensionless number $N_b = \frac{\gamma H}{Sub}$ where S_{ub} is the undrained shear strength

for the soil below the base level. Plastic zones may begin to form at the lower corners of the cut when N_b reaches 3.14. Base failure takes place when N_b equals the critical value 5.14. Upward displacement, when N_b is less than 3.14, will largely be of elastic nature and be relatively small. N_b values as high as 6.5 to 7.5 will be experienced in cuts of infinite length before failure occurs. Accordingly, N_b can be expected to be somewhat greater than 3.14 before the plastic zone begins to form. A theoretical basis is needed to evaluate the influence of the stiffness and the depth of embedment of sheetpiles below the excavation level. The beneficial results of such piles are often over-estimated.

2.3.2. Stiff Clays. Bjerrum (1969) suggested that the rise of the bottom of cuts in stiff clays may be associated with passive failure of the soil beneath the excavated zone produced by large lateral pressures existing in the soil mass before excavation. Such pressures associated with greater-than-unity at-rest earth-pressure values has been well established in many localities.

SECTION 2.4. REDUCTION OF SETTLEMENT

The amount of material excavated may be reduced to the absolute minimum required for installing the walls and bracing. The main mass of the soil is excavated after the bracing system is completed. The change in stress caused by excavation can be reduced by keeping the hole full of water, slurry, or even compressed air. The permanent structure or the temporary bracing system and bottom

slab are completed before either the fluid is pumped out or the air pressure removed.

2.4.1. Trench Method. Braced trenches were excavated to the full depth of the outside walls. The trenches were completely sheeted and reinforcement was then set in the trenches, and concrete placed directly against the sheeting. Cross-lot bracing was constructed in similar trenches. Concrete struts, later forming a part of the lowest basement floor, were cast in the bottom of the trenches.

Excavation to subgrade level can be carried out in small sections at a time, and the floor slab cast in that section and a temporary backfill be replaced until other sections are similarly completed. Thus, the full weight of the overlying soil was not removed until the basement floor was structurally capable of resisting upward loads.

The slurry-trench method is a development from the original trench method.

2.4.2. Cast-in-Place Concrete Walls. Settlement and loss of earth may be experienced behind cast-in-place concrete walls unless lateral support such as struts or tie-backs are placed either before the general excavation is made or as the excavation proceeds. Even the apparently very stiff cast-in-place concrete walls accommodate themselves to the movements of the mass of the soil in which they are enclosed.

The soldier-pile tremie-concrete (SPTC) wall is a cast-in-place wall reinforced vertically with steel soldier-piles spaced at

about twice the thickness of the wall. The soldier-piles are placed in predrilled slurry-filled holes.

One example shows that prestressing the upper rakers reduces the deflection at the top to approximately half.

2.4.3. Cast-in-Place Concrete Walls. The deflections of the walls under a distributed loading depends not only upon the inherent stiffness of the walls, but approximately on the fourth power of the distance between supports.

Cast-in-place concrete walls, with struts or other supports at vertical intervals, permit about twice as deep excavations than can be tolerated with the more flexible sheet-piling. Cast-in-place concrete walls are most properly called semi-rigid.

Walls extending well below the bottom of an open cut will only reduce, but not eliminate, the loss of ground associated with inward movements of the walls as excavation deepens when underlain by a considerable depth of soft material. Nor is the problem of base failure by heave eliminated. Lateral support may be provided by struts or tie-backs installed as the excavation is deepened. The supports must be installed before the material to be excavated is fully removed, if excessive movements are anticipated.

Cross-bracing used as part of the framing for the permanent structure is a very attractive method. The cast-in-place perimeter walls are especially useful in areas where the external water level should not be lowered. They are well adapted to controlling running sands and silts. Ground might be lost, however, either by the

anchor holes caving in or by flow of granular material into the excavation through the anchor openings.

2.4.4. Dredging. This method can be used where earth groundwater lowering is absolutely out of the question as in organic materials. In this technique, the hydrostatic head inside the enclosure is kept equal to or greater than the external water level. The method was used in both Rotterdam and Oslo. The excavation in Oslo was made without struts in the lower half of the cut, and without excessive earth movements.

2.4.5. Air Pressure. This so-called upside-down construction method has been used in Scandinavian and other countries. Sheetpiles are first driven along the boundaries of the excavation, after which the soil between the sheetpiles is excavated to the level of the roof slab. Struts are inserted between the sheetpiles, if necessary. The roof slab is then built and supported on the sheetpiles, after which the excavation proceeds by tunneling methods beneath the concrete roof slab with the help of compressed air. The air pressure reduces the inward movement of the sheetpiles and also the tendency of the base to heave.

2.4.6. Caissons. An attempt to use caissons in Mexico City led to disruption of the surrounding ground and to excessive settlements because of the drag-down forces exerted by the descending caisson on the surrounding soil. More recently, successful procedures have involved injecting bentonite and lubricants around the

periphery of the caisson, and controls to detect deviations from verticality. Air pressures have been used in the working chamber of the bottom of the caisson for final cleanup.

2.4.7. Other Procedures. Other procedures, like freezing, grouting, and electro-osmosis have been primarily used as construction expedients.

SECTION 2.5. EARTH PRESSURE

2.5.1. Introduction. The behavior of a cut is not only dependent upon the softness or stiffness of the clay, but also upon the stability Number "N" which is dependent upon the depth of excavation.

2.5.2. Cuts in Clay, $N > 5$ or 6. Reference is made to Terzaghi and Peck, 1967, for an estimate of the apparent pressure diagrams to compute strut loads in braced cuts.

An "m" value of 1.0 should be used except where "N" is between 6 and 8 or if there is a great depth of soft material beneath the cut. The theory should in this case take into account the greatly increased depth of the plastic zones. An "m" value of 0.4 appears to be in agreement with observations. The earth pressure may be much larger and very large settlements can also be expected.

2.5.3. Cuts in Clay, $N < 4$. The classical earth-pressure theory suggests that the earth pressure against bracing should be zero in the case when N is less than 4. This is of course wrong,

the pressure must have a positive value and the earth-pressure theory should not be used for "N" less than about 3 or 4 whether the cut is a shallow one in soft clay or deeper one in stiff clay. The shape of an apparent pressure diagram serving as the envelope of the measured strut loads at any stage can be represented by a trapezoid. The width of the trapezoid should be in the range of 0.2 H to 0.4 H.

2.5.4. Cuts in Clay, N=4 to 6. It is suggested that the earth-pressure coefficients $0.2\gamma H$ to $0.4\gamma H$ should be considered as the lower limit.

2.5.5. Clays and Sandy Clays. Measurement of one cut in clays, sands, and stiff sandy-clays suggests an arched distribution of earth pressure with the center of pressure near mid-height of the cut. Drained parameters gave the best agreement with the observed values.

"Deep Excavation and Tunneling in Soft Ground", Proceedings of the Seventh International Conference on Soils Mechanics and Foundation Engineering, 1969, vol. 3, Session 4, p 312.

PANELIST - T. KUESEL

Mr. Kuesel, of the firm of Parsons, Brinkerhoff, Quade & Douglas of New York, presented his experience on constructing 14 miles of soft-ground tunnels and six large subway station excavations for the BART Project in San Francisco.

BART is a 75-mile route which includes 14 miles of cut-and-cover and tunneled subways in San Francisco, Oakland, and Berkeley.

The tunneling methods used in the construction are described.

A. DEEP EXCAVATIONS

The cut-and-cover sections include 18 subway stations, and involve excavations up to 70-ft deep, 60-ft wide, and 800-ft long. Six of the stations are located in three-and-four track sections.

These stations are up to 60 ft below the groundwater table and resist the hydrostatic uplift pressure. The walls and slabs are made of 3- to 7-ft-thick concrete. An internal structural steel frame braces the exterior concrete shell. The concrete interior floor and slabs complete the system.

The permanent structural-steel frame is designed to be used during construction to support the excavation. In addition, temporary struts are required to limit the depths of unbraced excavation to 15 ft below the deepest installed bracing level. The temporary struts may be removed after the concrete and invert slabs are installed. This

combination of requirements provides maximum support of the bulkhead walls during construction, involves minimum quantities of temporary materials, and requires only reasonable construction working space.

B. TYPES OF EXCAVATION SUPPORT

Temporary walls which are eventually removed and permanent walls which become an integral part of the completed structure were the two basic types of bulkhead wall construction used.

The temporary structures were designed by the contractor and generally constructed of steel soldier-piles spaced at 6-ft centers and spanned with wood lagging, with dewatering systems consisting of eductors or deep-well pumps.

The permanent walls, designed by the engineers, consisted of steel soldier-piles spanned with tremie concrete, which were designated "SPTC walls".

The piles were installed in undersized, slurry-filled augered holes so the flanges of the piles are in direct contact with undisturbed soil. This use of steel piles in the concrete wall aides control of vertical plumbness, facilitated connection of the permanent interior structural framework, provided improved security of the slurry-filled trenches against seismic shocks, and eliminated all reinforcing steel. The concrete bulkhead wall provides an impermeable cofferdam which allowed excavation and construction within without lowering the groundwater table. However, the differential head between the water level inside and outside required special provisions to control the seepage beneath and wall and hydrostatic uplift pressures on the base.

The soldier pile and tremie concrete wall was specified for two of the deep stations where the presence of highly-compressible soils precluded external dewatering, and was an option for the other four stations. The contractor opted for only one additional station where the bulkhead walls had to be installed with less than 4-ft clearance from the basement walls of two stores.

The depth of fill and soft bay-clay at one end of the Embarcadero Station approached 90 ft while the depth of excavation was 65 ft. The piles and tremie-concrete walls are anchored in firm sand and dense-clay layers beneath the soft clay to obtain lateral support. The most critical stage of the work occurred at an early stage of excavation when only the upper levels of internal bracing were installed and the unexcavated soft clay supplied negligible lateral support because of the small modulus of deformation.

Consideration was given to underwater excavation methods and installing cross-lot diaphragms in advance of general excavations. These methods would add to the cost, and the selected method was satisfactory as long as adequate lateral support of the toe was developed.

Vertical settlements were monitored by surveys of marks painted on existing buildings, sidewalks, and pavements. Some points were installed via pipes driven through the pavement into the underlying soil to eliminate bridging effect.

Horizontal wall movements were generally measured by inclinometers in vertical casings installed immediately outside the soldier piles.

C. PRELOADING

At the time of installation, all struts were generally required to be preloaded to about 25% of the design earth-pressure load. The struts were required to be shielded from direct sunlight to reduce the temperature-change effects.

D. WALL MOVEMENTS

Wall movements were erratic but were generally kept within one inch without difficulty, with no significant surface settlements.

E. STRUT LOADS AND EARTH PRESSURES

The design criteria for free-draining soldier-pile walls specified a total earth pressure as K_oH, with K_o taken as 0.4 to 0.5, and redistribution of this total pressure in the trapezoid shape. An allowance for hydrostatic pressure was added for impervious walls.

Generally, the strut loads were found to be lower than the design loads, but they frequently approached the design loads.

The load on the permanent struts showed considerable variation. The load increased from the preload value as the excavation deepened. Temperature variations caused the strut to swell and shrink, changing its load. When the concrete slab was poured, the heat of hydration swelled the steel strut. This swelling dissipated, but was replaced by concrete shrinkage. Final-stage concrete-creep produced a gradual relaxation of stress in the beam as shrinkage strains were relieved. These effects were considerably more pronounced than any variation in earth pressures.

F. EFFECTS ON ADJACENT STRUCTURES

Most of the subway station entrances are located in the sidewalks.

Where entrances required construction below the existing building footings, the footings were generally extended to the required depth by underpinning, with the piers constructed by sections in hand-excavated pits.

Where soldier-pile-and-lagging construction was used for the deep station-excavations, limited precautionary underpinning was generally undertaken. For large, heavy buildings, pretest pipe-piles were used. "Underpinning control-piers" were installed in shallow pits under the front column-footings for lighter buildings, with hollow spaces provided to receive jacks to adjust the footing depth if necessary.

"Deep Excavation and Tunneling in Soft Ground", Proceedings of the Seventh International Conferences on Soils Mechanics and Foundation Engineering, 1969, vol. 3, Session 4, p 335.

PANELIST - M. ENDO, JAPAN

A. INTRODUCTION

Japan is a generally mountainous area so that most low-lands are situated on deltas covered by alluvial strata. Japan's major cities are located on alluvial strata near the seashore. The profile of soft alluvial strata consists of sand or silty-sand overlying very soft or soft silty-clay.

B. EXCAVATION METHODS FOR BASEMENTS IN THICK ALLUVIAL CLAY

The article describes three methods of installing basements: an open-casing method, a trench method, and a floating-island method. The main problem in Japan is failure by heave.

The Japanese are trying to improve the vertical alignment of units by using the ICOS method, the Soletanche method, the Else method, and the CCCF method from Europe, as well as several original methods in an effort to cut the costs of constructing basements. Even after construction has been started, the method is altered when distress is observed in the base of the excavation.

C. MEASUREMENT OF BOTTOM HEAVE CAUSED BY EXCAVATION

Ground stress-changes influenced by removal of load in the excavation or addition of load due to buildings, may be reflected

as bottom heave, lateral movement, and surface settlement. These movements must be a design consideration. The floating-island method is described as applied to actual building construction. An equation is presented to approximate the period of bottom heave and settlement.

D. EFFECTS OF EXCAVATION ON BUILDINGS IN SURROUNDING AREA

A discussion is made on the study and monitoring of a pile-supported building beside excavation on two sides. Generally, there were no adverse effects on the structure. Total settlement was large while the angular distortion was 1/1000. A conclusion is drawn that there is a fear of adverse effects of excavation caused by changes in pore-water pressure; however, workmanship has a great effect on settlement.

Golder, H. Q. and Seychak, J. L., "Soil Problems in Subway Construction", Third Pan-Am Conference on Soils Mechanics and Foundation Engineering, Vol. II, 1967, p 203.

The authors have divided the soil problems into three classes: open-cut excavations; ground-water control; and underpinning and foundations.

OPEN-CUT EXCAVATIONS

The problems which arise are:

a. The magnitude and distribution of earth pressures on the temporary supports.

b. The magnitude and distribution of earth pressures on permanent structures.

c. The type of temporary supporting structure and:

   1. the horizontal force on it;

   2. the horizontal resistance required at the toe; and

   3. the vertical loads.

The authors state the responsibility of a soils engineer is to supply strictly the end-result to the designers, preferably as a diagram of lateral earth-pressures. The authors present the classical method of calculating the earth pressures.

Earth Pressure on Permanent Structures

It is not always realized that the earth pressure on a permanent structure buried in the ground can be greater than that on a temporary structure used in its construction. The difference is due

to strain in the soil and the deformation of the structure, whereas for the temporary work there is nearly always sufficient deformation of the supporting structure to reduce the lateral earth-pressure to the active value. This is not so with the rigid box-type structure.

Types of Temporary Supporting Structures

The vertical face can be supported in many different ways, including the following:

a. Soldier-piles penetrating to below the base of the excavation, either driven into the ground or placed in drilled holes, with horizontal timbers wedged into the soldier piles as excavation proceeds.

b. Vertical timber-sheeting, driven down as excavation proceeds and supported by horizontal walers at intervals.

c. Steel sheet-piling driven to, or below, the level of the bottom of the excavation before excavation starts and supported by walers at one or more levels.

d. Vertical reinforced-concrete walls formed in the ground before excavation, either in panels by the slurry-trench method or as a continuous row of bored piles.

e. In granular soils, solidification of the material by injection and support of skeleton timbering.

Of these methods, the first is usually the cheapest and is used where soil and other conditions permit.

Horizontal Forces on the Structure

The design of the supporting structure itself presents no problem. The strut arrangement is usually dependent on the layout of the finished structure.

Passive Resistance at the Toe

Passive resistance can be calculated using the classical formula. Where the supporting structure is a continuous wall, the classical formula for two-dimensional analysis applies. Where soldier-piles are used, the width of the pile is multiplied by an empirical factor to allow for a three-dimensional effect.

Vertical Loads from Supporting Structure

There is always some vertical load on the supporting structure from the downward drag of the soil on the adjacent buildings or, in some cases, from the pull of inclined anchors.

Stability of the Base of Excavation

The first approach is to calculate the critical depth of excavation using the formula $H = \frac{4.C}{8.F}$. Where:

H = critical height;

C = shear strengths of soil,

γ = weight of soil per unit-volume; and

F = factor of safety.

If the required depths exceed the value of H for a reasonable factor of safety, then an unsupported excavation cannot be made.

Sloping Ground

The problem of supporting the lateral earth pressure is generally not normally serious, but the problem becomes more difficult if the ground surface slopes downward away from the subway on one side. The passive resistance on the downhill side can become less than the active pressure from the uphill side.

GROUND-WATER PROBLEMS

It is not always possible to visually observe the water level in clay soils, and the hydrostatic conditions must be determined by piezometers. The piezometric level may be appreciably above the bottom of the excavation and a dangerous upheaval pressure may exist; therefore, the first essential is a careful determination of the hydrostatic conditions, whatever the soil may be.

If the free ground-water level is above the bottom excavation, then some form of water lowering will be necessary.

The ground-water level may be lowered by the construction work since the excavation itself may act as a large well. The permeability of clay is low, and the water flow may be so small the free water either evaporates or is removed with the excavated material.

Silts are in many respects the most difficult to deal with. Gravity flow of water is either slow or nonexistent, and vacuum systems or electro-osmosis must be used. Injection processes are of little use, but an alternative is to excavate using compressed air.

The geotechnical investigation should establish the ground-water level along the route both by piezometer measurements and by

inspection. Ground-water levels vary during the year and the observations must therefore be made over a sufficient period of time.

The most important soil property in ground-water studies is the permeability. The coefficient of permeability can be estimated from a particle-size distribution-curve by using Hazen's approach, where K (centimeters per second) = D_{10}^2mm. Actual pumping tests are otherwise the best method to obtain the coefficient of permeability.

DESIGN OF WATER-LOWERING SYSTEM

When water-lowering is necessary, a system should be planned, installed, and operated before the excavation reaches the water level.

Two general types of system are available: the suction or shallow system, and the pressure or deep system. The shallow system includes well-points and suction wells; the deep system uses submersible pumps or eductors.

Well-points are usually effective only to depths of 12 to 15 ft. With careful installation of the system, dewatering to depths of 18 ft can sometimes be achieved.

Suction wells can lower water 18 to 20 ft. This is because of the greater diameter of the valve, say 20 inches.

Pumps are installed at the bottom of the well and pump against pressure in the deep-well system. There is no limit to the lowering which can be achieved with this system. Eductors can be used as an alternative.

The first step in designing a system to lower the water table is to make an estimate of the total quantity of water which will have to be pumped to achieve the required lowering. A check is made immediately after the first well is in operation to see if the design is correct. The wells should always be bored deeper than seems necessary in a deep-well system. The added costs during the construction of the well are small, but a well that is not deep enough is practically useless and it is impossible to deepen it after the filter sands have been placed and the boring tube withdrawn.

UNDERPINNING AND FOUNDATION PROBLEMS

It is always important to realize that small settlements of a building which will cause minor cracking involve no risks to structural damage, and can sometimes be allowed when the cost of repairing the cracks is much less than the cost of preventing them.

Examples

The authors present 15 examples in their paper illustrating types of problems. Some of these examples affect the design and construction of cut-and-cover tunnels.

Knight, G. B., "Subway Tunnel Construction in New York City", American Society Civil Engineers Journal of Construction Division, September, 1964, p 15.

The applicable parts of this paper concern the underpinning of the Hudson and Manhattan RR Station at 30th Street and Avenue of the Americas.

The tunnel was advanced by a pilot-tunnel-slabbing procedure parallel to the strike of the almost vertically-dipping Manhattan Schist. Generally, pressure-relief holes (two 8-inch diameter burn-out holes) were only used in the pilot-tunnel drive, but relief holes were also made under the station for blasting control of the slabshots.

The original design of the floor included structural members spanning the tunnel and bearing 3 ft on the rock on both sides of the excavation.

Temporary columns were placed to limit the floor member spans to 12 ft during construction.

The load was transferred to permanent steel columns with steel wedges (up to 26 by 26 by 2 inches in size). Finally, the steel connections were welded and encased in concrete.

Mayo, R. S., Tunneling - The State-of-the-Art, Study prepared for HUD, 1968, p 179.

Cut-and-Cover Projects:

A. RECENT PROJECTS COMPLETED

1. Montreal Metro: 30-percent cut-and-cover method. Stations built close to surface by cut-and-cover methods.
2. Toronto Subway: mainly cut-and-cover method. Had several test sections.

B. EXISTING

1. New York
2. Boston
3. Philadelphia

Chapter 8 - Alternatives to Tunneling

This chapter refers to cut-and-cover tunnels in general only, but gives good references.

Meister, Kurt, "Probleme des U-Bahn-Baus", Bauplan-Bautechnik, June, 1970, p 278.

1. FUNDAMENTALS

Improvements to traffic at several levels at high traffic-flow centers include increased traffic capacity, higher travel speeds, increased traffic safety, fewer accidents, and increased traffic economy.

2. TECHNICAL AND ECONOMIC VIEWPOINTS OF SELECTION OF CONSTRUCTION METHOD

Underground construction is extremely expensive. Extensive research and study, and knowledge of construction methods and the problems associated with them, plus an awareness of developments and new procedures are necessary for selecting an optimum system. The construction engineer should solve these problems in close cooperation with the designer.

Limitations of Open and Closed Construction Methods

The choice of construction methods depends mainly upon: routes for relocating traffic and utilities and allowable traffic interruptions, geology, hydrology, and type of urbanization.

Particular Aspects of the Open Construction Method

Open construction methods are economical to about 20-meter depths.

Advantages: Open construction is the most technologically developed and can be used any place where the local conditions, especially urbanization, permit.

Disadvantages: Existing structures, tracks, utilities, and waterways which must be underpassed or relocated, traffic interruptions, disturbance to the residents from noise.

The following methods have been shown to be economical if selected considering the above-mentioned factors: construction with sloping excavation sites; construction with partly-sloped excavation walls; construction with retrievable earth-support; driven soldier-pile wall; drilled-in soldier-pile wall; steel sheet-pile wall; and construction with ground support left in place, especially drilled-pile walls in connection with trench construction.

Economic Aspects of the Closed Construction Method

The costs are 1.5 to 2.5 times higher than for open construction.

3. CONSTRUCTION WITH SOLDIER-PILE WALL

The Berliner Bauweise (Berliner Construction Method) consists basically of I-beams placed at 1.5 to 2.5 meters spacing and driven 2 to 3 meters below the excavation bottom. Timber lagging is placed as excavation proceeds, and cavities are carefully filled with sand. Struts are placed between the soldier-piles as excavation proceeds. The vertical walls of the final structure were built directly against the timber lagging between years 1900 and 1940.

A plastic layer was placed on the timber lagging after the base concrete was placed. Waterproofing was placed on the base concrete and the plaster. The disadvantage was the ground support could

not be retrieved. A development was to create an 80-cm-wide space between the ground support and the structure. The bulkhead could then be retrieved without damaging the waterproofing, and larger-sized form-elements could be used. Further developments involved drilling in the soldier-piles which reduced vibrations and the soldier-piles could be placed with greater accuracy.

4. MONOLITHIC CONSTRUCTION WITH BITUMINOUS WATERPROOFING

The construction method is dependent upon the design. The predominant method is to use cast-in-place concrete. The use of large form-elements and movable inner forms were rationalized. Closed box-sections of square or rectangular shape have proven to be feasible. Center supports have been used in some places, for example, Hamburg, Tokyo, and Berlin, while designs without center support have been used in Cologne, Moscow, and Mexico City. Typical cross-section dimensions are given in the article. The factor of safety of 1.1 is desirable against hydrostatic uplift. Anchors have been tried to resist uplift.

5. TUNNEL CONSTRUCTION WITH PREFABRICATED ELEMENTS

The advantages of prefabricated elements are shorter construction time, shorter time for traffic disturbance and rerouting, shorter time for groundwater lowering, fewer problems for residents, and less equipment at the site. The Moscow Metro was the first subway constructed with prefabricated elements. The design was such that the same type of elements could be used both for one-and-two-track sections as well as for the stations. Elements for the

two-track tunnels were the base slab, sidewalk panels, footings for the center wall, the center-wall panels, and deck elements.

6. CONSTRUCTION PHASES

A high ground-water table may add additional items.

a. Preparation Work

Survey
Rerouting traffic
Inspection of obstacles in alignment
Relocation of utilities
Fences

b. Construction Phase 1

Construct guide-trench
Drive piles

c. Construction Phase 2

Break-up street
Install dewatering system
Excavate
Place lagging between soldier-piles
Place first bracing

d. Construction Phase 3

Excavate
Place lagging between soldier-piles
Place second and third bracing
Build in waler in excavation bottom at toe of wall

e. Construction Phase 4

Leveling course (mud seal)
Underconcrete (base course)
Place slab insulation
Pour protection-concrete
Pour slab-concrete

f. Construction Phase 5

Rearrange bracing
Place concrete forms
Place reinforcement
Pour the structure concrete

g. Construction Phase 6

Remove forms
Place wall and deck insulation
Build brick walls outside waterproofing
Backfill the working space on the sides of the structure
Remove lagging

h. Construction Phase 7

Place protection-concrete on roof
Backfill excavation
Remove lagging and struts

i. Construction Phase 8

Extract soldier-piles
Restore street pavement

j. Final Work

Remove dewatering system
Clean up construction site
Remove traffic blocks

The work can be divided into four main phases:

1. Installation of ground support
2. Excavation and backfilling
3. Concrete and steel work
4. Waterproofing

It is not possible to exactly separate the four construction phases; for example, placement of lagging and struts must be done in close relationship with the excavation. The concrete work is closely related to the waterproofing.

7. CONSTRUCTION WITH WATERTIGHT CONCRETE

Watertight concrete has been used frequently during the last ten years. Tunnel sections have been built with watertight concrete

in Brussels, Cologne, Hamburg, Munich, Stockholm, and Toronto. Toronto now exclusively uses watertight concrete after successful experiments.

Construction time is saved due to less earth work, elimination of separate waterproofing, elimination of protection concrete and masonry protection, walls, reduced construction time, and lower costs.

The entire cross section was poured at the same time without horizontal construction joints.

8. ECONOMIC COMPARISON OF DIFFERENT CONSTRUCTION METHODS WITH RETRIEVABLE GROUND-SUPPORT SYSTEMS

Four different methods are compared. The first method has struts while the other three have tiebacks. The second method is the same as the first except for the tiebacks. The third method has watertight concrete and the fourth method has prefabricated elements. The working time breaks down as follows:

Method	Ground Support System	Earth Work	Concrete	Waterproofing
1	26%	30%	28%	16%
2	32%	28%	26%	15%
3	39%	28%	33%	
4	33%	31%	21%	16%

The total construction time for the different method of construction was in percent of the total construction time for Method 2: 94% for Method 1: 78.5% for Method 3: and 93% for Method

4. In other words, a savings of about 21.5% was possible by using the watertight concrete. The savings on the construction site was 7% using prefabricated elements.

9. SUMMARY

The soldier-pile walls have shown themselves to be the most economical method. Geologic or hydrologic conditions may show that large-diameter drilled piles or slurry-trench walls are economical in certain places. The further development of the tunnel structure should be based upon the economy of using watertight concrete. The problem of electrical insulation of the tunnels should be solved in cooperation between construction and electrical engineers.

"Novel Methods Expedite London Underpass Scheme", World Construction, July, 1961, p 18.

The construction site was located in the heart of London at Hyde Park corner and Marble Arch. The heavy traffic (120,000 vehicles per 12-hour period at Hyde Park) had to be kept flowing at all times.

A central concrete plant and steel yard was set up in Hyde Park. The concrete plant was semi-automatic with a 60-cu-yd/hr mixer. Aggregate was loaded by hydraulic shovels. Distribution was made by 4-cu-yd truck-mixers, the standard tipping trucks, and skip dumpers. The steel was cut and bent, and the cages were prefabricated in the steel yard. To save double-handling, much steel was transported by trailer directly from the bending tables.

The maximum advantage was taken of the dual purpose of the plant, for example: excavators were used as cranes.

The Milan Method was used past a hospital to avoid the noise from pile driving. The guide walls were 3-1/2 to 4-ft wide. Trenches were 20 inches wide and 40 ft deep. The concrete was placed in 16-ft bays.

The diaphragms were supported by steel walings and struts in standard units of two struts to a 30-ft length of waling. All struts were preloaded by hydraulic jacks. The excavation was carried out in steps, according to the position of the bracing. One-and-a-half cu yd drag lines were used for the top section. Narrow heavy-weight grabs were used between the bracing. Tractor shovels assisted in grabs.

Dense concrete was used in the box structure, which made asphalt waterproofing unnecessary. This reduced the number of operations and speeded up the work.

Pedestrian subways were built by precast segments. The site operation time for the precast subways was a third to a quarter of the time for regular in-situ construction. Fifty linear feet of precast segments were built per week. Some underpasses were built by U-shaped units forming floor and walls.

"Rail Tunnel Underpasses a Runway in Holland", Engineering News-Record, April 20, 1967, p 42.

An excellent article on general procedures.

Two methods of construction were used: a) slurry walls, and tension piles to hold the tunnel down, and b) chemical stabilization of soil excavation in the dry.

The high water-table made conventional site drainage impractical. Thirty-eight-ft-deep walls were built by the slurry-trench method. Three-ft-deep guide-beams were cast on each side of the 28-inch-wide wall. Walls were cast in 12-1/2-ft-long panels, which were completed in a nine-hour workday. The tunnel was divided in sections by transverse steel sheetpiles.

Shores were placed between the deep walls and could be adjusted with jacks to compensate for changes in temperature and water level. Excavation below water was made first with hydraulic grabs and buckets, followed by waterjets and suction to get a smooth bottom.

Uplift was resisted by tension piles beneath the floor. The head, shaft, and toe of piles were cast separately, then joined by gluing and prestressing with a single bar. The piles were vibrated into place which caused subsidence around each pile and settlement of the tunnel walls. The joints accommodated the wall movements.

A 3-1/2-ft-thick floor was cast under water and, after dewatering, a 9-inch-thick reinforced concrete floor was cast on top thereof.

Chemical stabilization eliminated the need for tension piles in the other section.

A sealed layer was created beneath the excavation by injecting chemical grout into the soil 52 ft below the surface. At that depth, the weight of the overlying soil was in equilibrium with the water pressure.

The injection points were 30- by 36-inches apart, covering 8 sq ft. Injection tubes were vibrated in place.

The tunnel was divided into 50-ft sections. The water tightness was checked by well-points and piezometers in each section.

The roof was cast in-the-dry directly on the soil, with temporary wood sheetpiling as forms. The excavation was made under the roof, and the final step was to cast the floor.

Skempton, A. W. and MacDonald, D. H., "The Allowable Settlements of Buildings", Institution of Civil Engineers, Part III, Vol. 5, December, 1956, p 727.

The numerous surveys the authors have made show the design loads are generally conservative.

The authors have shown a relationship between angular distortion and maximum settlements, and have recommended safe settlement criteria.

The table below summarizes the type of damage that can be expected, due to angular distortion.

Angular Distortion /L	Damage Criteria
1/150	Considerable cracking in panel walls and brick walls.
	Safe limit for flexible walls, $h/L < \frac{1}{4}$.
	Limit where structural damage of general buildings is to be feared.
	Severe distortion of frame.
1/250	Limit where tilting of high, rigid buildings might become visible.
1/300	Limit where first cracking in panel walls is to be expected.
	Limit where difficulties with overhead cranes are to be expected.
1/500	Safe limit for buildings where cracking is not permissible.
1/600	Diagonals start to buckle.
1/750	Limit where difficulties with machinery sensitive to settlement are to be feared.

Note: The above limits are strictly under the buildings over dead weight.

In the discussions, Terzaghi mentions he hopes the above criteria will not be included in text books because of the shortcomings. Terzaghi stated that the ratio between angular distortion and maximum settlement were too sweeping to be accepted in their present form.

Thon, J. G. and Amos, M. J., "Soft-Ground Tunnels for BART", Civil Engineering - American Society Civil Engineers, June, 1968, p 52.

Two support systems - underpinning and column pickup - are specified for buildings which, because of age or construction, may be damaged by settlements.

Underpinning is used to support existing footings located within the zone of ground movement caused by tunneling. The underpinning is made by piers on piles seated below the zone of potential ground movement. However, a column pickup system is preferred where it appears that underpinning may make a building vulnerable to damage by future ground movement. With the column pickup method, a building is maintained in its original position by separating its columns and walls from the existing footings. The superstructure is maintained in place by jacking the columns and walls away from the sinking footing. When the tunnels are past, the superstructure is permanently reconnected to the footings.

Slurry-wall construction techniques were used for building a 60-ft vent shaft (16th Street and Civic Center Station) in San Francisco. It was anticipated that lowering the watertable in the sand strata might cause loss of ground beneath adjacent buildings.

The walls of the 60-ft by 20-ft shaft were designed as eight concrete panels spanning between vertical steel-joint members and totaling 93-ft in depth. These members were placed in slurry-filled holes which were then filled with a weak sand-cement grout. The trenches between the joint members were excavated next and simultaneously filled with slurry.

The slurry acted as a water barrier and ground support, preventing movement under the adjacent buildings. It contained a minimum of 0.6-lb of bentonite per gallon of water; it had a density of 60 to 85 pcf, a minimum viscosity of 15 centipoises at 20 deg C, and a minimum water filtration loss of 20 cc in 30 minutes. In the final stage of the process, concrete was tremied through the slurry, displacing it to form the wall.

"Two Canadian Cities go Separate Ways in Building Their Subways", Engineering News-Record, August 6, 1964, p 86.

Toronto is building for steel-wheeled trains in shallow cut-and-cover trenches on off-street rights-of-way. Montreal is drilling through rock beneath city streets to build tunnels for rubber-tired trains. Both to be completed in 1967.

Advantage for Toronto: Did not lose any major artery during the years of construction; streetcar route (on Bloor Street) could be kept running until the subway replaced it, working relatively unimpeded on private right-of-way; having to maintain traffic only on cross streets; avoiding the utility pipes and cable under the main streets; and increased value of the right-of-way property itself once the subway runs under it. Almost the full cost of the right-of-way is expected to be recovered from the sale of air-rights. Part of the subway is built to carry buildings up to 20 stories.

The tunnel runs generally about 25 ft underground with 8-ft cover in sand and clay, sometimes below groundwater. The Milan Method was used in one short section because of problems with adjacent buildings and groundwater, not because it was cheaper.

Regular cut-and-cover tunneling; soldier-piles (12WF40) prebored at 10-ft centers along both sides of the right-of-way, 2-ft outside the width of the subway structure. First lift was excavated with backhoe to expose utility pipes. Struts (24WF100) were placed at ground level and utilities suspended from there. Timber decking (12 by 12 inches) placed on cross streets carried the traffic

temporarily for side roads. The rest of the excavation was taken out with backhoes and loaders in one or two lifts. The bracing was completed with struts just above the subway roof and 9 ft above the invert.

The subway structure is 33-ft 2-inches wide and 15-ft 7-3/8-inches high. Concrete was poured in 50-ft sections. Two-ft-thick invert and benches cast on compacted gravel base. Mobile forms were used for walls and roof. The outside walls are 2-ft thick and the center wall 1-ft 6-inches. The roof is 2-ft thick. The utilities were placed on columns after roof was poured and the trench was backfilled.

Some sections in Montreal were built by the cut-and-cover method, but no details are given in the article.

Montreal's tunnel (single tubes 23-ft 4-inches wide by 16-ft 3-inches high) drilled through good rock will give a much cheaper tunnel than the Toronto cut-and-cover tunnel.

Caspe, M. S., "Surface Settlement Adjacent to Braced Open Cuts", Journal, American Society Civil Engineering, V-92, July, 1966, p. 51.

The procedure is to estimate the maximum probable movement of a bulkhead, compute the settlement curve, and determine whether the structure can sustain the settlement.

The settlement will gradually decrease with increasing distance from the cut. A sharply defined limit for the settlement will occur only if a complete Rankine-type of wedge movement is developed. The maximum tolerable differential settlement between the foundations will be governing, therefore, instead of the absolute movement.

The theory is, in short, that the horizontal displacement of the bulkhead is related to the vertical settlement by Poissons Ratio. These calculations are made for horizontal strips reaching through a zone near the bulkhead which is in plastic equilibrium and through a transitional zone to the undisturbed soil which is in elastic equilibrium. The settlement is summarized vertically over the horizontal strips extending through the observed point.

The weakness of the theory is the normally-vague knowledge about Poisson's Ratio. However, the formula given to calculate the shape of the zones for elastic and plastic equilibrium may give a clue to estimating the area under influence.

D'Appolonia, D. J., "Effects of Foundation Construction on Nearby Structures", 4th Pan American Conference Soil Mechanics and Foundation Engineering, San Juan, Puerto Rico, June, 1971, p. 1.

I. INTRODUCTION

One or more of three principal construction operations is involved in cut-and-cover tunneling: excavation, dewatering, and pile driving. Any one of these may cause important movements of the adjacent ground.

Table 1. Steps in Engineering Construction Operation So As To Prevent Damage to Nearby Structures

Steps	Party Responsible
Survey adjacent structures and utilities and establish allowable movements	Design Engineer
Evaluate soil conditions and probable construction methods Identify key measures of construction performance	Design Engineer
Write construction specifications relating to performance of nearby structures	Design Engineer
Design temporary-support systems, dewatering operations, etc. Establish construction procedures	Contractor
Initiate surveillance program for checking performance and evaluating construction procedures	Design Engineer
Modify construction as necessary	Contractor

II. MOVEMENTS CAUSING DAMAGE TO NEARBY BUILDINGS

Angular distortion (differential settlement between two points divided by the distance between points) is usually used as an index of damage potential. Skempter and MacDonald (1956) and Bjerrum (1963) establish a criteria for different components that may be tolerated.

Table 2. Factors Influencing Tolerable Additional Movement of Existing Buildings

Type of movement
Rate of movement
Magnitude of distribution of movement
Type and construction of building
Age and existing condition of building

Generally, movements caused by nearby construction can be tolerated less than under its own load. Settlements caused by nearby excavation occur suddenly and with greater differential movements.

Economics is involved in determining the amount of movement that a building can take; for example, the cost of repairing cracks versus preventing the cracks.

III. MOVEMENTS CAUSED BY PILE-DRIVING

Adjacent structures may be damaged by pile-driving operations.

In hard ground by transient vibrations -
4 in./sec particle velocity is usually sufficient to crack plaster.

Loose deposits of fine sands and silty sands below water table will densify, causing settlement at distances of 30 to 50 ft.

In soft-to-medium clays, large excess pore-pressures are generated during driving, since the ground is displaced laterally and the surface heaves. Subsequently, the ground settles as the excess pore-pressures dissipate.

Excavation and dewatering tend to decrease the heave and increase the settlement.

Factors having an effect on the induced pore-pressures and movements are:

The spacing of the piles;
The type of piles;
The method of pile installation; and
The sequence of pile driving to minimize movements.
Steel H-piles or prebored holes may be used.

Important movements may be expected at distances up to the thickness of the clay being penetrated.

IV. MOVEMENTS CAUSED BY DEWATERING

The ground-water level must be lowered when excavation is to be made below the water table in-the-dry. Excavation in sandy soils will require some form of pumping, while excavations in clays may not, because of the clay's low permeability. Pore pressures are changed at the boundary of excavation and these changes may cause movements. Movements may also be caused by soil erosion, accompanying uncontrolled seepage, or by soil consolidation. Sands and silts are most susceptible to erosion from seepage. Problems are most often caused by careless pumping from sumps or ditches, or by failure to prevent erosion of soils through leaks in temporary retaining walls. Troublesome settlements during excavation in cohesionless soils are almost invariably caused by failure to adequately control groundwater flow.

Pumping from sand strata may decrease the pore-water pressure at large distances from an excavation. Dewatering will cause settlement if the subsoil contains layers of compressible clay or silt. Large erratic settlements caused by flow or migration of sands into an excavation are not uncommon. Piping can lead to catastrophic failures because movements usually occur rapidly and result in large differential settlement. Piping is usually initiated at a smaller average gradient than the critical gradient predicted by Terzaghi and Peck. They indicate that piping in each instance has two common characteristics: First, the material overlying the pipe always has some degree of cohesion sufficient to form the roof or the erosion channel. Second, subsidence of the roof occurs at considerable distance from the discharge end of the pipe, indicating that the erosive capacity of a spring increases as the length of tunnel increases.

The mechanics of piping failure by heave are discussed. An example in the New York subway is presented, where the excavation was made in fine sand and coarse silt near buildings founded on short piles. The ground water percolated up under the sheet piles which led to boiling at the base of the excavation and caused footings of adjacent buildings to settle about six inches. Driving sheet piles deep may be used to prevent piping by heaves.

Another measure is to use permeable rather than impermeable sheeting and control leakage through the wall to reduce the total head. This method was used successfully in the silty sand in a subway construction in New York.

In granular soils the resulting settlement of adjacent buildings is very insignificant from lowering of water table, except in very loose sand. Lowering the ground-water level may cause large settlements over widespread areas, however, when layers of soft clay, silts, or organic materials are present. Until recently, engineers believed that wellpoint dewatering from the sand at MIT would lower the water table only in the vicinity of the excavation. Measurements made in observation wells have proved this belief to be incorrect. Data presented by D'Appolonia shows that dewatering, even for shallow excavations in sand, can depress the ground-water table at very large distances. Limiting the extent of the drawdown by such methods as grouting, recharging ground water, and the use of steel sheeting can be devised. However, these procedures produce disappointing results at times.

V. MOVEMENTS CAUSED BY EXCAVATION

D'Appolonia describes first the general mechanics of soil movements caused by excavation in different soil types and gives then a more comprehensive description of the behavior of soft to medium-stiff clays.

Excavation removes a mass of soil and water and produces a reduction in total stress along the sides and in the bottom of the excavation. The reduction in total stress during excavation causes the soil to tend to move inward toward the excavation and upward at

the bottom of the cut. The upward movement of the bottom is accompanied by an inward movement of the soil below excavation level. If these movements occur, the soil adjacent to the excavation undergoes lateral displacement and settlement.

The movement depends upon the dimensions and especially the depths of the excavation: the soil conditions, the rigidity, and the method and sequence of installing the support system, the time during which the excavation is left open, and the construction details and workmanship.

During the last decade, numerous field measurements have been made. Almost all of the data was obtained from excavations involving soldier piles and timber-lagging or steel sheeting. Peck in his evaluation of lateral movement and settlement associated with excavation, has classified observational data in accordance with four principal types of subsurface materials: cohesionless sand, cohesive granular soil, stiff clay, and soft-to-medium clay. To this list, David D'Appolonia adds organic silt.

Cohesionless sand and cohesive granular soil - the few available studies suggest that the movements are small if the ground-water level is below the bottom of excavation or otherwise brought under complete control. The evidence is that movements will be small if the braces are adequately prestressed.

Soft and medium clay - the maximum inward movements of the sheeting and maximum surface settlements are commonly on the order of 1% - 2% of the excavation depth. Peck has prepared a diagram for estimating the settlements that might be expected under various conditions which has been included in the article.

Stiff clay - as the stiffness of the clay increases, the movements caused by excavation decrease rapidly. Only a small number of cases have been reported where clay's undrained strength is greater than about 2000 psf. For these clays, maximum movements are only a small fraction of one percent of the excavation depth.

Compressible silt - measurements made in several test sections along a subway excavation in Boston demonstrated that movements associated with excavation of compressible organic silt can be as large as the movements caused by excavation of soft clay.

Excavation in Soft and Medium-Stiff Clays

The relationship between settlement, sheeting movements, and bottom heave is described. The writing is largely based on the comprehensive measurements made at several excavations in Oslo and reference is frequently made to work by Bjerrum. It is shown quite clearly, among other things, that both sheeting deflection and settlement increases as bottom-stability failure is approached.

The following factors controlling lateral wall movements that occur above excavation are listed:

a. Horizontal and vertical braced spacing.
b. Depth of excavation below braced level before brace is installed.
c. Length of excavation parallel to wall at any one level prior to installing braces at that level.
d. Elapsed time between excavation and base installation.
e. Details of prestressing and bridging braces.
f. Details of excavating and placing lagging between soldier beams

A diagram shows how the sheeting deflections occur above and below excavation levels for sheeted excavation in medium clay, during the construction period. A comparison is made between sheet-pile walls and cast-in-place concrete walls. The concrete wall constructed using the slurry-trench method had less movement by a factor of 10 than the sheet-pile wall.

In conclusion, D'Appolonia has made a table summarizing the foundation construction effects on nearby structures under the following headings: Construction Operation and Soil Type; Cause of Movement and Type of Problem: Nature of Movement; and Preventive Measures.

"Three Uses of Chemical Grout Show Versatility", Engineering News-Record, May 31, 1962, p. 68.

This article deals with three different projects in which chemical grouting was used.

Plattsburgh Missile Base

Chemical grouting was used. After that, the contractors first had tried to stop the leakage in joints and bolt holes with welding and sealing compound. AM9 was used and the gel-time was controlled to between three seconds and several hours.

A basic principle of chemical sealing is to prevent water from flowing through the soil to a potential point of leak. The flow of water is stopped by filling the voids in the soil with fluid chemicals which are allowed to solidify in place and create permanent water-impermeable barriers.

Pipe-Jacking for the Almeda, California County Flood Control and Water Conservation District

A pipeline was built through a 65-ft-high levee. Dry sand, gravel, and small boulders were encountered. The contractor decided to inject a mixture of sodium silicate (waterglass) and a chemical reagent into the formation. Any of several reagents can be used to cause it to gel. The setting time was experimented with on the job site. Ten-ft-long 1/2-inch pipes were driven into the formation. The grout was injected under pressure ranging between 100-120 psi. The injection needles were withdrawn 1 ft at a time.

Caissons Founded on Rock in Dallas

A chemical-grout injection system was used to sink shafts for a drainage tunnel under downtown Dallas. The tunnel itself was in rock. The overburden varies, being an average of 25 ft of watery sand with clay about that.

The contractor built a grout-injection system, using 3/4-inch pipe welded to the inside of the caisson wall, about 1 ft up from the cutting edge. Chemical grout was pumped down a vertical riser pipe to the injection and out into the sand around the bottom of the caisson. The chemical grout used was AM9.

The caisson was sunk through the sand and embedded into the limestone. When the risers were in place and boxed-in with wood, the bottom of the caisson was backfilled with about 8 ft of wet sand to equalize the hydrostatic pressure so the chemical grout did not flow back into the caisson. After the AM9 was injected, the sand was removed and the casing was checked for any leakage.

The contractor felt the cost wouldn't be too much more than the cost of renting sheet piling and at the same time they have the caissons. A chemical grout made it easier to retrieve the casings.

The contractor estimated that they could install the caisson with grouting in two days instead of the two weeks needed when sheet piling alone is used.

"Builder Excavates Under Protest", Engineering News-Record, January 18, 1962, p. 22.

The Contractor stopped excavating 10 ft above the required depth claiming the dewatering method he was required to use was unsuitable for excavating below that level.

The contract required excavation to dewater the site with two-stage wellpoint systems. Observations of the effects of pumping led the contractor to be concerned over the probable effectiveness of the lower water-stage wellpoint system. Professors Ireland and Rutledge were engaged, and concluded that the wellpoint system would not work.

The soil was very fine silt, with D_{10} grain-size from 0.001 to 0.002 mm. The coefficient of permeability was on the order of 10-7 cm/sec. The installed piezometer indicated no appreciable lowering of water with continuous pumping operations.

"Dry Foundation Work in 34 Feet of Water", Engineering News-Record, July 20, 1961, p. 41.

Excavation for a Humble Oil & Refining Company Office Building had to go down 54 ft. The groundwater was at 20 ft below street level. The contractor installed a perimeter dewatering system, completely encircling the city block. It was especially designed for Moretrench ejector system with 100 ejector wells spaced on 10-ft centers.

The pumping system was in operation night and day for over a year to control the groundwater and hydrostatic pressure.

The major soil at this site is stiff clay with silty-sand strata.

Conventional dewatering methods would have interfered with construction. The ejector system could lower the groundwater 50 ft or more in a single stage.

Twenty-five ejector wells were installed along each side with two 5-horsepower electric pumps operating each group of 25 wells. The ejector systems operated under pressure of 60 psi. The ejector system consisted of 6-inch rigid steel pipe for both the supply and return headers and the 16-inch sanding or well casings. The casings were jetted and driven to depth of 75- to 80-ft since they had to penetrate 20 ft below subgrade to get proper relief from hydrostatic pressure.

After the casing was in place and cleaned, the free water was removed and a four-inch casing with 3-ft-long screen section on its

lower end was set in a 16-inch casing. Five cubic yards of special filter-sand were then placed around the 4-inch casing, and the 16-inch casing was pulled. The ejectors were installed in the 4-inch casing, using flexible plastic pipe for both the 1-inch supply line and the 1-1/4-inch return line.

"Foundation for Tallest Towers' Water Out, Trains In", Engineering News-Record, October 31, 1968, p. 30.

The slurry-trench cut-off walls supporting the basement and foundation excavation, are virtually impervious; thus, the contractor's water problems were limited pretty much to handling the water trapped within the excavation. Therefore, the dewatering was routine except in the areas of the subway tubes where water level was extremely critical.

PNYA Specifications call for lowering the water table outside an excavation to a depth of 5 to 10 ft. The contractor installed a 4-inch hole in each wall section rather than install wellpoints around the perimeter. Water from the outside ran into the excavation, from which it was pumped to the nearby Hudson River.

Near the two new subway tubes, the contractor had to maintain a delicate balance between water and the earth pressures. To maintain the balance, a three-stage ejector wellpoint system was installed on both sides of the tubes. One stage went to the spring line, one a little below it, and one to the rock.

With the aid of piezometers and some accurate calculations, the contractor was able to maintain a vertical balance of the subway tubes.

To support the subway tubes, the contractor installed 24-inch-diameter caissons 40-50 ft on-center on either side of each tube. The caissons were capped, and the caissons were spanned with 8-ft-deep trusses on either side of the tube.

A 5-ft-wide transverse trench was then cut under the tube and a saddle was slipped through it. The saddle was attached to high-strength rods extending from cross members above. The rods were tensioned to pick up the load of the tube.

Pragh, Byron J., "Tools and Techniques for Dewatering", Transactions American Society Civil Engineers, Vol. 126, Part II, 1961, p 38

The paper describes and compares the use of present-day dewatering tools including conventional wellpoints and high-lift systems with ejectors, submersible- or turbine-pump units, sand drains, and grout curtain-walls. Wellpoint systems and their limitations are briefly described, as is an example of a typical wellpoint system. The author briefly describes the sand drains used to stabilize excavation slopes and to increase the rate of drawdown of the water table. The sand drains, in the described case, were used to drain organic silty-clay down to a very uniform fine sand. Wellpoints were installed in the fine-sand strata.

A grout curtain-wall was installed for constructing a power plant on the Ohio River. Steel sheeting was not readily available on this project. The cost of the grouting, using cement-clay mixture, was considerably less than the single row of steel sheet-piling.

The author stressed that the dewatering system primarily depends on the soil properties at the site, and the physical limitations of the job. Where the total dewatering cost at a particular project is high, such as on very large or deep excavations, extensive advance engineering analysis to determine the most suitable and economic method is warranted.

"Water Removes Water From Deep Cut-and Cover Tunnel", Engineering News-Record, October 1, 1959, p. 34.

The dewatering system described in this article contains high-pressure pumps, double pipe lines, wellpoints, and eductors. Eductors are units in which vacuum is created by high-speed flow of liquid through a jet nozzle.

The eductors were superior to the ordinary wellpoints in the following ways:

1. Each wellpoint must be constantly tuned or regulated so that at no time is any point working in-the-dry or sucking air. The eductor wellpoint requires no tuning. Any air picked up by a dry point is merely pushed through the lines to the reserve tank where it leaves the air flow.
2. Any leaks are immediately visible.

Bledsoe, Dr. John D., "A System Approach to Excavation," Proceedings of the Second Symposium on Rapid Excavation, 1969, p.12-1.

The paper is rather futuristic in several aspects, but it has a number of interesting views which should be viewed in entirety by anyone interested in computerized systems analysis of excavation models.

The ultimate vision is a mathematical model covering the total environment i.e., the technological, the political, the economic and business, and the social environment working either as a deterministic or stochastic model. Eventually it will also include a failure-mode analysis for subsystem components.

Game theory should be applied, especially on geological predictions.

The author works with macro-, meso-, and micro-scale functions, which is good for identifying the subject level. Tying these definitions into the terminology for cut-and-cover systems the macro-functions correspond to the subsystem level, meso-functions to methods within the subsystems, and micro-functions to the details of the method.

A feasibility study should stop on the meso-level because the system designer cannot be familiar with the micro-scale function of all subsystems. The computer capacity will also put limits on the degree of detail to which the systems can be analyzed.

More micro-functions may enter into the structural design for cut-and-cover tunneling than for deep tunneling. This would mean increased difficulties, both technical and organizational, in making an overall failure-mode analysis.

The outlined performance and cost analysis on the meso-level is very comprehensive and includes initial cost, depreciation, overhaul, salvage, fuel and power cost, expendables, and labor cost. The model can, therefore, be used for bid estimates.

"Deep Freeze to Keep Shaft In Dry", Engineering News-Records, September 3, 1959, p. 25.

At New York City, the tunnel contractor froze a solid cylinder of earth about 36 ft in diameter and 123 ft deep to sink a tunnel shaft for a sewer tunnel under the East River. The New York City Public Works Department ruled out pumping for fear of causing settlements under nearby apartment houses. The contractor used two 125-horsepower reciprocating ammonia compressors, and a picket fence of brine pipes circling the full depths of the cylinder being frozen. About 90 days were required to freeze the cylinder and the periphery.

Hartmark, H., "Geotechnical Observations During Construction of a Tunnel Through Soft Clay in Tyhold by Trondheim", Norwegian Geotechnical Institute Publication 11, 1955, p 1.

Shield-driven tunnels may sometimes be considered as an alternate to cut-and-cover tunneling methods. This paper illustrates some problems that could be catastrophic in an urban area.

The paper deals with a shield-driven railway tunnel partly constructed through firm-to-soft quick clay. The quick clay has a shear strength of 2.0 t/m^2 and a sensitivity of more than 100.

The quick clay was constantly flowing into the tunnel so that more soil was removed than corresponding to the theoretical cross section. A corresponding settlement of the ground surface was observed.

A series of failures occurred either as local slides at the face or as total slides where the soil mass moved simultaneously from the tunnel right up to the ground surface. Attempts to use higher air pressure than corresponding to the water pressure, in order to reduce the strutting of the face, led to outblows. Adhesion between the shield and the quick clays caused large disturbances and soil displacements.

Peck, R. B., "The Measurement of Earth Pressures on the Chicago Subway", American Society for Testing Material Bulletin, August 1941, p. 25.

A historical review for backup data to Terzaghi's wedge theory on flexible retaining walls.

Reviews the deflection measurements of Chicago Subway bracings from 1916 to 1941. Explains jacking procedures, and gives the measurements for horizontal deflection of the piles, the settlement of adjacent buildings, and the heave of a tunnel at the bottom of the excavation.

"Amsterdam Subway Built on Surface Then Sunk Into Water-Laden Soil", Engineering News-Record, August 19, 1971, p. 31.

Construction was completed without lowering the water table, which was only 5 ft below grade. All adjacent buildings were on piles.

The cut-and-cover operation used both driven sheet piles and slurry-trench-constructed walls. The roof was cast after excavation to 11-ft depth; backfill was then made and the pavement restored, after which excavation continued under air. The excavated material was mixed with water and pumped out as a slurry.

The pneumatic caissons consisted of 98- to 131-ft-long, 30-ft-wide concrete sections cast in a shallow trench on the ground. The sections had cutting edges along the sides, and openings along the center for air-pressure equipment and men. The sections were sunk by excavation under air below the floor. Once in place the contractor froze the ground around the joints with liquid nitrogen and cast the concrete joints.

"U-Bahn Stuttgart Bau Einer Tunnel-decke in DYWIDAG-Spannbeton-Kontaktbauweise", DYWIDAG, 1971.

The construction method was selected because of the danger of shallow foundations settling within the heavily built-up city and the requirement for as little traffic interruption as possible.

The upper deck was built of prefabricated concrete beams. The beams were between 16.45 and 17.65 m long, 66 cm wide, and 75 cm deep. The beams had a 40-cm-diameter longitudinal void-channel for weight reduction. The beams were cast and longitudinally prestressed in the same position as they would be finally erected to insure perfect contact surfaces. Cross channels were cast for transverse prestressing steel. DYWIDAG steel class ST. 80/105 26-mm diameter was used for prestressing.

The precast beams were placed in sections of 8 to 14 beams which were transversely prestressed together. Spaces were left between the sections to provide working space for the transverse prestressing operation. These spaces were finally used for utilities. The transverse prestressing allowed openings of 5.5 m to be spanned.

The beams were supported on neoprene bearings.

A 50-cm-thick base-course was placed on the beam deck. The allowable traffic load was corresponding to bridge class 60.

Sequence of Construction

A. 1. Piles were installed along the perimeter throughout the tunnel. (The piles were unreinforced, but the article does not explain how they were installed. The piles supported the traffic deck and the middle deck, i.e., the tunnel ceiling. No other lateral earth supports appear to have been installed).

2. Excavation was made to top of piles.

3. The pile caps were poured.

B. 1. Excavation was made to the underside of middle deck.

2. Support for the middle deck was cut into the unreinforced piles.

3. The prefabricated traffic deck segments were placed.

C. 1. The concrete for the middle deck was poured on a concrete leveling-course (mud seal).

2. The prefabricated deck was installed. A protective concrete layer and pavement was placed.

D. 1. The excavation was completed and the drainage was installed.

2 A concrete leveling-course was placed on the excavation bottom. Concrete was placed on walls to obtain a smooth surface and base concrete under slab insulation.

3. Slab insulation was placed on the base concrete and protection concrete.

4. The bottom slab was poured.

E. 1. The wall insulation was constructed.

2. The concrete for the inner walls was placed.

Bruns, T. C., "Z-Pile Cofferdam For New Orleans' Tallest Building", Civil Engineering, May, 1961, p. 68.

The author outlines step-by-step procedures to install the foundations and the basement for the structure.

1. Interlocking z-piles were driven around the entire site, and the area was excavated to 6 ft below the street level.

2. Foundation piles were driven for support of the building.

3. The permanent steel wales were installed.

4. The center of the site was excavated to 18-ft depth below street elevation.

5. Light-weight steel sheeting was driven at the center, and the central footings were concreted.

6. The cylindrical raker struts were installed between the wales and the center footing, core, or abutments.

7. The entire site was excavated to 25 ft below street level, the predriven piles were cut out, and their main footings were concreted. No two footings adjacent to each other were excavated at the same time.

This is an excellent article on the case history of an actual deep excavation; however, no theory is discussed

Dean, W. E., "Prestressed Concrete Sheet Piles for Bulkhead and Retaining Walls", Civil Engineering, April, 1960, p. 68

The author reviews the Florida State Road Department's design of retaining walls. Prestressed concrete sheet piles have replaced regular reinforced concrete in practically all their retaining structures, including splash walls and groins.

At the time of the article, Florida used the concrete sheet-piles for up to 18-ft-high walls, but he mentions that it is not the limit. The sheet piles, used as Florida's standard, have a uniform width of 30 inches and vary in thickness from 6 to 12 inches.

Concrete sheet-piles are placed by a variety of methods, depending on the material through which they are installed. Most piles are simply jetted to-grade in the prevailing granular soils of Florida. Where the foundation material is not easily erodible, steam or gravity hammers are used for driving the sheet piles.

One of the most critical construction requisites is to get a tight face of splash walls that will not leak material near the water line. Even the smallest crack in the zone of the wave action will permit large quantities of fill material to pass through the crack. The use of tongues and grooves will not provide leakproof construction even with the best construction practices. The only satisfactory method devised is continuous grouting between piles.

In conclusion, the author challenges the designer to use prestressed concrete in other structural applications; for example, as part of permanent structures.

Reider, George, "Power Unit Built Within River Edge Cofferdam", Civil Engineering, March, 1962, p. 56.

Cofferdam conventional bracing techniques could not be used because of irregular rock conditions at the river edge.

The solution in this case was to use a temporary tremie seal. The seal acted as a lower brace between the sloping rock and the sheeting after the cofferdam was dewatered. Later it served as a base for an encased lower wall as the tremie concrete was systemically removed and replaced by the permanent concrete foundation.

The author also outlines step-by-step procedures used in constructing foundations for two screen pump-wells at the Astoria Park Plant of Consolidated Edison Company.

Anderson, Colin, "Tunnel Tests Beats Cut-and-Cover", Heavy Construction News, February 25, 1960, p. 12.

The Toronto Transit Commission became interested in the Milan slurry-trench construction method as a result of a tour of European subways. A summary of possible advantages of the Milan method over standard cut-and-cover methods are as follows: cuts time in half, no steel-pile work at ground level, noise abatement, less traffic delay, shoring eliminated, and all-weather operation. The article outlines step-by-step operations of the Milan construction.

Step 1. Excavate a 3- by 5-ft trench whose walls were previously lined with concrete. These walls were used as guides for the clamshell excavator and have no structural purpose.

Step 2. Excavate the subway wall to its full depth. The bentonite solution is placed in the trench as work progresses, the level being maintained near the top of the excavation. A reinforcing steel cage is lowered when the excavation is completed.

Step 3. Concrete is tremied through the slurry. A vibrator attached to reinforcing steel is used to consolidate the mix. The bentonite solution displaced by concrete is drawn off and saved for future use.

Step 4. A space between the completed walls is excavated to the subway roof level and the roof slab is poured.

Step 5. The excavation is backfilled and the street paved.

Step 6. Final excavation of the tunnel can be done while the traffic is free to move on the street.

Two problems became apparent at this section. The excavation of the trenches is a relatively slow job. Too great a speed will hamper the action of the bentonite solution and result in collapsed walls. Too slow a speed will result in an inefficient use of labor and equipment. As in most slurry-trench construction work, the operator must be experienced, one who can go by the feel of the control, which varies with different types of soil. It takes about six months to sufficiently train a new operator. The second problem, which was specific for the equipment used, was that the discharge chute on the derrick was too low to dump the material directly into trucks. This problem could have been easily corrected.

This is an excellent article illustrating the slurry-trench method of construction. Diagrams illustrate step-by-step stages of construction.

"Bentonite Slurry Stabilizes Trench, Keeps Ground Water Out", Engineering News-Record, February 11, 1960, p. 42.

The application of bentonite slurry in construction work and for permanent ground water control is discussed in this article which deals with the Wanapum Dam on the Columbia River. Trenches up to 80-ft-deep were filled with bentonite slurry during excavation, and the excavation could be kept free of groundwater without benefit of sheetpiling, shoring, or other ground support.

The slurry was mixed in three portable plants. The bentonite was injected through a narrow opening in the hopper box and into a high-velocity airflow created by a stream of water under 120 psi pressure. The bentonite was sucked into a mixing chamber where individual particles are bombarded by water from 16 small-diameter jets. The slurry thus formed is in the ratio of 1 part bentonite to about 12 parts water. The slurry weighed about 65 pcf when introduced into the trench. This, however, increased quickly to more than 70 pcf as fines became suspended in the slurry.

In the cofferdam construction, where the specifications did not apply, the density of the slurry frequently exceeded 100 pcf. This seemed to have no effect on drag-line operations or on the backfilling of the trench. The trenches were 7- to 10-ft-wide and could accommodate a drag-line bucket, and large boulders could be removed. The slurry level was kept within 3 ft of the surface.

The following method was used to cut off ground water after the trenches were constructed: a concrete seal at least 3-ft thick was placed on rock at the bottom of the trench to prevent erosion by ground water, which might pass through the rock crevices. The excavated material, saturated with bentonite slurry, was stockpiled near the trench. The backfill material particles became caked by bentonite. A dozer pushed the stockpiled material back into the trench while mixing in the local silt. This established an effective cutoff. The backfill material did not need compaction and the in-place density was about 150 pcf with a dry density of 130 pcf.

Brehm, H R., "A New Method for The Construction of Stable Building Pit Walls in Municipal Work", Baumachine and Bautechnik, December, 1959, p. 439.

This article deals with application of the Milan slurry-trench method in subway construction in Berlin.

The construction followed the method patented by ICOS. Brehm points out in the foreword that pretensioning is difficult to apply successfully to walls cast before excavation since the load and, accordingly, the deformation changes as the excavation proceeds. This is interesting since ICOS now has a prebending method in use.

The bentonite loss was about 50% in the comparatively loose Berlinger sand. Ten percent bentonite was mixed into the slurry.

The wall could be kept within $\pm$ 1.5% of plumb despite the somewhat primitive Italian equipment (e.g. the wire for the clamshell was not torsion-free).

The experience was good; excavation was made without damage in one case, only 10 ft from an old church with gypsum decorations.

The construction cost was considerably higher than for the especially price-worthy "Berliner method" using soldier piles and timber lagging.

"Special Rigs Go Through Rock and Wood to Form Slurry Trench", Construction Methods, July, 1967, p. 72.

The article deals with constructing the cutoff wall around the Port of New York Authority's World Trade Center. The contract sum for this work was 8-1/2 million. The walls are 3,100 ft long, 3 ft wide, and 50 to 70-ft deep. They are keyed from 2 to 7 ft into bedrock (Manhattan Schist). Drilling was done with a churn drill. The main problem was to go through a 10- to 15-ft-thick layer of ballast stones which caused up to 85 percent overbreak, but old wooden piles were no problem. A 10-ft-wide, 10-ft-deep trench was first cut out and filled with one-sack cement concrete forming a seal. The trench was laid out by 1-ft-thick by 2-ft-high concrete guide walls. Overbreaks were corrected by filling the trench with one-sack cement concrete and recutting the trench through the lean mix. The slurry had a specific gravity of 1.05. The mix consisted of 150 lbs of bentonite to 160 gal of water.

The trench was divided into 22-ft sections by pipe bulkheads.

The reinforcement cages were built flat on the ground and lifted into the trench sections. Precast 7-inch-diameter concrete disks served as rollers to keep the cage away from the walls, which were cast in 4,000-psi 8-inch-slump concrete. Displaced slurry was wasted.

Anchors for tiebacks were attached to the cage at eight levels. Blocking out was done with styrofoam plugs.

Spielgelman, J., "Subway Construction in Toronto", Civil Engineering, November, 1962, p. 58.

This article reviews the construction procedures and design considerations used for the Toronto Subway. For the most part, the tunnel was largely built by the conventional cut-and-cover method, but the slurry-trench method was tested in one section.

Conventional Cut-and-Cover Construction

Soldier piles and timber lagging is the conventional method used by the Toronto Transportation Commission for subway construction. Underpinning was done with needle beams or by excavating pits when the walls could support themselves over short spans. The soldier beams supported the timber deck for traffic and lagging, and the utilities were suspended from the deck.

The piles for soldier beams were driven in pre-bored holes to limit the noise. The piles drilled to rock were given a few blows to ensure bearing, while the piles seated in rock were encased by concrete or driven the last few feet. The problem of losing ground around the piles was solved by backfilling with clay; very lean concrete was used in later contracts.

The soldier beams were set back two feet from the neat line of the structure where the excavation was carried into rock, and 2 inches where subgrade was above rock. Concrete was placed directly against the lagging in earth sections.

To provide headroom and reduce horizontal reactions and, hence, the anchorage requirements at the toe of the deck, the girders and soldier piles were designed to act as a rigid frame with steel knee-braces.

The excavation was carried out under the deck. Every fourth bracing was originally left out to provide loading areas for trucks. Side beams were left in place.

The granular backfill under the base slab was compacted to 90-percent density with a vibratory compactor.

Cut-and-Cover Construction by the Milan Method

The excavation was made with clamshell within a 3-ft-wide, 5-ft-deep guide-trench. Reinforcing cages were placed in the slurry. The concrete was tremied from the bottom and the displaced slurry was reclaimed for further use. The walls were concreted to give the final thickness of subway wall.

Excavation was made to the subway ceiling after the walls had been poured. The roof was constructed on the earth and the earth was subsequently tunneled out under the roof slab. The invert concrete was placed when the excavation reached subgrade. The center columns were poured in sleeves cast in the roof. Backfill was then placed on the roof to-grade. Backfill on top of the roof could have been done before excavation if the roof had either been designed to carry the soil weight without midspan support or the center columns had been drilled in and poured together with the roof.

The underground space above the subway at the St. Andrew station was used for a parking garage. Consequently, economies were realized both for the subway and the garage.

"Bulkhead Tied Back to Soft Soil", Construction Methods, October, 1967.

The article deals with the 60-ft-deep foundation for the Bank of America Building in San Francisco.

The tieback bulkhead cost 20 to 30 percent more than the conventional raker system, but the uncluttered working space saved up to 30 percent of the overall foundation cost.

Tiebacks anchored by soil-friction reached in under streets and into a jungle of utilities.

Soldier beams were first drilled on 8-ft centers to 15 ft below the foundation level. The soldier beams consisted of back-to-back channels 13 inches apart placed in predrilled holes, which afterwards were filled with lean concrete. Lagging was connected to the soldier beams with welded studs.

The lagging served as the outside form for the concrete basement walls and was left in place.

The tiebacks consisted of 7/8-to-1-1/4-inch high-strength steel rods reaching beyond the theoretical slip plane, which was assumed to extend on a 60° angle to the horizontal from the bottom of the soldier beam. The average tie-length was 55 ft.

The rods were placed in 12-inch-diameter holes drilled with a continuous-flight auger and sloped 15° from the horizontal. The rods have anchor plates attached to the embedded end. The holes were filled with 3000 psi grout up to the theoretical slip plane. The rods

were greased between the bulkhead and slip plane, and the hole filled with sand to insure that the retaining forces were developed beyond the slip plane.

After seven days the tiebacks were post-tensioned to 150% of design load, which was held for 30 minutes and then reduced to design load. (The pictures show that five rows were installed.)

Vertical rock drains were provided behind the bulkhead to take care of water from a layer near the surface. Some soldier beams were filled with skip-graded concrete to serve as vertical drains.

Comments: The grouted section appears to have been 30-to 35-ft long and the skin friction to have been on the order of 700 psf (design load). The soil type is not given but is most probably a medium-stiff clay.

Bethel, Roger, "Underpinning a Landmark", Civil Engineering, August, 1968, p. 67.

The Monadnock Building in Chicago's loop area was the last masonry skyscraper. The building was constructed on several floating concrete mats, each supporting 1-4 masonry piers. The building settled some 5 inches during construction and continued to settle for several years until a total of 20 inches was recorded.

The bottom of the original footings rested on a stratum of soft silty-clay with an unconfined compression strength as low as 0.4 tons/sq ft. The clay gradually becomes more firm until hardpan is reached at about 75 ft below the surface.

The building was underpinned twice. The first time was in 1940 in advance of subway construction along Dearborn Street. The second time was in 1967 when the new Federal Government Office Building was built on the opposite side of Jackson Boulevard. The different underpinning procedures offer an interesting comparison.

The following method of underpinning was used in 1940. The exterior piers were temporarily shored on a system of needle beams supported on mats. Adjustments were made by screw jacks carrying ten tons each. Caissons were constructed by hand excavation to the hardpan strata about 75 ft below the sidewalk. The loads were then transferred from the needle-beam system to the caissons. Constructing the needle-beam system was very cumbersome, requiring continual adjusting of as many as 90 jacks per column.

The new Federal Government Office required basement excavation to nearly 60 ft below street level. Differential settlement was noted across the street in the Monadnock Building during the excavation.

Although underpinning utilizing heavy shoring and caissons is still being used, it was decided to do the underpinning with pretest piles. The pretest piles were installed under the footing working within small wood-sheeted pits. Short lengths of open-end pipe were forced down by hydraulic jacking using the building load as reaction. These pile sections were joined with special pipe splices. The piles were cleaned out and filled with concrete when the tips reached the hardpan. The column load was transferred directly from the jacks to the pile via steel plates, wedges, and short posts called wedging beams. The piles were tested by jacking to an overload capacity, usually 50-percent over the permanent load. The top of the pile and the rigid beams were later encased in concrete. By carefully planning the location of each pretest pile, the underpinning subcontractor kept the pile groups concentric around the piers.

Experienced underpinning personnel kept the work pits tightly sheeted. At first the piles were jacked down one at a time until sufficient load to insure the stability of the building had been transferred to the new units, after which the piles were worked on simultaneously.

The columns were expected to settle about 1/2-inch but

actual settlements were kept to a maximum of 3/16 inch, which was about the same settlement as experienced in the 1940 underpinning operations. However, the work in 1967 was not started until the building had begun to experience distress and settlement was underway.

Golder, H. Q., Harding, H.J.B., Jenkins, R. A., Sefton, "An Unusual Case of Underpinning and Strutting for a Deep Excavation Adjacent to Existing Buildings", Proceedings of the 5th International Conference of Soil Mechanics and Foundation Engineering Paris, 1961, p. 413.

A new 14-story apartment building was constructed among late 18th-century six-story-high terrace houses in London, England. The new building has an underground garage which necessitated excavating a 30-ft-deep basement beside existing big houses.

The street elevation was about 90 ft and the basement level of the houses was about 80. Down to elevation 76 the soil was fill consisting of rubble, ashes, concrete, and clay. Below this down to level 62 were sands and gravels, with the groundwater level at 69 underlain by London clay.

The conventional methods of underpinning would be to go down in timbered pits to the level of the new foundation at intervals under the walls. These pits would then have to be filled by masonry or concrete. This would have been extremely difficult to do through the gravel below water level without losing material into the excavation.

The proposed alternative was to solidify the sands and gravels by injecting chemical grout. The wall so formed was horizontally supported by vertical steel soldier-piles placed in holes drilled through the gravel and into the clay. The tops of the soldier piles were supported by raking steel struts whose toes bore on edges of

concrete foundation slabs, placed in the center of the excavation. Thus nearly all the excavation could be done by mechanically eliminating the slow hand-underpinning.

Sequence of Operations

1. Erect temporary shoring against the walls of the buildings to a level below the new foundations.

2. Grout the fill below and around the footings of existing buildings using cement grout

3. Inject chemical grout into the sands and gravels to solidify the box below the existing building foundations

4. Drill 17-inch-diameter vertical holes through the sands and gravel and 12 ft into the clay. Insert steel soldier-piles in the holes, setting them in concrete in the clay and backfill above with sand around the soldier-piles as the casing was withdrawn.

5. Excavate the center portion of the site and cast the foundation slab in this area.

6. Excavate a narrow trench opposite each steel soldier-pile and erect a steel raking-strut to the footing bearing on the concrete slab.

7. Continue excavation between the struts.

8. Install second strut when excavation is half-way down.

9. Continue the excavation down to foundation level.

10. Extend the slab to the edges of the site. Construct walls and floors around the steel struts and leave the struts in. Soldier piles are concreted into the walls and concrete is poured directly up against the steel sheeting boards along the building sides.

11. When floors are complete across the site, cut out the steel struts and complete the floors.

This method had the following advantages:

1. No fear of ground loss during the excavation.
2. Excavation at the center could start any time.
3. Practically all excavation could be done by machines.
4. The raft slab gave a clean working area.
5. Grouting around the perimeter of the site reduced the amount of groundwater inflow.

The pressure calculations and theory are presented in this paper. The lateral pressure caused by the soil itself was calculated by conventional methods using $\emptyset = 35^{\circ}$, unit weight=120 pcf for the gravels and sands, and C=1,500 psf, with a unit weight of 120 lbs for the clay. This showed that chemically-treated soil had a minimum unconfined compressive strength of 200 psi with an angle of internal friction of 35°.

The article describes the grouting details that were used and a sketch of the injection-pipe arrangement is also shown. The chemical was TDM solution with a gelling time of one hour which was discharged one-half hour after mixing.

Sloane, Victor C., "Drilled Caissons Cut Underpinning Cost", Engineering News-Record, September 3, 1964, p. 36.

An addition to the Cincinnati General Hospital with a 20-ft-deep basement was built next to the existing structure. The design incorporated drilled caissons, thick grade-beams and sprayed-concrete rock face. The grade beams were supported inside the old building on the shale and limestone just below the floor elevation and outside the building on drilled-in caissons seated 3 ft below the new basement excavation (8 ft below the new basement floor). The rock face and caissons exposed in the excavation face were sprayed with concrete, saving the expense of basement walls.

The contractor claims that the cost was half of regular underpinning. However, no backup was given in the article to substantiate this saving.

"Underpinning Does Triple Job", Engineering News-Record, September 28, 1961, p. 40.

This article deals with constructing a deep basement for a P. Ballantine & Sons brewery. The underpinning had the primary function of shoring the walls of existing buildings during construction and to form gravity-type retaining walls for the new building's deep basement. The underpinning also acts as column pedestals supporting new and existing columns.

The foundation contractor's problem was how to cast 12 by 12-ft monolithic spread-footings under the walls of the existing buildings to carry the new columns. The underpinning sequence was as follows:

The walls between the new column locations were first supported by pit-wall underpinning, beginning with the middle segment. The pit-wall segments extending in over the new spread footings were temporarily supported on steel posts, which were founded on small pads seated below the new foundation elevation. The spread footings were then monolithically cast, encasing the steel supports for the underpinning elements.

The pit-wall underpinning was designed as a gravity wall, having a sloping backface which undercut the existing building. The load was transferred from the existing wall foundations to the pit-wall by drypack concrete. Grout pipes were inserted to permit adjustments if settlement occurred; however, no grouting was needed during the construction work.

APPENDIX B

QUESTIONNAIRE EVALUATION

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QUESTIONNAIRE EVALUATION

Introduction

The questionnaire was sent to the largest construction, engineering-construction, and consulting engineering companies in the USA. The returned completed questionnaires cover the significant contracts awarded in the USA for this type of work, i.e., for the Washington Metropolitan Area Transit Authority (WMATA) and the Bay Area Rapid Transit System (BART), and from designers where construction on some major projects is to be started within the next few years. Answers were also received pertaining to utility construction in built-up areas which is a type of work that shares many problems with traffic tunnel construction under the same conditions. Eighteen completed questionnaires were received, which is a relatively small number, but many interesting conclusions can be made as the answers are very comprehensive.

Sixty-two respondents stated that they had no experience related to the subject of the questionnaire. This is significant in that it indicates the state-of-the-art may be vested in a proportionately small number of organizations.

The goal has been to make an objective summary of the answers to each question; however, the conclusions are influenced by the analyst's own experience. Some conclusions are, however, indisputable. For example, the utilities (locating, relocating, and supporting, etc.) are definitely the biggest bottleneck in the present cut-and-cover construction methods, followed by traffic problems.

The conclusions from the answers to the questions about Geotechnical Information and Subsurface Conditions may exemplify how the analyst's experiences influenced the evaluation. The majority of respondents stated that the preconstruction Geotechnical Information had been sufficient for design and construction but the questions of later sections state that construction problems due to unexpected soil conditions were encountered. The conclusions from these contradictory statements, as supported by interviews, is that the design and construction planning was made anticipating that worse conditions than actually shown by the investigation would be encountered and/or the contractors anticipated to obtain extra payment due to changed conditions, thus no difficulty is placed on the Contractors economically. Conclusions of this nature can, of course, be disputed.

It is clearly realized by the authors that several of the questions are of very little value presented out of context and without additional information from the particular project. For example, question B3, "which one of these soil groups best describes the predominant soil stratum" is needed for cross reference to a number of other questions. The information that most of the projects included in the survey were constructed in cohesionless granular or soft to medium stiff clays means very little by itself.

Nevertheless, a uniform format to indicate the frequency of a certain event has been maintained throughout, in some instances, only for the purpose of showing the presence of the question and the nature of the answers. The actual use of the information has been, as indicated above, as background to evaluate other answers.

No attempt has been made for statistical analysis due to the limited amount of information available.

It is felt by the authors, despite the shortcomings indicated above, that the outcome of the survey gives a fairly good indication how cut-and-cover construction work is carried out, the inadequacies of the present common methods and areas needing urgent improvement.

Presentation of the questions and evaluation of the answers

A. Environmental Criteria

1. Did the project specification require the Contractor to control:

a.	Air pollution	b.	Noise
c.	Dust	d.	Vibration
e.	Site appearance	f.	Other

Control of noise, dust, and site appearance was required on a majority of the projects, air pollution and vibrations on about half. Other more general specifications were formulated as minimization of inconvenience and that special consideration should be given to the commercial life. Considerations to the traffic were also included among "other" environmental criteria. Considerations to all the environmental criteria are made and will be made for the four projects to be completed in 1972 or later.

In short, the answers showed that Environmental Criteria are specified for all projects within urban areas and as time progresses more and stricter controls are imposed.

B. Geotechnical Information

1. Was the geotechnical information sufficient for planning the construction?

All respondents, except one, found the geotechnical information sufficient. The contractor answering "no" had requested additional borings but this was denied. He claims that the request was later found to have been valid.

2. How was the geotechnical information presented to the contractor?

The soil data are presented as complete soils reports, soils profiles, boring logs, or profiles and logs. It appears to be more common to provide complete reports for the larger projects like BART and WMATA.

3. Which one of these soil groups best describes the predominant soil stratum?

a.	Cohesionless granular	b.	Cohesive granular
c.	Soft to medium-stiff clay	d.	Stiff clay
e.	Organic	f.	Rock
g.	Man-made fill		

Most projects were constructed in cohesionless granular or soft to medium-stiff clay followed in order by cohesive granular and stiff clays. Rock was encountered twice and organic soil once. Man-made fill of any importance was reported only four times, which is surprising as all projects are in urban areas. More than one soil type was encountered in over half the contracts.

4. Depth range to the original groundwater table:

Ground water was encountered in all except two projects. The depth varied between the projects from the ground surface to 60 ft. The depth range within projects varied between 2 ft and about 50 ft.

The format of presentation of the subsurface information is very variable. It is felt by the authors that it is more or less imperative that the contractors be given a full geotechnical report, including a narrative of the geotechnical analysis, pointing out the critical areas in the soil stratigraphy and the most critical construction phases. The most suitable construction methods and scheduling should be suggested in the report.

C. Underpinning

Underpinning includes the construction of supplementary elements to existing foundations or maintaining the bearing of the soil by, for example, grouting. Merely retaining the soil by a tightly braced cofferdam is not considered as underpinning.

1. Was any underpinning of adjacent structures necessary?
2. Was the underpinning: mandatory or voluntary?

Underpinning was necessary on seven projects; out of these seven the underpinning was mandatory on five, voluntary on one and differentiated in one case into two categories; mandatory within category 1 and voluntary within category 2. Category 1 included structures within the zone of influence from the construction as established by the engineer.

3. Was the underpinning designed by the Contractor or the Engineer?

When "mandatory" underpinning was specified, it was designed by the Engineer in all cases except one. The contractor designed all the "voluntary" underpinning and in the exception among the mandatory cases.

4. What type of underpinning was used?

a. Jacked piles	b. Driven piles
c. Augered piles	d. Pit wall
e. Slurry wall	f. Grouting
g. Other	

More than one method of underpinning was used on most of the seven projects in which underpinning was necessary. Jacked piles were used on four projects, augered piles on two, pit wall, piles embedded in pit wall, grouting and freezing on one project each.

5. Give some typical examples showing the distance from the excavation to the furthest point of underpinning. Describe the type of building and its foundation (Ex. 6-story on spread footings) in Column 1 (Building) of the tabulation below, give the soil type in Column 2 (Soil), the distance from the excavation to the furthest point of underpinning in Column 3 (Dist.), and the excavation depth below the foundation in Column 4 (depth).

The examples from the answers are listed below and a column (5) showing the distance (3) to depth (4) ratio is added.

1 Building	2 Soil	3 Dist.	4 Depth	5 Dist./Depth
3 storeys	sandy	12	22	0.6:1
1 bridge abutment	silty clay	8	15	0.5:1
8-story on spread footing	sand & gravel	14 ft	30 ft	0.4:1
12-story on spread footing	sand & gravel	20 ft	32 ft	0.6:1
10-story on spread footing	fill	22 ft	28 ft	0.8:1
7-story on spread footing	sand & gravel	23 ft	32 ft	0.7:1
2-story church building on spread footings				
11'x14' horseshoe sewer	silt & sand & decomposed rock	6 ft	12-15 ft	0.5:1 to 0.4:1
In Washington D. C.:				
Washington Building (10-story stone-faced office building, constructed circa 1920) spread footings.	sand-clay	45 ft	33 ft	1.4:1
Chamber of Commerce (4-story stone-faced, constructed circa 1930) continuous spread footing.	sand-clay	37 ft	45 ft	0.8:1
Civil Court 3-story	cohesionless	0	25 ft	-
Criminal Court 3-story	cohesionless	0	25 ft	-
Juvenile Court 3-story	cohesionless	0-30 ft	30 ft	1:1

1 Building	2 Soil	3 Dist.	4 Depth	5 Dist./Depth
1020 G Street 8-story spread footings	clayey sand & gravel	24 ft	23 ft	1:1
1100 G Street 11-story spread footings	sand & gravel	8 ft	11 ft	0.7:1 ~~1.4:1~~

The extent of the underpinning, as expressed by the distance to depth ratio, is quite variable and appears to be governed, as can be expected, by a number of factors such as soil properties, type of building and loading condition. The information is too limited to allow an attempt to separate the variables.

Since underpinning is more of an art than a science, economics may be realized if contractor and the engineer could jointly design the underpinning as the contractor knows his capabilities and the engineer is interested in the end product. However, it is always a question whether or not underpinning is needed in the first place, a more rigid excavation support may serve the same function, but in a more economical way.

D. Excavation Support System

1. Type of excavation support system:

a. Sheet piles b. Pit wall
c. Soldier piles with lagging of wood, steel, concrete
d. Slurry trench constructed wall with:
a) bar reinforcement b) pile reinforcement
e. Others

Soldier piles with timber lagging was definitely the most common system. Variations to this system were noted by using steel and concrete lagging. Steel sheet piling is the next most common. Slurry trench wall with pile reinforcement (SPTC) was used on one

project and pit wall was used on one project. A 90-ft-deep excavation was reportedly planned to get its support from 8-ft diameter cylinder concrete piles. More than one type of excavation support system was used on six projects.

2. Was the selection of the system due to space or right-of-way limitation?

The selection of ground support system was in 13 cases based upon space or right-of-way limitations. The selection was said to be based on economy in the case where soldier piles and steel lagging had been used and in one case based both on space and right-of-way limitations.

3. Type of bracing or tiebacks?

Most common is bracing by WF beams or pipe struts. Anchored tiebacks are reported in three cases, in one of which the anchors are specified as deadmen. Truss struts have been used for one project and reinforced concrete is planned as bracing for the 90-ft-high cylinder pile structure.

4. Was the bracing or tiebacks prestressed? To what percent of the design load?

Prestressing was reported for five projects. The level of prestressing ranged between 10 and 100% of the design load.

5. Were parts of the excavation support used in the final structure? Specify members:

The only case where any part of the ground support system will be used in the final structure was the project using the cylinder pile wall. The top bracing will become part of the roof structure of the completed facility.

6. Were parts of the excavation support retrieved? Specify members:

Parts of the excavation support system was retrieved in all projects except one. The contractor can in most cases retrieve, in order, (1) struts, deck beams and other crossbracing, (2) wales, (3) sheetpiling, (4) upper part of soldier piles and lagging. Successful retrieval of the entire excavation support system, including lower parts of soldier piles and lagging, appears to be very unlikely.

7. In your opinion was the criteria established for design of the excavation support conservative, not conservative, other opinion?

The opinion was, in all cases except two, that the criteria were "conservative". The other two opinions were "not conservative" and "reasonable".

8. Were any special kind of equipment used to install the excavation support? Describe.

Special equipment was used in nine cases. The special equipments were all related to driving piles or auger holes for inserting piles. One contractor had to build a special rig to get in under a bridge and another developed and patented a soldier pile puller with 400 T capacity.

9. Did any of the following environmental criteria affect the equipment selection?

a. Air pollution	b. Noise
c. Dust	d. Vibration
e. Site appearance	f. Other

Noise and vibration was mentioned in four cases to have had effect on the equipment selection. Noise alone was mentioned in one case. All the criteria was believed to have effect on one project to be started in 1972.

10. Did the readily available commercial equipment permit you to work within the environmental criteria or did you have to modify the equipment? Describe the nature of necessary modifications.

All respondents answered that the "readily available commercial equipment" did permit work within the environmental criteria.

11. Was the performance of the excavation support system monitored? What was monitored?

a. Settlement of ground surface outside excavation?
b. Settlement of adjacent structures?
c. Movement of vertical retaining walls?
d. Bracing loads?
e. Other?

Settlement of the ground surface was monitored on 16 projects and of adjacent structures on 13. The movement of vertical walls on seven projects and the bracing loads on six. One contractor wished that slope indicators had been specified to monitor horizontal movements. The trend is that larger projects are more extensively monitored but there is a surprisingly lack of observation of stresses in the ground support system even on the largest projects included in this survey.

12. What components or methods were used for monitoring?

a. Settlement
(1) Bench marks: On structures on ground surface
(2) Internal settlement probes within soil

A combination of benchmarks on ground surface and on structures was used on 11 projects, benchmarks only on structures on two and only on the ground on two. Internal settlement probes were used on two projects.

b. Lateral movement
(1) Bench marks: on structures on ground surface
(2) Slopemeters: within soil on excavation support

A combination of slopemeters on excavation support and benchmarks on structures and on the ground surface were used on four projects. Slopemeters alone on the excavation support or in the soil were used in one case each. In the remaining five monitored cases benchmarks both on structures and on ground were used three times and only on the ground twice.

c. Earth pressures and load on excavation support

(1) Within soil: Pressure cells, Flat jacks
(2) On bracing: Hydraulic jacks, Load cells, Strain gages
(3) On wall members: Strain gages

Strain gages were used on three projects on the bracing and one project both on bracing and on wall members.

d. Others (such as crack observations). Describe:

Preconstruction surveys of buildings including taking pictures were mentioned under this question, also the use of "Tell Tales" such as taping of joints. The deflection of the soldier piles was checked in one case.

13. How frequently were observations made of the monitoring system?

The observations were commonly made either on a daily or weekly basis. Schedules of increasingly larger intervals were used in some cases e.g. first daily, then weekly, and finally monthly.

14. In your opinion were the employed systems and observation methods reliable?

All respondents, except one, who had used a monitoring system answered "yes" to this question. No explanation was given for the case where the monitoring system was considered as unreliable.

15. Were any changes made in the excavation support system or in the construction procedure due to monitoring?

One level of lateral bracing could be eliminated in one case as the monitoring system showed that the loading was not as much as anticipated. Some settlement was observed in another case and the contractor was directed to close up with soldier pile spacing especially at utility locations. The soil was in the first case soft to medium stiff clay and in the second case cohesionless-granular and soft to medium stiff clay. Changes had been made in one more project; however, no description was provided.

The present practice is generally to abandon the temporary retaining structure and retrieve only struts, deck beams and cross-bracing. Possible savings could be obtained if the soldier piles, or other parts that cannot be retrieved, could be incorporated into the final structure.

The now available equipment appears to meet the currently imposed environmental requirements, but the anticipated future stricter regulations may force costly development of new or modified equipment. These criteria must be kept in mind when designing the excavation support system to assure that there is equipment available that can install the structure.

Instrumentation may be used to check that the actual conditions agree with the design assumptions. Changes can be eventually made during construction which may cost savings to the owner and/or contractor. However, no instrumentation should be installed without the purpose being clearly understood and specified.

E. Groundwater and Dewatering

1. Type of dewatering system

a. Deep wells
b. Open pumping in shallow wells
c. Open pumping in sumps
d. Well points
e. Other

Some kind of dewatering was used on 13 projects. Deep wells were used on ten projects, twice in combination with sump pumps. Sump pumps only on two projects, for one of these it was noted that the seepage was very small from perched water table. A combination of shallow wells, sumps and well points was used in one project in a soft to medium stiff clay.

2. Was the dewatering system planned by the engineer, the contractor, or other outside specialist?

The dewatering is generally planned by the contractor, frequently with assistance from outside Dewatering Engineer or Consultant. The engineer was reported to have planned the dewatering only in one case. Basic dewatering specifications may otherwise be furnished by the engineer.

3. Did the system operate at design capacity?
If not, was this due to planning or installation?

4. Approximate actual capacity of dewatering system per 100 ft on construction in gpm?

All systems except two operated at design capacity. The actual capacity per 100 ft of construction varied from less than 1 gpm to 300 gpm. The 300 gpm was for deep wells in granular material with the groundwater 10 to 20 ft from the surface. The 1 gpm or less was for one of the systems that did not work. Deep wells were used also there and the soils consisted of granular material and stiff clays with the groundwater 10 ft below the ground surface.

5. Did the specifications require drawdown inside the excavation to a certain depth below:

   a. Bottom of excavation
   b. Top of fill during backfill
   c. Other controls

Drawdown below the bottom of excavation had been required in 13 projects. Three cases with the qualification that the drawdown should extend to 5 ft below the bottom. Drawdown below top of backfill was required on one project.

6. Was the original groundwater elevation maintained outside the excavation? How was this accomplished?

The original groundwater elevation was maintained in one case but the respondent did not describe how it was accomplished.

7. Was the drawdown monitored?

The drawdown was monitored on ten of the projects.

8. What was the general layout of the monitoring system? (Ex. spacing between observation sections and distance to observation points.

The spacing between the observation sections varied greatly from 50 ft to 700 ft. The max. offset was commonly 100 to 150 ft from the excavation.

9. Did the monitoring system provide the intended function? If not, what was the reason?

All respondents, except one, who had used dewatering and employed a monitoring system stated that the system had provided the intended function. The non-functional system was said to give "erratic readings, probably due to perched water tables and other conditions not representative for the general water table."

10. Did any piping or boils occur?
    If so, describe the corrective measure taken.

Only one isolated case of blowout in a deep well was reported. No description of any corrective measures were given.

The dewatering systems appear to be operating technically satisfactorily in general. However, the isolated case of blowout, and the system that did pump only an extremely small amount of water, indicates that better understanding of dewatering and ground water under certain conditions should be obtained. The ground support structures must be overdesigned to compensate for this potential lack of knowledge in dewatering.

F. Traffic Maintenance and Decking

1. Was excavation decking required?
2. Did decking become a part of final structure?
3. Was decking installed above existing street grade?
4. Was decking installed before full-depth excavation?
5. Was traffic requirement to maintain full street-width or part street-width open?
6. Were decking details included in design drawings?

Traffic decking was required on 12 projects but did in no case become a part of the final structure. The decking was installed above final grade only on one project. The installation was made before full depth excavation in all cases. The requirement was to keep the street partially open on 11 projects and fully open on three. Two of the projects having specifications for partially open street did not require traffic decking. The decking details were included in the design only on one project.

7. Describe decking material.

Timber on steel beams was used in all cases. The timber varied between 8" x 8" in 12' lengths to 14" x 14" in 17.5' lengths or 12" x 12" in 24' lengths.

8. How was decking supported?

   a. On excavation support?
   b. On independent support system?
   c. On ground outside excavation?
   d. Were intermediate supports used in combination with the system checked above?

9. If intermediate supports were used, did they become a part of the final structure?

The decking was in all cases, except two, supported by the excavations support (soldier piles). Independent support was used in the two exceptional cases.

Intermediate supports were not used in any case.

10. Were entrances to adjacent buildings maintained during installation of traffic decking?

11. Was construction equipment permitted on decking?

Entrances had to be maintained during installation of the traffic decking, and construction equipment was permitted on the decking, on all projects where decking was used.

Timber decking was used by the contractors in all cases where decking was necessary. Timber decking has certain drawbacks, such as warping, noise, difficulties in maintaining a wearing surface but is still most feasible for the contractors because the cost of decking material most generally is written off on one project. A better solution could be that the owner, when planning to award several contracts following each other in time, purchases a more satisfactory decking material to be moved between the contracts.

G. Utilities

1. Did specifications require the contractor to determine the exact location of existing utilities?

2. Were all, some, or none of the services maintained during construction?

The specifications did require the contractor to locate the utilities in all cases except one. All utilities were maintained except on one case; there only "some" had to be maintained.

3. Did the utilities have to be relocated for:

a. Excavation support system
b. Traffic decking

The utilities had to be relocated for the excavation support on 12 projects. The utilities have also to be relocated for the traffic decking in four of these 12 projects.

4. What utilities were relocated by others in advance of construction?

a. Water
b. Sewer
c. Electric
d. Telephone
e. Gas
f. None

Gas was relocated by "other" on ten projects. Water, electricity, and telephone on seven. Sewers had to be relocated on five projects. Four projects had no relocation, while 4 projects required relocation of all types of utilities.

5. Did utility work done by others:

a. Delay start of construction
b. Lengthen the construction time

The utility work delayed the start of construction on seven projects and lengthened the construction time on seven projects. Both the start was delayed and time lengthened on four of these projects.

6. Were utilities supported from:

a. Excavation support system
b. Traffic decking

The utilities were supported from the excavation support on 11 projects and from the traffic decking on seven. The utilities were supported both from the excavation support and traffic decking on five of these projects.

The presence of utilities lengthens the construction period especially at the beginning of the work while locating and exposing the utilities and constructing the temporary supports. The construction activities may be completely stopped when unknown utilities are encountered. Valuable time and money could be saved if utilities were either relocated ahead of construction off the site or permanently relocated to utility tunnels. The permanent relocation would facilitate the restoration work and permit the contractor to work more freely with his equipment.

H. Excavation

1. What was the general type of excavation equipment used?

Backhoes are most commonly used followed by clamshells, dozers, and front-end loaders, hi-loaders, draglines and conveyors are occasionally used. Different equipment is used for various stages of construction, for example, the excavations are generally started by backhoe and then continued at larger depths by clamshell assisted by dozer or backhoe.

2. What controlled the excavation rate?
Digging or spoil removal. If other, describe:

Digging controlled the excavation rate on eight projects. The ground support, especially installation of lagging, controlled on three projects. Stage construction and traffic maintenance on one.

Spoil removal was the controlling factor in the case where a conveyor belt was used and in one case where trucks were used.

3. Did any other operation or event such as installation of bracing, relocation or removal of utilities, excessive earth movements, etc., control or reduce the excavation rate? If yes, describe:

Again, installation of bracing and support or protection of utilities was repeated as the most common cause of reduced excavation rate, besides the digging. Other causes were poor soil conditions and excessive vibrations that caused concern and held up the work.

4. Was the spoil material hauled out on ramps or lifted to the surface in vertical shafts? If other, describe:

A combination of ramps and shafts were used on four project shafts only in two and ramps only on three. The spoil was otherwise removed by backhoe, dragline, clamshells and conveyors without the use of what the respondents would classify as ramps or shafts.

5. What general type of equipment was used to transport the spoil material out of excavation from place of digging?

The common means for transportation of the spoil material is, as expected, trucks, the only exception being where the conveyor was used.

6. Did off-site transportation of spoil material influence the excavation progress? For example, through traffic congestion? How were such situations considered in the scheduling?

The traffic did influence the excavation progress in five cases. Two respondents stated that this was taken care of by supplying more trucks. A plan was in one case filed with the Highway Department.

The technology for the individual equipment units is presently at a high standard. However, improvements are needed in the overall excavation operation and complete systems should be developed

for excavation and spoil removal. These systems should be adapted to the specific conditions caused by the different schemes for ground support, dewatering, etc.

I. Final Structure

1. How far was the excavation support system built from the neat line of the final structure?

2. Did the excavation support system enter beyond the neat line?

3. What corrective measures were taken if the excavation support system was found to encroach on the final structure?

The excavation support system was built typically 0 to 5 ft from the neat line. The excavation support system entered beyond the neat line in four cases. The distance from support to the neat line was intended to be three inches, 0.5 ft or less and 2 ft respectively when this happened. The corrective measures were generally: to remove the lagging and place it behind the soldier piles, encase the piles in the structure, cut holes in the webs of the soldier piles for bars to be encased in the structural concrete, place additional reinforcement against cracking and apply additional external waterproofing; parts of soldier piles may have to be burned off.

4. Were there, in your opinion, any provisions that could have been made in the design of the final structure that would have facilitated the construction?

There was only one suggestion of a change that would have facilitated construction; long reinforcing bars from the walls for slab reinforcement, interfered with the construction. The bars should have been doweled out when possible.

Encroachment of soldier piles into final structure does not seem to be a serious problem. Designers should keep in mind the feasibility of different construction procedures and their limitations in application when designing the final structure. The final structure must be compatible with the groundsupport system and other temporary construction elements. The designers must be aware of advancements in construction methods and adapt their design thereafter. The designers may also have to initiate new ideas that can speed up the construction and thus cut the costs.

J. Subsurface Conditions

1. Was the subsurface information adequate for construction?

The answers to this question were identical to the answers from B1; in other words, the information deemed adequate for planning; it was also good for construction.

2. Did any soil type cause special problems or did unexpected subsurface conditions affect the construction? Describe the soil type and the nature of the problems.

3. What additional subsurface information would have been helpful for the construction?

Problems were described from four projects, three of these relate directly to the behavior of clays.

1. The soil profile consisted of soft to medium stiff clays. The softer clays caused problems when the subway profile rose to the surface. Piles were driven deeper to counteract the movement. It was not felt that any additional soil information would have been necessary and the problems were expected.

2. A soft clay was encountered which was too unstable to run equipment on. No additional information would have helped.

3. Man-made fill was encountered in an old lake bed. Borings at 100 ft spacing would have been helpful.

4. The presence of clay at several points near the footing line was not known until excavation was completed. Available borings were several hundred ft apart. More samples should have been obtained in the borings which indicated only granular material. The clay affected the progress of the construction.

Soft to medium stiff clays are the most troublesome soils for the contractors. More extensive subsurface investigations should be used or developed that will give better information about geological stratification and the groundwater conditions. It should be kept in mind, when planning the geotechnical investigation, that even minor pockets or layers of unstable material may jeopardize the integrity of the ground support system and delay the construction. The design must generally have been overly conservative from the beginning since no further information was deemed necessary in most projects even when unexpectedly bad soil conditions were encountered.

K. General

1. Did any construction procedures result in complaints from residents or businesses? What generally were the nature of the complaints?

Numerous complaints were registered for most of the projects. However, four major projects were reportedly completed without complaints. A fifth project in a redevelopment area was also completed without complaints. Following are some typical problems encountered:

-- Pile driving caused cracks in walls and/or dewatering may have been cause of settlement in basements.

-- Loss of business and inability to park at curbside, some forced closures of marginal businesses; dust, mud, and noise were also sources of complaints.

-- Slurry caused mess, access to stores was limited, traffic was limited through construction site, therefore, store owners felt loss of business.

-- Interference with access to adjoining business properties.

-- Vibration-noise-dust-traffic-congestion-pedestrian traffic inconvenienced during construction.

-- Noise and temporary disruption to parking in front of business establishments.

-- Interference with retail business. Compressor operation noise, spillage of excavation material from trucks, poor housekeeping and programming of work by contractor.

-- Design of facility, fumes, dust, noise, inconvenience, and lack of access for customers, disruption of utility services, damage to property, window breakage, working days, working nights.

-- Minor complaints, but slowed-down business and broken windows.

2. Were any not previously described methods used or considered that you would characterize as unconventional or innovative?

A few methods, all from different areas, were described.

-- Underpinning of footings using prestressed concrete segments.

-- Prefabricated and sectionalized traffic bridges.

-- Truss bracing welded to soldier pile at one side and having a screw system for adjustments on the other side.

-- Conveyor excavation set up.

-- Bulletins to the neighborhood describing methods to be used and progress of work.

3. Would standardized dimensions improve the efficiency of construction and thereby reduce the construction time?

Seven "yes" answers and five "no" answers to this question.

4. Were any precast or preassembled elements used for any part of the construction?

The following elements were preassembled or precast on one or several projects.

-- Temporary timberdecking into panels.

-- Lateral bracing for ground support.

-- Precast "T" beams for roof slab.

-- Precast beams for sidewalk gratings.

-- Transverse traffic bridges.

-- Structural steel frame for roof and mezzanine walls.

-- Precast concrete parapet walls.

5. Would, in your opinion, increased use of precast or preassembled elements facilitate the work and thereby reduce the construction time?

Five "yes" and five "no" answers. The application of these methods depends very much on the project; in other words, increased use may prove to be feasible if the use of precast or preassembled elements is considered in the design.

6. Would you increase your research if equipment and methods could be patented?

Four "yes" and seven "no" answers. One yes answer was qualified that "recognition would encourage research".

7. What would you consider to be the bottlenecks in the present methods of cut-and-cover construction. List in order of importance.

The following were the bottlenecks listed in order of importance:

Very frequently listed: Utility relocation, Traffic

Occasionally listed: Community objections, Human and public environment, Dewatering and drainage, Backfill and compaction.

Listed once: Support of utilities, Depth of excavation, Excavation, Space for work, Undue concern with minor ground movements, Excessive time for stripping forms, Restrictions on working time, Restrictions imposed by governing city agencies permits, etc.

Businesses definitely lose revenue during construction period because people stay away from the construction area due to lack of parking, noise, dust, mud, traffic congestions, etc. It is the general opinion that preassembled, precast, or prefabricated elements may facilitate the work if considered in the initial design. At present, traffic decking is frequently preassembled with several contractors showing imagination by preassembling elements for other purposes, however, on some projects, imaginative initiatives were discouraged. The answers clearly point out that the major bottlenecks are the utilities and traffic with considerable problems due to the environment, the groundwater control and the backfilling.

General About The Respondents

Ten of the responding companies were Consulting Engineers, seven Contractors, and one company did both design and construction. All the Consulting Engineering companies also did construction inspection.

APPENDIX C

CANADIAN NOISE-CONTROL BY-LAWS

TABLE OF CONTENTS

BOROUGH OF ETOBICOKE

BY-LAW NO. 797

A BY-LAW RESPECTING NOISES

NOW THEREFORE THE MUNICIPAL COUNCIL OF THE CORPORATION OF THE BOROUGH OF ETOBICOKE ENACTS AS FOLLOWS:

1. No person shall ring any bell, blow or sound any horn or cause same to be rung, blown or sounded, shout or cause, create or permit any unusual noise or noise likely to disturb the inhabitants.

2. None of the provisions of this By-Law shall apply to:

(a) any excavation or construction work, including the erection, demolition, alteration or repair of any building authorized by the Corporation and undertaken between the hours of 7:00 o'clock in the forenoon and 7:00 o'clock in the afternoon of the same day on any day other than Sunday;

(b) any situations of public convenience or necessity.

3. Any person convicted of a breach of any of the provisions of this By-Law shall forfeit and pay in the discretion of the convicting Magistrate a penalty not exceeding (exclusive of costs) the sum of Three Hundred ($300.00) Dollars for each offence, recoverable under The Municipal Act and The Summary Conviction Act.

4. By-Law Number 8233 of The Corporation of the Township of Etobicoke, By-Law Number 2421 of The Corporation of the Town of New Toronto and By-Law Number 2013 of The Corporation of the Town of Mimico are hereby repealed.

READ A FIRST, SECOND AND THIRD TIME AND PASSED IN COUNCIL THIS 17th day of June, A.D., 1968.

E. A. Horton
MAYOR

K. F. Pennington
CLERK

BILL No. 206

BOROUGH OF SCARBOROUGH

BY-LAW NUMBER 12855

being a by-law to prohibit the ringing of bells, the blowing of horns, shouting, unusual noises and noises likely to disturb the inhabitants of the Municipality.

NOW THEREFORE BE IT AND IT IS HEREBY ENACTED:

1. No person shall ring any bell, blow or sound any horn or cause same to be rung, blown or sounded, shout or create, cause or permit any unusual noise or any noise likely to disturb the inhabitants of the Municipality.

2. For the purpose of Section 1, and without limiting the generality of the foregoing, the following noises or sounds, among others, shall be deemed to be noises likely to disturb the inhabitants.

(a) The sounding of any bell, horn, siren or other signal device on any motor vehicle, motorcycle, bicycle, street car, or other vehicle of whatsoever kind, except when required by law.

(b) The sounding of any such bell, horn, siren or signal device for an unnecessary or unreasonable period of time.

(c) The sound or noise from or created by any radio or phonograph, or any musical or sound-producing instrument of whatsoever kind when such radio or phonograph or instrument is played or operated in such manner or with such volume as to annoy or disturb the peace, quiet, comfort or repose of any individual in any dwelling house, apartment house, hotel or other type of residence.

(d) Any sound made by any pet, animal or bird which persistently disturbs the peace, comfort or repose of any individual in the neighbourhood, provided that this section shall not apply in areas which, by the Borough's Official Plan or by a restricted area By-law, are designated Agricultural.

(e) The grating, grinding or rattling noise or sound caused by a condition of disrepair or maladjustment of any motor vehicle, motorcycle, or other vehicle whatsoever or part or accessory thereof.

(f) The blowing of any steam or air whistle attached to or used in connection with any stationary boiler or other machine or mechanism, except for the purpose of giving notice to workmen of the time to commence or cease work or as a warning of danger.

(g) The discharge into the open air of the exhaust of any steam engine, stationary internal combustion engine, motor vehicle or motorcycle except through a muffler or other device which effectively prevents loud or explosive noises.

(h) Any noise arising between the hour of 8:00 o'clock p.m. of any day and 7:00 o'clock a.m. of the next following day from any excavation or construction work whatsoever, including the erection, demolition, alteration or repair of any building, authorized by the Corporation except in case of necessity and then under a permit from the Commissioner of Buildings or Commissioner of Works.

12855

(i) Any unnecessary noise in the vicinity of any church, school, seminary of learning or court while the same is in session, or in the vicinity of any hospital or convalescent or rest home when such noise interferes with the undertaking of such hospital or home, provided conspicuous signs are displayed in or upon the streets adjoining any such school, church, court, hospital or home indicating that loud noises are prohibited in the vicinity.

(j) The noise created by driving any vehicle bearing material, articles or things which are loaded upon such vehicles in such manner as to create such noise.

(k) The noise or sound created by the use or operation of any drum, horn, bell, radio or mechanical loudspeaker, or other instrument or device or sound-producing, sound-reproducing, or sound transmitting instrument or apparatus for the purpose of advertising or for attracting attention to any performance, show or sale or display of goods, wares or merchandise or which projects noise or sound into any street or other public place.

(l) The noise or sound created by the use or operation of any radio or mechanical loudspeaker or amplifier or other instrument or device or sound-producing, sound-reproducing, or sound transmitting instrument or apparatus in or upon any vehicle except for such time and under such conditions as Council may prescribe.

(m) Crying, shouting or loud speaking in or adjacent to any public street or place.

3. None of the provisions of this By-law shall apply to:

(a) The use in a reasonable manner of any apparatus or mechanism for the amplification of the human voice or of music in a public park or any other commodious space in connection with any public election meeting, public celebration or other reasonable gathering, provided written permission of Council has first been obtained.

(b) Any military or other band or any parade, operating under written permission first obtained from the Council.

(c) Any newsboy, peddler, hawker or petty tradesman plying his calling legitimately and moderately.

(d) Any vehicle of the police or fire department or any ambulance or any public service or emergency vehicle while answering a call.

(e) The sound from any private radio in a motor vehicle, installed for the sole benefit or entertainment of the operator and occupants of such vehicle, when same is not audible at a distance of twenty-five feet from such vehicle.

(f) Any sound arising from the operation of any railway which operated under The Railway Act of Canada or from any plant or work in connection with any such railway.

(g) Any case of public convenience or necessity.

12855

4. Any person convicted of a breach of any of the provisions of this By-law shall forfeit and pay, at the discretion of the convicting Magistrate, a penalty not exceeding (exclusive of costs) the sum of $300.00 for each offence; and every such penalty shall be recoverable under The Summary Convictions Act, all of the provisions of which shall apply, except that the imprisonment may be for any term not exceeding six months.

5. By-law Number 12740 is hereby repealed.

READ a FIRST, SECOND and THIRD time and passed in open Council this 17TH day of JULY, A.D. 1967.

Mayor

DEPUTY Clerk

OFFICE CONSOLIDATION

This consolidation is prepared for purposes of convenience only; for accurate reference see by-laws as adopted by City Council.

CITY CLERK

By-law No. 14913 as amended by By-law Nos. 15171 and 19821.

Respecting Noises

(Passed March 14th., 1938.)

The Council of the Corporation of the City of Toronto enacts as follows:

I

No person shall ring any bell, blow or sound any horn or cause same to be rung, blown or sounded, shout, or create, cause or permit any unnecessary noise which disturbs the inhabitants.

II

For the purpose of Section I, the following noises or sounds, among others, shall be deemed to be unnecessary noises which disturb the inhabitants:

(1) The sounding of any bell, horn, siren or other signal device on any motor vehicle, motorcycle, bicycle, street car, or other vehicle of whatsoever kind, except when required by law.

(2) The sounding of any such bell, horn, siren or signal device for an unnecessary or unreasonable period of time.

(3) The sound or noise from or created by any radio or phonograph, or any musical or sound-producing instrument of whatsoever kind when such radio or phonograph

or instrument is played or operated in such manner or with such volume as to annoy or disturb the peace, quiet, comfort or repose of any individual in any dwelling house, apartment house, hotel or other type of residence.

(4) Any sound made by any animal or bird which disturbs the peace, quiet, comfort or repose of any individual in the neighbourhood.

(5) The grating, grinding or rattling noise or sound caused by a condition of disrepair or maladjustment of any motor vehicle, motorcycle, or other vehicle whatsoever or part or accessory thereof.

(6) The blowing of any steam or air whistle attached to or used in connection with any stationary boiler or other machine or mechanism, except for the purpose of giving notice to workmen of the time to commence or cease work or as a warning of danger.

(7) The discharge into the open air of the exhaust of any steam engine, stationary internal combustion engine, motor vehicle or motorcycle, except through a muffler or other device which effectively prevents loud or explosive noises.

(8) Any unnecessary noise arising between the hour of 6:00 o'clock p.m. of any day and 7:00 o'clock a.m. of the next following day from any excavation or construction work whatsoever, including the erection, demolition, alteration or repair of any building authorized by the Corporation, except in case of urgent necessity and then under a permit from the Commissioner of Buildings or Commissioner of Works.

(9) Any unnecessary noise in the vicinity of any school, seminary of learning or court while the same is in session or in the vicinity of any hospital or convalescent or rest home when such noise interferes with the undertaking of such hospital or home, provided conspicuous signs are displayed in or upon the streets adjoining any such school, court, hospital or home indicating that loud noises are prohibited in the vicinity.

(10) The noise created by driving any vehicle bearing material, articles or things which are loaded upon such vehicle in such manner as to create such noise.

(11) The noise or sound created by the use or operation of any drum, horn, bell, radio or mechanical loudspeaker, or other instrument or device or sound-producing, sound-reproducing, or sound transmitting instrument or apparatus for the purpose of advertising or for attracting attention to any performance, show or sale or display of goods, wares or merchandise or which projects noise or sound into any street or other public place.

(12) The noise or sound created by the use or operation of any radio or mechanical loudspeaker or amplifier or other instrument or device or sound-producing, sound reproducing, or sound transmitting instrument or apparatus in or upon any vehicle or aircraft except for such time and under such conditions as the Council of the said Corporation may prescribe. (19821)

(13) Crying, shouting or loud speaking in or adjacent to any public street or place.

III

None of the provisions of this By-law shall apply to:

(1) The use in a reasonable manner of any apparatus or mechanism for the amplification of the human voice or of music in a public park or any other commodious space in connection with any public election meeting, public celebration or other reasonable gathering provided written permission of the Council of the said Corporation has first been obtained. (19821)

(2) Any military or other band or any parade, operating under written permission first obtained from the Council of the said Corporation. (19821)

(3) Any newsboy, peddler, hawker or petty tradesman plying his calling legitimately and moderately.

(4) Any vehicle of the police or fire department or any ambulance or any public service or emergency vehicle while answering a call.

(5) The sound from any private radio in a motor vehicle, installed for the sole benefit or entertainment of the operator and occupants of such vehicle, when same is not audible at a distance of twenty-five feet from such vehicle.

(6) Any sound arising from the operation of any railway which operates under The Railway Act of Canada or from any plant or work in connection with any such railway.

(7) Any case of public convenience or necessity.

(8) The operations of the Salvation Army as heretofore carried on. (15171)

IV

Any person convicted of a breach of any of the provisions of this By-law shall forfeit and pay, at the discretion of the convicting magistrate, a penalty not exceeding (exclusive of costs) the sum of $300.00 for each offence; and every such penalty shall be recoverable under The Summary Convictions Act, all of the provisions of which shall apply, except that the imprisonment may be for any term not exceeding six months. (19821)

This By-law shall take effect upon, from and after being validated by the Legislature of the Province of Ontario.

R.C. DAY,
Mayor.

J.W. SOMMERS
City Clerk.

COUNCIL CHAMBER,
Toronto, March 14th, 1938.
(L.S.)

By-law No. 14913 validate Chap. 73 Statutes of Ontario, 1939.

By-law No. 15171 approved by the Ontario Municipal Board (P.F.A. 8615) July 5, 1939.

By-law No. 19821 approved by the Ontario Municipal Board (P.F.M. 5536-56) December 19, 1956.

THE MUNICIPALITY OF METROPOLITAN TORONTO

BY-LAW No. 835.

To prohibit the driving or operating of vehicles creating undue noise within The Municipality of Metropolitan Toronto.

The Council of The Municipality of Metropolitan Toronto HEREBY ENACTS as follows:

1. In this by-law,

(a) "motor vehicle" means automobile, motorcycle and any other vehicle propelled or driven otherwise than by muscular power and used for the transportation of persons or things but does not include the cars of electric or steam railways or other motor vehicles running only upon rails.

(b) "undue noise" means any sound, the overall sound pressure level of which exceeds 94 decibels when measured at a distance of 15 feet or more from its source by use of the C-weighting scale of a sound-level meter.

(c) "sound-level meter" means an instrument consisting of the following components:

(i) meter type 1551-A manufactured by the General Radio Company of Cambridge, Massachusetts, U.S.A., without a Rochelle-salt-crystal diaphragm type microphone.

(ii) microphone transformer type No. 759-P26 manufactured by the General Radio Company of Cambridge, Massachusetts, U.S.A.

(iii) dynamic microphone type 759-P27 manufactured by the General Radio Company of Cambridge, Massachusetts, U.S.A. or its equivalent type No. 633-A dynamic microphone as manufactured by either the Northern Electric Company of Canada Limited or the Altec Lansing Corporation, California, U.S.A.

(iv) microphone extension cables type No. 759-P22 as manufactured by the General Radio Company of Cambridge, Massachusetts, U.S.A.

which when appropriately assembled provides a means of measurement of noise and other sounds in decibels when acoustically calibrated at a frequency of 1,000 cycles per second to measure the overall sound pressure level at the microphone thereof relative to 0.0002 microbars.

2. No person shall drive or operate any motor vehicle that creates an undue noise within the limits of The Municipality of Metropolitan Toronto.

3. The provisions of this By-law shall not apply to the operation of police, fire department or ambulance sirens, horns or bells in the course of duty or vital necessity.

4. Every person who contravenes any of the provisions of this by-law shall upon conviction thereof. forfeit and pay, at the discretion of the convicting magistrate a penalty not exceeding (exclusive of costs) $300.00 for each offence.

5. This By-law shall not become operative until approved by the Department of Transport.

ENACTED AND PASSED this 21st day of October, A.D. 1958.

W. W. GARDHOUSE,
Clerk.

FREDERICK G. GARDINER,
Chairman.

(Corporate Seal)

THE MUNICIPALITY OF METROPOLITAN TORONTO

BY-LAW No. 1790.

To amend By-law No. 835.

The Council of The Municipality of Metropolitan Toronto HEREBY ENACTS as follows:

1. Clause (b) of Section 1 of By-law No. 835, a By-law "To prohibit the driving or operating of vehicles creating undue noise within The Municipality of Metropolitan Toronto", is repealed and the following clause inserted in lieu thereof:

(b) "undue noise" means any sound, the overall sound pressure level of which exceeds 94 decibels when measured at a distance of 15 feet or more from its source by use of the C-weighting scale and the "slow" setting of a sound-level meter.

2. This By-law shall not become operative until approved by the Department of Transport.

ENACTED AND PASSED this 13th day of November, A.D. 1962.

WILBERT W. GARDHOUSE,
Metropolitan Clerk.

WILLIAM R. ALLEN,
Chairman.

(Corporate Seal)

I hereby certify this to be a true and correct copy of By-law No. 1790 passed by Council on November 13th, 1962.

Metropolitan Clerk.

10

PASSED September 11 1967

YORK TOWNSHIP

A BY-LAW

No. 186

TO REGULATE noises within the Borough of York.

Amended by Bylaw 873
Aug. 17, 1970

Amended by Bylaw 1137
July 5, 1971

INTRODUCED BY

Alderman W. Saunders

THE CORPORATION OF THE BOROUGH OF YORK

APPROVED AS TO FORM

SOLICITOR FOR BOROUGH OF YORK

BILL 202

A BY-LAW

Number 186

TO REGULATE noises within the Borough of York.

WHEREAS Section 379, Subsection (1) paragraph 118 of The Municipal Act, Chapter 249 R.S.O. 1960 provides that the Council of a municipality may pass by-laws for prohibiting or regulating the ringing of bells, the blowing of horns, shouting and unusual noises, or noises likely to disturb the inhabitants;

AND WHEREAS it is deemed advisable to pass a by-law regulating noises within the Borough of York.

NOW THEREFORE THE COUNCIL OF THE CORPORATION OF THE BOROUGH OF YORK ENACTS AS FOLLOWS: -

- 1 -

Within the Borough of York no person shall ring any bells, blow or sound any horn or cause same to be rung, blown, or sounded, shout, or create, cause or permit any unusual noise, or any noise likely to disturb the inhabitants of the Borough of York.

- 2 -

Nothing in this by-law shall be deemed to prohibit the following:

(a) the sounding of any bell, horn, siren or other signal device on any motor vehicle, motor cycle, bicycle or other vehicle of whatsoever kind, when the sounding of such signal device is required by law;

(b) the sounding of the siren or horn on any vehicle of the police or fire department or any ambulance or any public service or emergency vehicle while answering a call;

(c) the ringing of any church bells;

(d) the playing of any musical instrument.

- 3 -

By-laws Number 11574, 12188, 13182 and 16811 of the Township of York and By-law Number 1622 of the Town of Weston are hereby repealed.

- 4 -

Any person convicted of a breach of any of the provisions of this By-law shall forfeit and pay, at the discretion of the convicting magistrate, a penalty not exceeding the sum of Three Hundred ($300.00) Dollars exclusive of costs.

ENACTED AND PASSED this 11th day of September 1967.

MAYOR

CLERK

BOROUGH OF NORTH YORK

BY-LAW NUMBER 24654

A BY-LAW respecting unusual noises or noises within the Borough of North York.

THE MUNICIPAL COUNCIL OF THE BOROUGH OF NORTH YORK HEREBY ENACTS AS FOLLOWS:

1. No person shall ring bells, blow horns, shout or make or permit unusual noises, or noises likely to disturb the inhabitants.

2. Any person convicted of a breach of any of the provisions of this By-law shall forfeit and pay at the discretion of the convicting Magistrate, a penalty not exceeding (exclusive of costs) the sum of Three Hundred Dollars ($300.00) for each offence; and every such penalty shall be recoverable under the Summary Convictions Act.

3. By-law Number 23268 passed on the 22nd day of June, A.D. 1970 is hereby rescinded.

ENACTED and PASSED this 11th day of September A.D. 1972.

(Sgd) E. Roberts
Clerk

(Sgd) Basil Hall
Mayor

(S E A L)

THE CORPORATION OF THE
BOROUGH OF EAST YORK

BY-LAW NO. 98

To prohibit or regulate noises.

WHEREAS by Section 14 of The Municipality of Metropolitan Toronto Amendment Act, 1966, Statutes of Ontario 1966, Chapter 96, the Township of East York and the Town of Leaside were amalgamated under the name of The Corporation of the Borough of East York;

AND WHEREAS by Section 17 of The Municipal Act, R.S.O. 1960, Chapter 249, as amended, the Council of the Corporation has power to amend by-laws of the said former Township and former Town;

AND WHEREAS by sub-paragraph 114 of sub-section 1 of section 379 of The Municipal Act, R.S.O. 1960, Chapter 249, as amended, by-laws may be passed by the councils of local municipalities for prohibiting or regulating the ringing of bells, the blowing of horns, shouting and unusual noises, or noises likely to disturb the inhabitants;

AND WHEREAS the Council of the Corporation deems it desirable to enact regulations and prohibitions pursuant to the said statutory authority;

THEREFORE the Council of The Corporation of the Borough of East York HEREBY ENACTS as follows:

1. In this by-law,

(a) "Chief Building Inspector" means the Chief Building Inspector of the Corporation and includes a Deputy Building Inspector thereof;

(b) 'Commissioner of Works" means the Commissioner of Works of the Corporation and includes a Deputy Commissioner of Works;

(c) "motor vehicle" means any self-propelled vehicle designed for transporting property or one or more persons;

(d) "person' includes a corporation and the heirs, executors, administrators or other legal representatives of a person to whom the context can apply according to law;

(e) "vehicle" includes a motor vehicle, trailer, traction engine, tractor, road building machine and any vehicle drawn, propelled or driven by any kind of power, including muscular power.

2. In the Borough of East York no person shall:

(a) ring a bell or cause or permit a bell to be rung;

(b) blow a horn or cause or permit a horn to be blown;

(c) shout;

(d) make an unusual noise, or cause or permit the making of such a noise;

(e) make a noise likely to disturb the inhabitants of the Borough of East York, or cause or permit such a noise to be made.

3. For the purposes of subsection (e) of section 1 of this by-law the following noises or sounds shall, without limitations of the generality of such subsection, be deemed to be noises likely to disturb the inhabitants of the Borough of East York:

(a) the sounding of a bell, horn, siren or other signal device on a vehicle, except when such sounding is required by law;

(b) the sounding of any such bell, horn, siren or other signal device for an unreasonably long period of time;

(c) a sound or noise from or caused or created by a radio, television set, phonograph, musical instrument, sound-producing instrument or apparatus of whatever kind when such radio, television set, phonograph, musical instrument, sound-producing instrument or apparatus is played or operated in such manner or with such volume as to unreasonably annoy or disturb the peace, quiet, comfort or repose of a person in a dwelling house, apartment house, hotel or other residential accommodation;

(d) a noise or sound made by an animal or a bird which unreasonably disturbs the peace, quiet, comfort or repose of a person;

(e) a noise or sound from or caused or created by a condition of disrepair or maladjustment of a vehicle or a part thereof or an accessory thereto that unreasonably disturbs the peace, quiet, comfort or repose of a person;

(f) a noise or sound from orcaused or created by a steam, electric or air whistle or a horn attached to or used in connection with any stationary boiler, machine or other mechanism or apparatus that unreasonably disturbs the peace, quiet, comfort or repose of a person, except where such sound is given as a warning of danger;

(g) a noise or sound from or caused or created by a stationary steam or internal combustion engine or a device, apparatus or machine operated by compressed air or gas, gas, electricity or atomic reactor that unreasonably disturbs the peace, quiet, comfort or repose of a person.

(h) a noise or sound occurring at any time between 9:00 o'clock p.m. of any day and 7:00 o'clock a.m. of the day next following, from any excavation, building or construction work, including without limitation of the generality of the foregoing, the erection, demolition, alteration or repair of any building or structure under a permit therefor issued by the Chief Building Inspector, except in the event of an emergency and then only under the authority of a permit from the Chief Building Inspector;

(i) a noise or sound in the vicinity of a school, seminary of learning, court, hospital, convalescent home or rest home if such noise interferes unreasonably with the conduct or operation thereof, provided conspicuous signs are displayed in or upon streets in such vicinity indicating that the area is a zone of quiet;

(j) a noise or sound from or about a vehicle and caused or created by or from a person, animal, bird, article or thing in or on such vehicle that unreasonably disturbs the peace, quiet, comfort or repose of a person;

(k) a noise or sound caused or created by the use or operation of any drum, horn, bell, television set, phonograph or mechanical loudspeaker, or other instrument or device or sound-producing, sound-reproducing or sound-transmitting instrument or apparatus whatever for the purpose of advertising or for attracting attention to any performance, show or sale or display of goods, wares or merchandise or that projects noise or sound into any street or other public place;

(l) a noise or sound caused or created by the use or operation of any radio or mechanical loudspeaker or amplifier or other instrument or device or sound-producing, sound-reproducing or sound-transmitting instrument or apparatus whatever in or upon a vehicle, except for such length of time and under such conditions as Council may by resolution prescribe;

(m) crying, shouting or speaking loudly in or adjacent to any street or other public place.

4. This by-law shall not apply to:

(a) the use or operation, in a public park or other public place or any other commodious space in connection with any gathering, public election meeting or public celebration, of a loudspeaker, amplifier or other instrument, device or apparatus for the amplification of a sound, provided that written permission therefor has first been obtained as prescribed by resolution of Council;

(b) a parade, provided that written permission therefor has first been obtained from the Board of Commissioners of Police for The Municipality of Metropolitan Toronto;

(c) a newsboy, peddler, hawker or petty tradesman plying his calling legally and in a moderate manner;

(d) a siren, horn or bell of a police or fire department vehicle, ambulance, or public emergency vehicle in course of duty or vital necessity.

(e) the operation of a railway that operates under and in conformity with the Railway Act of Canada or a plant or work in connection with any such railway;

(f) a case of public convenience or necessity;

(g) the operations of the Salvation Army as heretofore carried on;

(h) construction or other work carried on by the Corporation or directed or required by the Commissioner of Works or the Chief Building Inspector.

5. Every person convicted of a breach of any of the provisions of this by-law shall forfeit and pay, at the discretion of the convicting magistrate, a fine of not more than $300, exclusive of costs for each offence.

6. By-law Number 5126, as amended, of the former Township of East York and By-law Numbers 939 and 1736 of the former Town of Leaside be and are hereby repealed.

FIRST AND SECOND READINGS: June 26th, 1967.

D. M. TUCKER — TRUE DAVIDSON

Clerk. — Mayor.

THIRD AND FINAL READING: June 26th, 1967.

D. M. TUCKER — TRUE DAVIDSON

Clerk. — Mayor.

Bill No. 245

THE CORPORATION OF THE
BOROUGH OF EAST YORK

BY-LAW NO. 245

To amend By-law No. 98, entitled
"To prohibit or regulate noises".

The Council of The Corporation of the Borough of East York HEREBY ENACT as follows:

1. The introductory portion of section 3 of By-law No. 98, entitled "To prohibit or regulate noises", be and is hereby amended by striking out "1" in the first line and "limitations" in the second line and inserting in lieu thereof "2" and "limitation" respectively, so that such introductory portion shall read as follows:

> "3. For the purposes of subsection (e) of section 2 of this by-law the following noises or sounds shall, without limitation of the generality of such subsection, be deemed to be noises likely to disturb the inhabitants of the Borough of East York:"

FIRST AND SECOND READINGS: August 13th, 1968.

D. M. TUCKER. TRUE DAVIDSON.

Clerk. Mayor.

THIRD AND FINAL READING: August 13th, 1968.

D. M. TUCKER. TRUE DAVIDSON.

Clerk. Mayor.

APPENDIX D

NEW YORK CITY NOISE-CONTROL ORDINANCE

OF 1972

GENERAL ORDER CALENDAR

G.O. No. 67—Int. No. 661-A

Report of the Committee on Environmental Protection in Favor of Adopting, as amended, a Local Law to Amend the Administrative Code of The City of New York, in Relation to Noise Control.

REPORT TO THE COUNCIL

REPORT OF THE COMMITTEE ON ENVIRONMENTAL PROTECTION WHICH FAVORED THE ADOPTION OF THE NOISE CONTROL CODE

COMMITTEE ON ENVIRONMENTAL PROTECTION

THEODORE S. WEISS, *Chairman*

EDWARD V. CURRY
BERTRAM R. GELFAND
WALTER WARD
CAROL GREITZER
CARTER BURDEN
MICHAEL DeMARCO
HOWARD GOLDEN
LEON A. KATZ
ROBERT I. POSTEL
THEODORE SILVERMAN
EUGENE F. MASTROPIERI
MORTON POVMAN
A. JOSEPH RIBUSTELLO
KENNETH HABER

EX-OFFICIO

SANFORD D. GARELIK, *President*
THOMAS J. CUITE, *Vice Chairman and Majority Leader*
ELDON R. CLINGAN, *Minority Leader*

Blaise Parascandola, *Counsel*

June 28, 1972

The Committee on Environmental Protection, to which was referred on July 13, 1971 (Minutes, page 89), respectfully REPORTS:

INTRODUCTION

As set forth in the "Declaration of Policy," (§ 1403.3-1.05) the aim of this legislation is to preserve, protect and promote the public health, safety and welfare and the peace and quiet of the inhabitants of the city. It is further stated as a matter of policy that the making, creation or maintenance of excessive or unnecessary noises is a menace to the public. The nature and extent of that menace is in the process of being defined in increasingly clearer fashion by scientific researchers and physicians.

No one questions the absolute fact that a continued exposure to noise beyond certain measurable levels will create partial or total deafness; nor the fact that far too many New Yorkers are subjected to these deafening noise levels. It has also been established beyond question that noise causes tension and nervous fatigue, headaches, depression and irritability. What is most frightening, however, is the apparent contribution which excessive noise makes toward the causation of heart, respiratory and digestive disorders.

Every indication available suggests that the problem has been growing more and more critical over the years. New Yorkers are being subjected to more noise from more sources more of the time than ever before. At the same time, noise prevention and noise abatement efforts by government and big industry have been sparse and sporadic at best. With rare exception, governmental effort is pressed only until economic or political influence is brought into opposition. As for industry, far too often, the very statement of support, upon closer examination turns out to be opposition in disguise. Again, even in its own purchase, contract and enforcement policies, as well as in general attitude, governmental action belies the noble words trotted out for public

consumption. The citizen, too, both alone and in combination often fails to appreciate his responsibility for reducing noise poilution.

And yet, it has been the individual New Yorker who has indicated that he will no longer tolerate the awful noises to which he has been subjected. It is his outcry and his support which have been responsible for the enactment of this legislation. His continued support for both enforcement and further development of this law must be sought and encouraged.

This legislation is in many ways just a beginning. In a number of areas, for example, we have mandated studies and called for legislative recommendations based upon those studies. In some other areas we are admittedly feeling our way; we believe we have taken first steps which can be fully justified and will serve as a sound foundation upon which to expand the law.

While this is probably the most comprehensive and advanced noise control legislation in the country, we believe that it is fair, practical and enforceable. With cooperative effort on the part of all New Yorkers, this new law can help provide the peace and quiet which we believe to be essential for a healthy environment.

This proposed local law, Intro. No. 661—the noise control code, was introduced in the Council on July 13, 1971.

The Committee on Environmental Protecton held a public hearing on September 9, 1971, followed by a public hearing on October 6, 1971. Subsequent thereto, the committee held 3 executive sessions, the last being on April 28, 1972, at which many of the proposed amendments were discussed. On May 31, June 1, and June 7, 1972, the committee held 3 open meetings at which the affected parties, industry, labor, utility groups were present, as well as the environmental protection administration. Following these 2 meetings, the committee held 3 executive sessions, the last being on June 28, 1972, at which the amendments were adopted.

There follows a technical analysis of the significant provisions of the noise control code as amended by the committee on environmental protection at its meeting of June 28, 1972.

ANALYSIS

This proposed local law, Intro. No. 661, as originally introduced has had many of its provisions significantly amended.

Most of these significant amendments are presented herein. There are, however, many other amendments, clarifying language changes and corrections. An attempt has been made to single out those noise control provisions of major significance to the public, as well as industry and labor; thus many amendments of a highly technical and of acoustical engineering nature are not included in this report (i.e., definition of "Sound Pressure Level").

An analysis of these significant amendments to articles I through IX, sections 1403.3-1.03 et seq. and sections 1403.2-15.03 and 15.13 of the administrative code of the City of New York, as well as Section 1404 of the New York city charter are presented herewith.

ARTICLE I—Policy and general definitions

§ 1403.3-1.03 Declaration of policy

While section 435-5.0 of the administrative code (existing noise code) is being repealed the Police Department as well as the Environmental Protection Administration will have the jurisdiction to enforce the noise control code.

§ 1403.3-1.05 General definitions

"Aircraft," "Airport"—definitions of aircraft and airport are being added in line with the amendment proposed in article V requiring that within one year from the effective date of the code, the administrator shall submit to the council for proposed enactment allowable sound levels and ambient noise quality standards with respect to noise generated by airports and aircraft using airports within the city of New York.

"Construction"—The definition of construction encompasses all forms of this activity in connection with the erection and demolition of buildings as well as highways, roads, parks, utility lines but excepts tunneling activity (see separate definition of tunneling).

"Railroad"—Railroad, other than a rapid transit railroad, is defined separately to reflect the proposed amendment in article V requiring the administrator to submit to the Council within one year from the date of enactment of the code allowable sound levels and acoustical performance for new and existing railroads. These standards are to cover not only the operation of the railroad's rolling stock but its tracks, bridges, tunnels, stations, yards and terminal facilities.

"Sound level meter"—is changed from "sound level appartus" and means any instrument for the measurement of noise and which complies with standards established by the American National Standards Institute (ANSI) specifications. Reference to

ANSI criteria were made at the suggestion of the Committee. Thus the technical definitions of the various aspects of sound and noise as amended are in conformity with ANSI terminology.

"Tunneling"—a separate definition of tunneling activity encompasses the construction of tunnels including the sinking of shafts and the surface activities required to sink the shafts and construct the tunnel.

ARTICLE II—General provisions

§ 1403.3-2.09 Registrations

The administrator may require written registration of the following devices: Air compressors, paving breakers, refuse compacting vehicles and rapid transit railroads including rolling stock, tracks, stations, tunnels, elevated structures, yards and garages.

As introduced, this section would have required the registration of any power-driven device with a sound level in excess of 40 db(A). The committee proposes to restrict the operation of this section to devices which could be regulated by the code.

§ 1403.3-2. Variances

This section is being deleted in its entirety inasmuch there is provision for variances under Article 4 of the code Section 4.11(b) allows for variances from the limitation on construction hours wherein the variance is granted by the city agency supervising the work (i.e., Departments of Buildings, Highways), subject to revocation by the Environmental Control Board; that section would also be applicable to a Fire Department special permit for a variance of the limitation on the hours of blasting pursuant to section C19-36.0(d) [see § 7.01(e)]. As amended, section 4.11(b) permits variances only in the case of urgent necessity in the interest of public safety. Thus, that revision is not only more restrictive for construction hours but at the same time eliminates the need for a variance based on unreasonable hardship with respect to the other regulatory sections of the code.

§ 1403.3-2.25 Noise abatement contract compliance

This section has been added to provide that any contract funded out of the capital budget of the city of New York, shall include certain provisions to insure compliance with the noise control code, i.e.:

1. Devices and activities which will be operated or conducted or constructed or manufactured under the contract must not cause a violation of the code.

2. Such devices and activities incorporate advances in the art of noise control. There is an overall proviso to the effect that any regulation promulgated by the administrator with regard to noise control, subsequent to the award of such a contract, shall not alter the terms, conditions and specifications of the contract.

§ 1403.3-2.27 Exemptions

An exemption from the provisions of this code was added to apply to the operation or use of any organ, bell or chimes by any church, synagogue or school.

ARTICLE III—Prohibited noise

§ 1403.3-3.01 Unnecessary noise—general prohibition

This section remains as introduced and codifies the common law prohibition against unnecessary noise.

ARTICLE IV—Prohibited noise—Unnecessary noise standard

§ 1403.3-4.03 Sound reproduction device

The ambient noise prohibition against the operation of a sound reproduction device has been extended to apply to the use of such devices for commercial or business advertising purposes, or for the purpose of attracting attention to any show or sale, or display of merchandise in connection with such enterprises, including those engaged in the sale of radios, televisions, phonographs, records or tapes.

The prohibition of this section shall not be applicable to incidental sounds emanating from a licensed sporting or public or entertainment event.

In addition, this section has been expanded to prohibit the operation of any radio, phonograph or tape recorder on any rapid transit railroad, omnibus or ferry in such a manner that the sound emanating from these sound reproduction devices is audible to another person.

§ 1403.3-4.05 Sound signal devices

Paragraph (4) has been amended to provide that any burglar alarm attached to a motor vehicle shall terminate its operation within 10 minutes of its activation and that any member of the New York city police department shall have the right to disconnect such burglar alarm during the period of its activation, and further, that any such motor vehicle shall have prominently displayed the telephone number at which the owner may be communicated with.

Paragraph (5) has been added to this section to provide that any sound signal device, attached to a motor vehicle, wagon, or cart from which wares are sold, shall not emit a sound signal of more than 10 seconds, more frequently than once every 10 minutes in any one city block.

§ 1403.3-4.11 Construction activities

Subdivision (a)—Limitation on the permissible hours of construction—The limitation on the permissible hours of construction for all residential, commercial or manufacturing zones have been changed to the hours of 7 a. m. to 6 p. m. for each of these zoning districts.

Subdivision (b)—The grounds for variances granted by city agencies supervising construction work (the Departments of Buildings and Highways) has been changed from "where no harm to the public health and comfort will result and benefit to the public interest will result" to "in the case of urgent necessity in the interest of public safety"; such variances may be granted for any necessary period of up to three days and may be renewed for such period as long as such urgent necessity continues, and shall be subject to revocation by the Environmental Control Board.

The effect of this amendment would be to continue to apply the standard for granting variances that existed under the previous noise code (§135.0-5.0 (b)7 of the administrative code which would be repealed by this local law.) The difference, however, under the new noise control code is that the grant of the variance by the supervising city agency (Department of Buildings, Highways or Water Resources) would be subject to review and possible revocation by the Environmental Control Board.

Thus, the administrative determination of what is an urgent necessity in the interest of public safety (i.e. failure of public utility, water or sewer service, construction or building hazard) would continue to be made by the city agency under whose jurisdiction the work is performed. This determination would be arrived at in accordance with the previous practice and procedures of each city department in defining urgent necessity and whether there exists a reasonable relationship to the public safety, at the same time being mindful of the ill effects of noise disturbance. The Environmental Control Board would now review this determination in accordance with applicable rules of law governing review of decisions by administrative agencies.

In the case of any emergency as defined by the code, construction activities directly connected with the abatement of such emergency may be undertaken without a variance and may proceed for a period of up to 12 hours.

ARTICLE V—Prohibited noise—Sound level standard

§ 1403.3-5.03 Motor vehicles

Allowable sound levels (decibels) in connection with the operation of motor vehicles, including trucks and motor cycles have been added as set forth below.

	Speed limit of 35 mph or less	Speed limit of more than 35 mph
dB(A) measured at a distance of 25 feet (city street)		
(1) Any motor vehicle with a manufacturer's gross vehicle rating of 8,000 pounds or more and any combination of vehicles towed by such motor vehicle	86 db(A)	90 db(A)
(2) Any motorcycle other than a motor-driven cycle		
before January 1, 1978	82 db(A)	86 db(A)
after January 1, 1978	78 db(A)	82 db(A)
(3) Any other motor vehicle and any combination of vehicle towed by such motor vehicle		
before January 1, 1978	76 db(A)	82 db(A)
after January 1, 1978	70 db(A)	79 db(A)
dB(A) measured at a distance of 50 feet (highway)		
(1) Any motor vehicle with a manufacturer's gross vehicle rating of 8,000 pounds or more and any combination of vehicle towed by such motor vehicle	92 db(A)	96 db(A)
(2) Any motorcycle other than a motor-driven cycle		
before January 1, 1978	88 db(A)	92 db(A)
after January 1, 1978	84 db(A)	88 db(A)
(3) Any other motor vehicle and any combination of vehicles towed by such motor vehicle		
before January 1, 1978	82 db(A)	88 db(A)
after January 1, 1978	76 db(A)	85 db(A)

§ 1403.3-5.05 Aircraft

One year from the effective date of the code the administrator shall submit to the council for enactment allowable sound levels and ambient noise quality criteria and standards for areas affected by noise generated by aircraft using airports in the City of New York. The sound levels and ambient noise quality criteria and standards shall be developed in accordance with methodology for controlling and abating airport noise as set forth in this section.

§ 1403.3-5.07 Rapid transit railroads

The provision is subdivision (a) permitting existing rapid transit railroads to attain only those allowable sound levels requiring no additional expenditures has been deleted. As a result, one year from the effective date of the code the administrator shall submit to the council for enactment allowable sound levels and acoustical performance standards for the operation of both new and existing railroads including existing rolling stock, track, stations, tunnels, elevated structures, yards, depots and garages.

§ 1403.3-5.09 Railroads

One year from the effective date of the code the administrator shall submit to the council for enactment allowable sound levels and acousticals performance standards for the operation of new and existing railroads including its rolling stocks, bridges, ferries, tunnels, tracks, stations, yards and terminal facilities. The allowable sound levels and acoustical performance standards shall be based on the latest economically feasible and available technology for noise abatement in railroads and on the latest scientific knowledge useful for indicating the effects on public health, welfare, safety and comfort which can be expected from noises generated by railroads.

§ 1403.3-5.11 Air compressors

Subdivision (a)—30 days from the effective date of the code, there shall be installed on all air compressors manufactured prior to December 31, 1972, a muffler certified to provide a dynamic insertion loss of 20 decibels dB(C) of the sound released from the exhaust source of the air compressor.

Subdivision (b)—after the effective dates set forth below, all air compressors manufactured prior to December 31, 1972, when operated, shall not exceed the specified allowable sound levels at a distance of one meter.

Effective date	Allowable sound level
December 31, 1972	90 dB(A)
June 30, 1974	80 dB(A)

Subdivision (c)—all air compressors manufactured after the effective dates set forth below, shall not exceed the specified sound levels at a distance of one meter.

Effective date	Allowable sound level
December 31, 1972	85 dB(A)
June 30, 1974	75 dB(A)
December 31, 1975	70 dB(A)

§ 1403.3-5.13 Circulation devices

After the effective date of this code, all circulation devices of air conditioning equipment shall not create a sound level in excess of 45 dB(A) when measured inside the dwelling unit affected in a line with the window nearest the exterior face of such circulation device. The measurement shall be taken with the window fully open at a point three feet inside the room. This revision, in effect, adopts the standard of the building code, which is applicable to new construction, to existing buildings.

§ 1403.3-5.15 Refuse compacting vehicles

The allowable sound standard of 70 dB(A) measured at a distance of 10 feet for refuse compacting vehicles, shall apply only to such vehicles manufactured after December 31, 1974.

§ 1403.3-5.17 Motor vehicle claxons

All motor vehicles of model year 1974 and thereafter, shall be equipped with a claxon (horn) which does not create a sound level in excess of 75 dB(A) at a distance of 25 feet; provision is made to permit the use of a city-country horn to meet the higher noise levels of highway driving.

§ 1403.3-5.19 Emergency signal device

The requirement that an emergency signal device shall not create a sound level in excess of 90 dB(A) at a distance of 50 feet is to be effective as of June 30, 1973.

§ 1403.3-5.21 Paving breakers

Subdivision (a)—30 days from the enactment of the code, there shall be installed on all pneumatically operated paving breakers manufactured prior to December 31, 1973, a muffler certified to provide a dynamic insertion loss of 5 decibels dB(A) of the sound released from the air discharge.

Subdivision (b)—all paving breakers manufactured after December 31, 1973, shall not exceed the specified sound levels on the effective dates set forth below, at a distance of one meter.

Effective date	94 dB(A)
December 31, 1973	90 dB(A)
December 31, 1975	Allowable sound level

ARTICLE VI—Ambient noise quality zones, criteria and standards

§ 1403.3-6.01, 6.02—These sections remain unchanged and provide that the Administrator shall submit to the Council within two years of enactment of the code ambient noise quality zones for the entire city, along with noise criteria and standards appropriate to each zone. Following the establishment of such zones and standards, the Administrator may then, by regulation, promulgate allowable sound levels for specific devices and activities within each zone.

ARTICLE VII—Certificates and tunneling permits

§ 1403.3-7.01—This section sets forth the requirements for the granting of operating certificates and tunneling permits and remains substantially unchanged except for the requirements and conditions governing the granting of tunneling permits.

Of note are the following subdivisions.

§ 7.01 (d)—provides that the agency of the city advertising the tunneling contract shall include in such contract specifications, the conditions under which the tunneling permit shall be granted after such agency requests and is furnished with a statement of such conditions by the administrator.

§ 7.01 (e)—Notwithstanding the existence of a valid tunneling permit, blasting operations shall be conducted only between the hours of 7 a. m. and 7 p. m. on weekdays unless a special permit from the Fire Department has been obtained pursuant to Section C19-36.0(d). This subdivision would be subject to the applicable provisions of Section 4.11(b).

ARTICLE VIII—Enforcement

§ 1403.3-8.01 through 8.25

Except for the civil penalties provision (§ 8.01) (5) and the citizen complaint section (§ 8.09) from which certain activities have been exeluded, the sections of this article have been revised to parallel the enforcement provisions of the air pollution control code. § 8.03 (c) now provides that a quorum of the Environmental Control Board shall be five members of the board, two of which are non-city officials.

§ 1403.3-8.01 Civil penalties

Civil penalties in the noise control code range from $50 for the improper use of sound reproduction devices to $1,000 for unauthorized construction activities prior to 7 a. m. and after 6 p. m.

§ 1403.3-8.25 Criminal penalties

1. Any violation of an order of the administrator or the Environmental Control Board or for failure to have an operating certificate or tunneling permit can result in a penalty of $50 but not more than $500 ($2,000 in the case of a corporation) or by imprisonment not to exceed 30 days.

2. Conviction of a willful failure to pay a civil penalty can result in a fine of up to $1,000 ($2,000 in the case of a corporation) or by imprisonment of not more than 60 days, or by both.

3. Conviction for a third or subsequent offenses against the code can result in fines of up to $5,000 or by imprisonment of not more than 4 months.

4. Any person who knowingly makes a false statement or falsifies any certification, registration, application or report under the provisions of the noise control code shall be guilty of a misdemeanor and shall be punished by a fine of not less than $100 nor more than $1,000 or by imprisonment not to exceed 5 months, or both.

ARTICLE IX—Budgetary Authorization

This article has been deleted in its entirety since not deemed within the scope of the noise control code.

NEW YORK CITY CHARTER, CHAPTER 57, ENVIRONMENTAL PROTECTION ADMINISTRATION

An amendment to section 1404 (d) of chapter 57 of the New York City charter has been included in Intro. No. 661 by action of the Committee on Environmental Protection.

This section which sets up the Environmental Control Board (ECB) to consist of nine members (five city officials, four non-city members) has been amended to provide that in addition to one non-city member being an air pollution expert and the second being a water pollution expert, a third non-city member shall be a noise pollution control expert.

EFFECTIVE DATE

The effective date of this proposed local law has been changed to September 1, 1972, except that October 1, 1972 shall be the effective date for sections 1403.3-8.03 (c) and 1403.2-15.03 (requirement of a five member quorum of the ECB) and section 1404 (d) of the New York City charter (requirement of one non-city member of the ECB being a noise pollution control expert).

Accordingly your committee recommends its adoption as amended.

A LOCAL LAW to amend the administrative code of the city of New York, in relation to noise control.

Be it enacted by the Council as follows:

Section 1. Section 435-5.0 of title A of chapter 18 of the administrative code of the city of New York is hereby repealed.

2. The administrative code of the city of New York is amended by adding to chapter 57 thereof, a new part III which is to read as follows:

ARTICLE I

SHORT TITLE, POLICY AND GENERAL DEFINITIONS

Section 1403.3—1.01 Short title

This local law shall be known as the New York city noise control code.

Section 1403.3—1.03 Declaration of policy

It is hereby declared to be the public policy of the city to reduce the ambient noise level in the city, so as to preserve, protect and promote the public health, safety and welfare, and the peace and quiet of the inhabitants of the city, prevent injury to human, plant and animal life and property, foster the convenience and comfort of its inhabitants, and facilitate the enjoyment of the natural attractions of the city. It is the public policy of the city that every person is entitled to ambient noise levels that are not detrimental to life, health and enjoyment of his property. It is hereby declared that the making, creation or maintenance of excessive and unnecessary noises within the city affects and is a menace to public health, comfort, convenience, safety, welfare and the prosperity of the people of the city. For the purpose of controlling and reducing such noises, it is hereby declared to be the policy of the city to set the unnecessary noise standards and decibel levels contained herein and to consolidate certain of its noise control legislation into this code. The necessity for legislation by enactment of the provisions of this local law is hereby declared as a matter of legislative determination.

The code shall be liberally construed so as to effectuate the purposes described in this section. Nothing herein shall be construed to abridge the emergency powers of the board of health or the right of the department of health to engage in any of its necessary or proper activities. Nothing herein shall abridge the powers and responsibilities of the police department to enforce the provisions of this code.

Section 1403.3—1.05 General definitions

When used in the New York city noise control code:

(a) *"A" level* means the total sound level of all noise as measured with a sound level meter using the "A" weighting network. The unit of measurement is the dB(A).

(b) *Activity* means any act or combination of acts which actually results in the production of sound.

(c) *Administrator* means administrator of the environmental protection administration. istration.

(d) *Administration* means the environmental protection administration.

(e) *Air compressor* means a device which draws in air or gas, compresses it, and delivers it at a higher pressure.

(f) *Aircraft* means any device that is used or intended to be used for flight in the air but does not include any such device used only in the service of a government or political subdivision thereof unless such device is engaged in carrying persons or property for commercial purposes. Aircraft includes but is not limited to:

1. subsonic transport aircraft;
2. subsonic turbojet-powered aircraft;
3. aircraft capable of flying at supersonic speeds;
4. rotorcraft;
5. vertical take-off and landing aircraft (VTOL aircraft);
6. short take-off and landing aircraft (STOL aircraft); and
7. aircraft capable of landing or taking off on water.

(g) *Air horn* means a device intended to produce a sound signal by means of compressed air or gas or exhaust gas.

(h) *Airport* means an area of land or water that is used or intended to be used for the landing and takeoff of aircraft, and includes its building and facilities, if any.

(i) *Ambient noise* means the all-encompassing noise associated with a given environment, being usually a composite of sounds from many sources near and far.

(j) *Apparatus* means any mechanism which prevents, controls, detects, measures or records the production of sound.

(k) *Authorized emergency vehicle* means every ambulance and every vehicle operated by a police department, fire department, fire patrol, chief or assistant chief of a fire department, county or deputy county fire co-ordinator, county or assistant county fire marshal, sheriff, or by a chief, assistant chief or deputy chief of a police department, a regular paid deputy sheriff or a motor vehicle of the New York city housing authority when engaged in the performance of duty as a peace officer, or by an authorized public utility company when on emergency calls, every state-owned vehicle operated by a law enforcement officer of the conservation department when engaged in performance of duty in enforcement of the conservation law, and every vehicle operated by a bridge authority or bridge and tunnel authority when on emergency calls.

(l) *Board* means the environmental control board of the city of New York.

(m) *Building* means a building as defined in sub-article 201.0 of part II of title C of chapter 26 of the administrative code.

(n) *Building aperture* means any designed opening in a building to which a person may reasonably have access includng but not limited to any door, gate, window, skylight or hatch.

(o) *Burglar alarm* means any sound signal device designed and intended to produce a sound signal upon unauthorized entrance by a person into a building or motor vehicle.

(p) *"C" level* means the total sound level of all noise as measured with a sound level meter using the "C" weighting network. The unit of measurement is the dB(C).

(q) *Certificate* means an operating or temporary operating certificate.

(r) *Charter* means the charter of the city of New York including all of its amendments.

(s) *Circulation device* means any device which circulates a gas or fluid, including but not limited to any air conditioner, pump, cooling tower, fan or blower.

(t) *Claxon* means any manually, mechanically, or electrically powered device, other than an emergency signal device, including but not limited to a motor vehicle horn, which is intended to, and when operated actually does, emit a sound signal.

(u) *Code* means the New York city noise control code.

(v) *Construction* means any or all activity, except tunneling, necessary or incidental to the erection, demolition, assembling, altering, installing or equipping of buildings, public or private highways, roads, premises, parks, utility lines including such lines in already-constructed tunnels, or other property, including land clearing, grading, excavating and filling.

(w) *Construction device* means any device designed and intended for use in construction including, but not limited to any air compressor, pile driver, manual tool, bulldozer, pneumatic hammer, steam shovel, derrick, crane, steam or electric hoist.

(x) *Construction material* means any material, regardless of composition, designed and customarily used in construction including but not limited to any rails, pillars, columns, beams, bricks, flooring, wall, ceiling or roofing material, gravel, sand, cement or asphalt.

(y) *Container* means any receptacle, regardless of contents, manufactured from wood, metal, plastic, paper or any other material including but not limited to any barrel, basket, box, crate, tub, bottle, can or refuse container.

(z) *Decibel.* The decibel is one-tenth of a bel. Thus, the decibel is a unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power.

(aa) *Device* means any mechanism which is intended to or which actually produces sound when operated or handled.

(bb) *Dwelling* means any building occupied in whole or in part as the temporary or permanent residence of one or more natural persons.

(cc) *Dynamic insertion loss* means the difference between two sound pressure levels which are measured at the same point in space before and after a muffler is inserted between the measurement point and the sound source under operating conditions.

(dd) *Emergency* means a public calamity or an exposure of any person or property to imminent danger.

(ee) *Emergency signal device* means any gong, siren whistle, or siren or any air horn or any similar device the use of which on authorized emergency vehicles is permitted by subdivision 26 of section 375 of the vehicle and traffic law.

(ff) *Exhaust source* means a system which removes and transports air or gas from a device.

(gg) *Internal combustion engine* means a device for the production of energy by means of the combustion under pressure of fossil fuel.

(hh) *Motor vehicle* means any device which is propelled by an engine in or upon which a person or material may be transported on the ground and which is intended to be operated upon a public highway.

(ii) *Muffler* means an apparatus generally consisting of but not limited to a series of chambers or baffles for the purpose of transmitting gases while reducing sound levels.

(jj) *Noise* means an erratic, intermittent, or statistically random oscillation.

(kk) *Owner* means and includes the owner of the freehold of the premises or lesser estate therein, or mortgagee thereof, a lessee or agent of any of the above persons, a lessee of a device or his agent, a tenant, operator, or any other person who has regular control of a device or an apparatus.

(ll) *Paving breaker* means any powered construction device intended to cut or trench pavement, subbase macadam, gravel, concrete or hard ground.

(mm) *Person* means any individual, partnership, company, corporation, association, firm, organization, governmental agency, administration or department, or any other group of individuals, or any officer or employee thereof.

(nn) *Railroad* means a railroad, other than a rapid transit railroad or street railroad, operated for public use in the conveyance of persons or property for compensation, with all bridges, ferries, tunnels, equipment, switches, spurs, tracks, stations and terminal facilities used, operated or owned by or in connection therewith.

(oo) *Rapid transit railroad* means a rapid transit railroad used for local service in the transportation of passengers as a common carrier for hire together with the appurtenances, facilities and equipment thereof.

(pp) *Refuse compacting vehicle* means a motor vehicle designed to compact and transport refuse.

(qq) *Sound* means an oscillation in pressure, stress, particle displacement, particle velocity, etc., in a medium with internal forces (e.g., elastic, viscous), or the superposition of such propagated oscillation which evokes an auditory sensation.

(rr) *Sound level meter* means any instrument including a microphone, an amplifier, an output meter, and frequency weighting networks for the measurement of noise and sound levels in a specified manner and which complies with standards established by the american national standards institute specifications for sound level meters S1.4-1971, as amended.

(ss) *Sound pressure level (decibels)* means a sound that is 20 times the logarithm to the base 10 of the ratio of the pressure of the sound to the reference pressure, 2×10^{-4} microbars.

(tt) *Sound reproduction device* means a device intended primarily for the production or reproduction of sound including, but not limited to any musical instrument, radio receiver, television receiver, tape recorder, phonograph or sound amplifying system.

(uu) *Sound signal* means any sound produced by a sound signal device designed to transmit information.

(vv) *Sound signal device* means a device designed to produce a sound signal when operated including but not limited to any claxon, air horn, whistle, bell, gong, siren, but not an emergency signal device.

(ww) *Sound source* means any activity or device as herein defined.

(xx) *Tunnel* means an underground passage which is intended for use as a railway, aqueduct, road, sewer or major utility artery.

(yy) *Tunneling* means any activity necessary or incidental to the construction of any tunnel, including the sinking of shafts to tunnel or to an intermediate level and the surface activities required to sink the shafts and construct the tunnel.

(zz) *Unnecessary noise* means any excessive or unusually loud sound or any sound which either annoys, disturbs, injures or endangers the comfort, repose, health, peace or safety of a person, or which causes injury to plant or animal life, or damage to property or business.

(aaa) *Zone* means any zone as defined in the zoning resolution of the city of New York, except that zone shall not mean any ambient noise quality zone under article V or article VI of this code or any noise sensitive zone under article IV of this code.

ARTICLE II

GENERAL PROVISIONS

Section 1403.3—2.01 **General powers of the administrator**

Subject to the provisions of this code, the administrator may take such action as may be necessary to abate a sound source which causes or may cause, by itself or in combination with any other sound source or sources, an unnecessary noise. The administrator may exercise or delegate any of the functions, powers and duties vested in him or in the administration by this code.

Section 1403.3—2.03 **Investigations and studies by the administrator**

The administrator may make or cause to be made any investigation or study which in his opinion is desirable for the purpose of enforcing this code or controlling or abating an unnecessary noise. For such purposes, the administrator may make tests, conduct hearings, compel the attendance of witnesses, and take their testimony under oath and may compel the production of books, papers and other things reasonably necessary to the matter under consideration.

Section 1403.3—2.05 **Testing by order of the administrator**

(a) If the administrator has reasonable cause to believe that any device is in violation of this code, the administrator may order the owner of the device to conduct such tests as are necessary in the opinion of the administrator to determine whether the device or its operation is in violation of this code and to submit the test results to the administrator within 10 days after the tests are completed.

(b) Such tests shall be conducted in a manner approved by the administrator. If any part of the test is conducted at a place other than the site where the device is located, that part of the test shall be certified by a laboratory acceptable to the administrator. The administrator may require that the entire test results shall be reviewed and certified by a professional engineer.

(c) The owner shall notify the administrator of the time and place of a test at least seven days before the commencement of such test. Reasonable facilities shall be made available for the administrator to witness the test.

(d) If in the opinion of the administrator, tests by the administration are necessary, the administrator may order the owner to provide such access to the device as the administrator may reasonably request, to provide a power source suitable to the points of testing, and to provide allied facilities, exclusive of sound level meter. These provisions shall be made at the expense of the owner of the device. The owner shall be furnished with copies of the analytical results of the data collected.

Section 1403.3—2.07 **Inspection**

(a) The administration may inspect at any reasonable time and in a reasonable manner any device which creates or may create unnecessary noise including but not limited to the premises where the device is used.

(b) The administration may inspect at any reasonable time and in a reasonable manner any record relating to a use of a device which creates or may create unnecessary noise.

(c) No person shall refuse entry or access into the public areas of a multiple dwelling or a place of business to an authorized employee of the administration who presents appropriate credentials nor shall any person refuse entry or access into any other portion of a premise to an authorized employee of the administration who presents appropriate credentials and a search warrant.

Section 1403.3—2.09 **Registrations**

(a) The administrator may require the written registration of air compressors, paving breakers, refuse compacting vehicles and rapid transit railroads, including but not limited to its rollig stock, track and trackbeds, passenger stations, tunnels, elevated structures, yards, depots and garages. A period of 60 days shall be allowed for the filing of such registration. However, in cases of emergency, the administrator may designate a shorter period of time.

(b) Registration shall be made on forms furnished by the administration. The forms may require information concerning the device covered by the registration, the sound level caused by the device or any additional information required by the administrator for the purpose of enforcing this code. The registrant shall maintain the registration in current status by notifying the administration of any change in any item of information furnished in compliance with this subsection within a reasonable time not exceeding 30 days after the change is made.

(c) Registration shall be made by the owner of the device. If a registrant is a partnership or group other than a corporation, the registration shall be made by one individual who is a member of the group. If the registrant is a corporation, the registration shall be made by an officer of the corporation.

Section 1403.3—2.11 **Interfering with or obstructing administration personnel**

No person shall interfere with or obstruct the administrator or any administration employee in carrying out any duty for the administrator or the board.

Section 1403.3—2.13 **False and misleading statements; unlawful reproduction or alteration of documents**

(a) No person shall knowingly make a false or misleading statement or submit a false or misleading document to the administration as to any matter within the jurisdiction of the administration.

(b) No person shall make, reproduce or alter or cause to be made, reproduced or altered a tunneling permit, certificate or other document issued by the administrator or

required by this code if the purpose of such reproduction or alteration is to evade or violate any provision of this code or any other law.

Section 1403.3—2.15 **Display of permits, certificates and other notices; removal or mutilation prohibited**

Any tunneling permit or certificate required by this code shall be displayed in the vicinity of the device on the premises designated on the tunneling permit or certificate or in the vicinity of the place where the device will be operated or supervised.

Section 1403.3—2.17 **Enforcement of code by other than compulsory means**

Nothing in this code shall prevent the administrator from making efforts to obtain voluntary compliance by way of warning, notice or educational means. However, such non-compulsory methods need not be used before proceeding by way of compulsory enforcement.

Section 1403.3—2.19 **Service of papers**

(a) Service of any written notice, order or decision required by this code shall be made on the owner as follows:

(1) Either by mailing the notice, order or decision directed to the owner of the device at the address listed in his application, tunneling permit or operating certificate or at the address where the device is located; or

(2) By leaving the notice, order or decision with the owner of the device, or if the owner is not an individual, with a member of the partnership or group concerned or with an officer or managing agent of the corporation.

(b) Service of any written notice, order or decision required by this code shall be made on a person:

(1) Either by mailing the notice, order or decision directed to the person at his principal place of business; or

(2) By leaving the notice, order or decision with the person, or if the person is not an individual, with a member of the partnership or group concerned, or with an officer or managing agent of the corporation.

(c) Service of any written notice required by this code shall be made on the administration, administrator or board as follows:

(1) Either by mailing the notice to the administrator; or

(2) By leaving the notice at the administration with an employee of the administration designated for this purpose.

Section 1403.3—2.21 **Inconsistent provisions**

Insofar as the provisions of this code are inconsistent with any provision of any other chapter of the administrative code, or any rule or regulation of any governmental agency of the city of New York, the provisions of this code shall be controlling.

Section 1403.3—2.23 **Effect of invalidity in part**

If any provision of this code is declared unconstitutional or the application thereof to any person or circumstances is held invalid, the applicability of such provision to other persons and circumstances and the constitutionality or validity of every other provision of this code shall not be affected thereby.

Section 1403.3—2.25 **Noise abatement contract compliance**

(a)(1) CONTRACT. As used in this section, the term "contract" means any written agreement, purchase order or instrument whereby the city is committed to expend or does expend funds authorized by the capital budget of the city of New York in return for work, labor, services, supplies, equipment, materials, or any combination of the foregoing; however, the term "contract" shall not include:

(i) contracts for financial or other assistance made with a government;

(ii) contracts, resolutions, indentures, declarations of trust, or other instruments authorizing or relating to the authorization, issuance, award and sale of bonds, certificates of indebtedness, notes or other fiscal obligations of the city, or consisting thereof;

(iii) employment by the city of officers and employees of the city.

(2) CONTRACTING AGENCY. As used in this section, the term "contracting agency" means any board, bureau, department, commission or other agency of the government of the city of New York, or any official thereof, who or which is authorized to and does, on behalf of the city, provide for, enter into, award or administer contracts or any other public agency which enters into, awards or administers contracts pursuant to which funds authorized by the capital budget of the city of New York are expended.

(b) CONTRACT PROVISIONS. No contract shall be awarded or entered into by a contracting agency unless such contract contains provisions requiring that:

1. Devices and activities which will be operated, conducted, constructed or manufactured pursuant to the contract and which are subject to the provisions of the code will be operated, conducted, constructed or manufactured without causing a violation of the code; and

2. Such devices and activities incorporate advances in the art of noise control developed for the kind and level of noise emitted or produced by such devices and activities.

(c) REGULATIONS. The administrator may from time to time promulgate regulations setting forth such specifications for the operation, conducting, construction or manufacture of devices and activities pursuant to city contracts as he deems necessary to comply with the provisions of this section.

(d) No person shall cause or permit the operation of a device or conducting of an activity in such a way as to violate any provision of a contract required by this section or any regulation promulgated pursuant to this section.

(e) No regulation promulgated pursuant to this section shall alter the terms, conditions and specifications of a contract already executed at the time of issuance of such regulation.

Section 1403.3—2.27 **Exemptions**

The provisions of this code shall not apply to the operation or use of any organ, bell, chimes or other similar instrument by any church, synagogue, mosque or school.

ARTICLE III

PROHIBITED NOISE

General prohibition

Section 1403.3—3.01

No person shall make, continue or cause or permit to be made or continued any unnecessary noise.

ARTICLE IV

PROHIBITED NOISE

Unnecessary noise standard

Section 1403.3—4.01

Any act in violation of the provisions of this article of the code is deemed to be in violation of article III of the code, without in any way limiting the generality of the provisions of article III of the code.

Section 1403.3—4.03 **Sound reproduction devices**

(a) Except as provided in section 435-6.0 of title A of chapter 18 of the administrative code, no person shall operate or use or cause to be operated or used any sound reproducton device in such a manner as to create an unnecessary noise.

(b) No person shall operate or use or cause to be operated or used any sound reproduction device for commercial or business advertising purposes or for the purpose of attracting attention to any performance, show, or sale or display of merchandise, in connection with any commercial or business enterprise including those engaged in the sale of radios, television sets, phonographs, tape recorders, phonograph records or tapes, in front or outside of any building, place or premises, or in or through any aperture of such building, place or premises, abutting on or adjacent to a public street, park or place, or in or upon any vehicle operated, standing or being in or on any public street, park or place, where the sound therefrom may be heard upon any public street, park or place, or from any stand, platform or other structure, or from any airplane or other device used for flying, flying over the city, or on a boat or on the waters within the jurisdiction of the city, or anywhere on the public streets, parks or places. Nothing in this section is intended to prohibit incidental sounds emanating from a sporting or entertainment or a public event for which a permit under section 435-6.0 of the administrative code has been issued.

(c) No person shall operate or use any radio, phonograph, or tape recorder in or on any rapid transit railroad, omnibus or ferry in such a manner that the sound emanating from such sound reproduction device is audible to another person.

Section 1403.3—4.05 **Sound signal devices**

No person shall operate or use or cause to be operated or used any sound signal device so as to create an unnecessary noise, except that:

(1) No person shall operate or use or cause to be operated or used any claxon installed on a motor vehicle, except as a sound signal of imminent danger provided that such operation or use shall be considered in any proceeding before the board pursuant to any applicable section of article VIII of this code except section 8.25 *prima facie* evidence of a violation of this subsection and that a notice of violation shall in every instance issue against a person operating, using or causing to be operated or used a claxon installed on a motor vehicle.

(2) No person shall operate or use or cause to be operated or used an air horn installed on any motor vehicle other than as provided in section 4.09 of this code.

(3) No person shall operate or use or cause to be operated or used any steam

whistle attached to any stationary boiler except to give notice of the time to start and stop work or as a sound signal of imminent danger.

(4) On or after one year from the effective date of this code no owner of a building or of a motor vehicle shall have in operation an audible burglar alarm thereon unless such burglar alarm shall be capable of and shall automatically terminate its operation within fifteen minutes of its being activated in the case of a building and ten minutes of its being activated in the case of a motor vehicle; notwithstanding this provision, any member of the police department of the city of New York shall have the right to take such steps as may be necessary to disconnect any such alarm installed on a motor vehicle at any time during the period of its activation. On or after thirty days from the effective date of this code, any motor vehicle on which a burglar alarm has been installed shall, when parked on a public highway or parking lot open to the public, prominently display the telephone number at which communication may be made with the owner of such motor vehicle.

(5) No person shall operate or use or cause to be operated or used any sound signal device attached to a motor vehicle, wagon or manually propelled cart from which food or any other items are sold, which emits a sound signal more frequently than once every ten minutes in any one city block and with a duration of more than ten seconds for any single emission.

Section 1403.3—4.07 **Animals**

No person shall permit an animal, including a bird, under his control to cause unnecessary noise.

Section 1403.3—4.09 **Emergency signal devices**

No person shall operate or use or cause to be operated or used any emergency signal device, except on an authorized emergency vehicle when such vehicle is in the immediate act of responding to an emergency, provided that such device shall not be operated so as to create an unnecessary noise nor for a period of time longer than is strictly necessary to respond to such emergency.

Section 1403.3—4.11 **Construction activities**

(a) Except as otherwise provided in this section, no person shall engage in or permit any person to be engaged in construction activities in any zone other than on weekdays between the hours of 7 a. m. and 6 p. m.

(b) Subject to the provisions of section 8.01 of the code, an agency of the city of New York authorized under the administrative code to issue permits or licenses authorizing construction activities may, in the case of urgent necessity in the interest of public safety, issue a variance from the provisions of subdivision a of this section with respect to any such construction activity. Such variance may be granted for an initial period of up to three days, and may be renewed for periods of three days or less while such urgent necessity continues. Such variance shall be clearly marked on such license or permit and shall be prominently posted at the site of such construction activities by the permittee or licensee. A copy of such marked license or permit shall be promptly forwarded to the board. In the case of an emergency, construction activities directly connected with the abatement of such emergency may be undertaken without a variance as herein provided for a period of not to exceed twelve hours from the commencement of such construction, during which time application for a variance hereunder shall be made.

Section 1403.3—4.13 **Construction devices**

Except as provided in article V of this code, no person shall operate or use or cause to be operated or used a construction device in such a way as to create an unnecessary noise.

Section 1403.3—4.15 **Containers and construction material**

No person shall handle or transport or cause to be handled or transported in any public place, any container or any construction material in such a way as to create an unnecessary noise.

Section 1403.3—4.17 **Exhausts**

Except as otherwise provided in the code, no person shall cause or permit discharge into the open air of the exhaust of any device, including but not limited to any steam engine, diesel engine, internal combustion engine or turbine engine, so as to create an unnecessary noise.

Section 1403.3—4.19 **Schools, hospitals, courts**

No person shall cause or permit the creation of any unnecessary noise through the use of any device on any street adjacent to any school or court while the same is in session, or adjacent to any hospital.

Section 1403.3—4.21 **Noise sensitive zones**

(a) Whenever the protection of the public health and comfort so requires, the administrator and the board of health may by joint order designate any geographical area of the city of New York as a noise sensitive zone. Such designation shall be accompanied by a joint administrative order setting forth a description of the subject geographical area, the reasons for determination as a noise sensitive zone, and shall list those activities which if undertaken in such zone, would constitute unnecessary noise. Such order shall be published in the City Record at least five days but not more than ten days prior to its effective date, and shall be effective for a period of not more than sixty days, renewable for additional periods of sixty days.

(b) Any person suffering undue hardship by reason of the operation of an order promulgated pursuant to subsection (a) hereof may request a hearing on written notice to the administrator. Such person shall be afforded a hearing within ten days of receipt of such notice. The administrator shall issue a final decision thereon within 3 days of the conclusion of a hearing held pursuant to this subsection.

(c) No person shall engage in or permit any person to be engaged in any activity so as to violate the provisions of any order issued pursuant to subsection (a) hereof.

Section 1403.3—4.23 **Regulations**

The administrator shall have the power to promulgate such regulations as may be necessary to carry out the purposes of this article.

ARTICLE V

PROHIBITED NOISE

Sound Level Standard

Section 1403.3—5.01

Any act in violation of any of the provisions of this article V of the code is deemed to be in violation of the provisions of article III of the code, without in any way limiting the generality of the provisions of article III of the code.

Section 1403.3—5.03 **Motor vehicles**

(a) No person shall operate or permit to be operated any motor vehicle at any time or under any condition whatsoever, including but not limited to grade, load, idling, velocity, acceleration or deceleration, in such manner as to exceed the sound levels set out in either column I or column II of table I below, measured as follows: the sound levels listed in column I shall be measured by a sound level meter placed at a distance of fifty feet plus or minus two feet from the center of the lane of the public highway in which the motor vehicle is idling or is traveling within the speed limits specified in this section; the sound levels listed in column II shall be measured by a sound level meter placed at a distance of twenty-five feet plus or minus two feet from the center of the lane of the public highway in which the motor vehicle is idling or is traveling within the speed limits specified in this section.

(b) Where a motor vehicle is operated in a place other than a public highway, the sound levels in column I shall be measured by a sound level meter placed at a distance of fifty feet plus or minus two feet from the center line of the rear face of such vehicle where such vehicle is idling or is travelling within the speed limits specified in this section; the sound levels listed in Column II shall be measured by a sound level meter placed at a distance of twenty-five feet plus or minus two feet from the center line of the rear face of such vehicle when such vehicle is idling or is traveling within the speed limits specified in this section.

	Speed limit of 35 mph or less	Speed limit of more than 35 mph
	Column I	
(1) Any motor vehicle with a manufacturer's gross vehicle rating of 8,000 pounds or more and any combination of vehicles towed by such motor vehicle	86 db(A)	90 db(A)
(2) Any motorcycle other than a motor-driven cycle		
before January 1, 1978	82 db(A)	86 db(A)
after January 1, 1978	78 db(A)	82 db(A)
(3) Any other motor vehicle and any combination of vehicles towed by such motor vehicles		
before January 1, 1978	76 db(A)	82 db(A)
after January 1, 1978	70 db(A)	79 db(A)
	Column II	
(1) Any motor vehicle with a manufacturer's gross vehicle rating of 8,000 pounds or more and any combination of vehicles towed by such motor vehicle	92 db(A)	96 db(A)

	Speed limit of 35 mph or less	Speed limit of more than 35 mph
(2) Any motorcycle other than a motor-driven cycle		
before January 1, 1978	88 db(A)	92 db(A)
after January 1, 1978	84 db(A)	88 db(A)
(3) Any other motor vehicle and any combination of vehicles towed by such motor vehicle		
before January 1, 1978	82 db(A)	88 db(A)
after January 1, 1978	76 db(A)	85 db(A)

Section 1403.3—5.05 **Aircraft**

On or before one year from the effective date of this code, the administrator shall define and submit to the city council for enactment into this code allowable sound levels and ambient noise quality criteria and standards for areas affected by noise generated by airports and aircraft using airports in the city of New York. Such sound levels and such ambient noise quality criteria and standards shall be developed in accordance with a comprehensive methodology for controlling and abating airport noise, including but not limited to the following methods:

1. Encouraging use of the airport by aircraft classes with lower sound level characteristics and discouraging use by higher sound level aircraft classes;

2. Encouraging approach and departure flight paths and procedures to minimize the noise in residential areas;

3. Planning runway utilization schedules to take into account adjacent residential areas, noise characteristics of aircraft and noise sensitive time periods;

4. Reduction of the flight frequency, particularly in the most noise sensitive time periods and by the noisier aircraft;

5. Employing shielding for advantage, using natural terrain, buildings, etc.; and

6. Development of a compatible land use within the noise impact boundary.

Preference shall be given to actions which reduce the impact of airport noise on existing communities. Land use conversion involving existing residential communities shall be considered the least desirable action for achieving compliance with allowable sound levels and ambient noise quality criteria and standards adopted pursuant to this section.

Allowable sound levels and ambient noise quality criteria and standards defined and submitted pursuant to this section shall accurately reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health, welfare and comfort of any noise, or combination of noises, generated by airports and aircraft using airports in the city of New York and shall be based on the latest economically feasible and available technology for the abatement of noise generated by airports in the city of New York.

Section 1403.3—5.07 **Rapid transit railroads**

(a) On or before one year from the effective date of this code, the administrator shall define and submit to the city council for enactment into this code allowable sound levels and acoustical performance standards for the design and operation of new and existing rapid transit railroads, including but not limited to allowable sound levels and acoustical performance standards for rolling stock, track and track beds, passenger stations, tunnels, elevated structures, yards, depots and garages.

Allowable sound levels and acoustical performance standards shall be based on the latest economically feasible and available technology for noise abatement in rapid transit railroads and on the latest scientific knowledge useful for indicating the kind and extent of all effects on public health, welfare, safety and comfort which can be expected from noises or combinations of noises generated by rapid transit railroads.

(b) No person shall operate or permit to be operated a rapid transit railroad, including but not limited to its rolling stock, track and track beds, passenger stations, tunnels, elevated structures, yards, depots and garages so as to cause a violation of allowable sound levels or acoustical performance standards adopted by the city council pursuant to this section.

Section 1403.3—5.09 **Railroads**

(a) On or before one year from the effective date of this code, the administrator shall define and submit to the city council for enactment into this code allowable sound levels and acoustical performance standards for the operation of new and existing railroads, including allowable sound levels and acoustical performance standards for rolling stock, bridges, ferries, tunnels, equipment, switches, spurs, tracks, stations, yards and terminal facilities.

Allowable sound levels and acoustical performance standards except as otherwise provided in this section, shall be based on the latest economically feasible and available technology for noise abatement in railroads and on the latest scientific knowledge useful for indicating the kind and extent of all effects on public health, welfare, safety and comfort which can be expected from noises or combinations of noises generated by railroads.

(b) No person shall operate or permit to be operated a railroad, including but not limited to rolling stock, bridges, ferries, tunnels, equipment, switches, spurs, tracks, stations, yards and terminal facilities, so as to cause a violation of allowable sound levels or acoustical performance standards adopted by the city council pursuant to this section.

Section 1403.3—5.11 **Air compressors**

(a) On or after thirty days from the effective date of this code, no person shall operate or cause to be operated an air compressor manufactured prior to December 31, 1972, unless a muffler certified by the manufacturer of such muffler to provide a dynamic insertion loss of 20 dB(C) of the sound release from the exhaust source of such air compressor is installed on such exhaust source.

(b) No person shall, after the effective dates set out in table II, operate or permit to be operated an air compressor manufactured prior to December 31, 1972 in such a manner as to cause the maximum sound level of such air compressor, when measured at a distance of one meter from the nearest major surface of such air compressor, to exceed the applicable allowable sound level set out therein.

Table II

Effective date	Allowable sound level
December 31, 1972	90 dB(A)
June 30, 1974	80 dB(A)

(c) No person shall sell, offer for sale or operate or permit to be operated an air compressor manufactured on or after the effective dates set out in table III which when operated produces a maximum sound level, when measured at a distance of one meter from the nearest major surface of such air compressor, exceeding the applicable allowable sound level set out therein.

Table III

Effective date	Allowable sound level
December 31, 1972	85 dB(A)
June 30, 1974	75 dB(A)
December 31, 1975	70 dB(A)

Section 1403.3—5.13 **Circulation devices**

No person shall operate or permit to be operated a circulation device not subject to the provisions of title C of chapter 26 of the administrative code in such a manner as to create a sound level in excess of 45 dB(A) when measured inside the dwelling unit affected in a line with the window nearest the exterior face of such circulation device. The measurement shall be taken with the window fully open at a point three feet from the open portion of the window.

Section 1403.3—5.15 **Refuse compacting vehicles**

No person shall sell, offer for sale, operate or permit to be operated a refuse compacting vehicle manufactured after December 31, 1974 which when compacting creates a sound level in excess of 70 dB(A) when measured at ten feet from the center line of the face of the compacting unit.

Section 1403.3—5.17 **Motor vehicle claxons**

No person shall sell, offer for sale, operate or permit to be operated a claxon installed on any motor vehicle of a model year 1974 and thereafter which when operated creates a sound level in excess of 75 dB(A) when measured at a distance of twenty five feet from the center of the forward face of such motor vehicle, but this section shall not preclude the sale or use of a city-country horn in accordance with allowable sound levels promulgated by the administrator.

Section 1403.3—5.19 **Emergency signal devices**

After June 30, 1973, no person shall operate or permit to be operated an emergency signal device installed on an authorized emergency vehicle which when operated creates a sound level in excess of 90 dB(A) when measured at a distance of fifty feet from the center of the forward face of such vehicle.

Section 1403.3—5.21 **Paving breakers**

(a) On or after thirty days from the effective date of this code, no person shall operate or cause to be operated a paving breaker, other than one operated electrically or hydraulically, manufactured prior to December 31, 1973, unless a pneumatic discharge muffler certified by the manufacturer of such muffler to provide a dynamic insertion loss of 5 dB(A) of the sound released from the air discharge of such paving breaker is installed on such air discharge.

(b) No person shall sell, offer for sale, operate or permit to be operated a paving breaker manufactured on or after the effective dates set out in Table IV which when operated produces a maximum sound level, when measured at a distance of one meter from a face of such paving breaker, exceeding the applicable allowable sound level set out therein.

Table IV

Effective date	Allowable sound level
December 31, 1973	94 dB(A)
December 31, 1975	90 dB(A)

Section 1403.3—5.23 Regulations

The administrator shall promulgate such regulations as he may deem necessary with regard to standards and procedures to be followed in the measurement of sound pressure levels governed by the provisions of this article, provided that such standards and procedures are substantially in compliance with any similar standards and procedures promulgated by the american national standards institute, international standards organization, society of automotive engineers, compressed air and gas institute, american refrigeration institute or any other generally recognized professional standard-setting organization.

ARTICLE VI

AMBIENT NOISE QUALITY ZONES CRITERIA AND STANDARDS

Section 1403.3—6.01 Ambient noise quality zones, criteria and standards

The administrator shall, as soon as practicable, but not later than two years from the effective date of this code, define and submit to the city council for enactment into this code the following:

(1) Ambient noise quality zones for the entire geographical area of the city of New York on the basis of those conditions which affect ambient noise levels, including but not limited to the following:

(i) The uses and activities permitted by the zoning regulation in such zones;
(ii) The intensity of sound levels produced by activities and devices in such zones;
(iii) The time at which such sound levels occur;
(iv) The duration of such sound level;
(v) The proximity of such activities and devices to buildings and to dwellings;
(vi) Whether the sound levels produced by such devices and activities are recurrent, intermittent or constant; and
(vii) The density of habitation of such zones.

(2) Ambient noise quality criteria and standards for each of the ambient noise quality zones defined above in subsection (1). Ambient noise quality criteria and standards shall accurately reflect the latest scientific knowledge useful in indicating the kind and extent of all identifiable effects on public health, welfare and comfort of any noise or combination of noises, and shall be based on the latest economically feasible and available technology for the abatement of noise produced by devices and activities within a referent ambient noise quality zone.

The provisions of this section 6.01 shall at all times be subject to the technical feasibility of defining such ambient noise quality zones, criteria and standards.

Section 1403.3—6.03 Allowable sound levels

(a) On or after the effective date of the ambient noise quality criteria and standards enacted under section 6.01 of this code, the administrator may by regulation promulgate allowable sounds levels with respect to any device or activity, provided that such allowable sound levels shall not be inconsistent with the ambient noise criteria and standards enacted under section 6.01, with the allowable sound levels set out in article V of this code, and with the provisions of title C of chapter 26 of the administrative code.

(b) No person shall engage in or cause any other person to engage in an activity, or operate or permit the operation of a device so as to cause a sound level in excess of the appropriate allowable sound level promulgated by the administrator pursuant to this section.

ARTICLE VII

CERTIFICATES AND TUNNELING PERMITS

Section 1403.3—7.01 Operating certificates and renewal of operating certificates; tunneling permits; when required

(a) The administrator shall at his discretion promulgate regulations pursuant to section 1105 of the city charter directing the placement of air compressors, paving breakers, refuse compacting vehicles and repid transit railroads, including but not limited to its rolling stock, track and track beds, passenger stations, tunnels, elevated structures, yards, depots and garages onto an operating certificate list, setting out the reasons for such placement, and setting out the period of time from issuance or renewal during which such operating certificate shall be valid, unless sooner revoked or cancelled.

(b) No person shall cause or permit the use or operation of any device placed on the operating certificate list pursuant to subdivision a of this section except for the purpose of testing such device without first obtaining an operating certificate from the administrator. The placement of such a device not bearing an operating certificate at a location of its customary operation shall be considered *pr.ma facie* violation of this section in any proceeding pursuant to any applicable section of article VIII of the code except section 8.25.

(c) No person shall engage in or permit any person to engage in tunneling without first obtaining a tunneling permit from the administrator. A separate permit shall be obtained for each shaft of a tunnel.

(d) Prior to advertising for bids for contracts involving tunneling, the agency of the city of New York proposing to so advertise shall request the administrator in writing for a statement of the requirements or standards that will govern the proposed tunneling activities pursuant to section 7.07. The aforesaid requirements shall be furnished by the administrator to the contracting agency in writing within 30 days after receipt of the request and shall be included by the contracting agency in the contract specifications for the proposed tunneling. The conditions under which the permit shall be granted to the contractor shall be consistent with the statement furnished by the administrator to the contracting agency for inclusion in the contract specifications.

(e) Notwithstanding the existence of a valid tunneling permit, no person shall, except in the case of urgent necessity in the interest of public safety, conduct or permit to be conducted blasting operations at any time other than on weekdays and other than between the hours of 7 a. m. and 7 p. m. unless a special permit is obtained from the fire department pursuant to § C-19-36.0(d).

Section 1403.3—7.03 General requirements for applications for operating certificates and for tunneling permits, and removal of operating certificates

(a) Application for an operating certificate or for the removal of an operating certificate shall be made by the owner of the device on forms furnished by the administration.

(b) Application for a tunneling permit shall be made on forms furnished by the administration by or in behalf of the owner or lessee of the tunnel; and if made by a person other than the owner, the application shall be accompanied by a signed statement of the applicant declaring that he is authorized by the owner to make the application. The permitee shall in all cases be the applicant.

(c) Each application hereunder shall be signed by the applicant. The signature of the applicant shall constitute an agreement that the applicant will assume responsibility for the operation or use of the device concerned or for tunneling in accordance with the requirements of this code. If the applicant is a partnership or group other than a corporation, the application shall be made by one individual who is a member of the group. If the applicant is a corporation, the application shall be made by an officer of the corporation.

(d) Application for the removal of an operating certificate shall be postmarked or date-stamped by the administration upon personal delivery no later than 30 days prior to the expiration of the certificate.

Section 1403.3—7.05 Information required for applications for operating certificates and for tunneling permits

(a) Each application for an operating certificate shall contain such information as the administrator my require in order to determine whether a device covered by the application is or will operate in compliance with the provisions of this code, including but not limited to:

(1) The model number and operating characteristics of the device covered by the application;
(2) A report certified by an approved testing laboratory as to the sound level generated by the device when operated under normal operating conditions or a manufacturer's warranty as to sound level provided that the device is regularly tested in accordance with procedures established by the american national standards institute or other appropriate professional standard-setting organization listed in section 5.23; and
(3) The proposed means, if any, for the prevention or control of unnecessary noise.

(b) Each application for a tunneling permit shall contain such information as the administrator may require to determine whether tunneling activities and the devices operated therein will be undertaken in compliance with the provisions of this code, including but not limited to:

(1) The types and operating characteristics of the devices employed in such tunneling;
(2) A detailed description of proposed tunneling; and

(3) The proposed means for the prevention of unnecessary noise.

(c) Information concerning secret processes which may be required, ascertained or discovered by the administration shall not be disclosed by any administration employee, except that the information may be disclosed by the administrator if the administration is subpoenaed for the information or if in the course of an administration court proceeding or administration or board hearing, the information is relevant to the proceeding or hearing.

Section 1403.3—7.07 **Standards for granting operating certificates and tunneling permits**

(a) No operating certificate shall be granted unless the applicant shows to the satisfaction of the administrator that:

(1) The device will be operated without causing a violation of the provisions of this code; and

(2) The device incorporates advances in the art of noise control developed for the kind and level of noise emitted by the applicant's device.

(b) No tunneling permit shall be granted unless the applicant shows to the satisfaction of the administrator that:

(1) The devices employed in such tunneling, including construction devices, storage bins and hoppers, will be operated or used without causing a violation of the provisions of this code;

(2) The motor vehicles employed in such tunneling will be routed at such times of day and such routes as not to cause unnecessary noise; and

(3) All advances in the art of noise control, including appropriate closures around devices, and sound deadening linings on storage bins and hoppers, developed for the kind and level of noise emitted by applicant's activities or devices have been incorporated into such tunneling activities and devices.

(c) The administrator may from time to time issue regulations for the guidance of applicants indicating the technical specifications which he deems will comply with the performance standards of this section.

Section 1403.3—7.09 **Testing before granting or renewing of operating certificates; testing before granting of tunneling permits**

(a) Before a tunneling permit is granted or before an operating certificate is granted or renewed, the administrator may require the applicant to conduct such tests as are necessary in the opinion of the administrator to determine the sound level emitted from a device or an activity or to determine whether the device or its operation or an activity is contributing to, or is in violation of this code. The test shall be made at the expense of the applicant.

(b) Such tests shall be conducted, reviewed and certified as provided by section 2.05(b) of this code. The applicant shall notify the administration of the time and place of a test as provided by section 2.05(c) of this code. Reasonable facilities shall be made available for the administration to witness the test.

If in the opinion of the administrator tests by the administration are necessary, the facilities for such tests, exclusive of sound level meters, shall be furnished by and at the expense of the owner or lessee or his agent as provided by section 2.05(d) of this code.

Section 1403.3—7.11 **Action on applications for certificates or tunneling permits**

(a) The administrator shall act within a reasonable time not to exceed 60 days on an application for a tunneling permit, for an operating certificate, or for a renewal of an operating certificate, and shall notify the applicant in writing of his approval or disapproval of the application.

(b) If an application is disapproved, the administrator shall set forth his objections in the notice of disapproval or notice of violation.

(c) Within 60 days after service on the applicant of the notice of disapproval, exclusive of the day of service, the applicant may request the administrator to reconsider the application by answering in writing the administrator's objection to the application.

(d) The administrator shall consider the applicant's answer to his objections, and shall notify the applicant in writing within a reasonable time, not to exceed 60 days, of his approval or denial of the application. Failure to answer or request an extension of time within 60 days after service of the notice of disapproval or a notice of violation shall be deemed a denial of the application.

(e) The administrator may grant a temporary operating certificate or tunneling permit for a period not to exceed 60 days upon receipt of an application for the granting or renewal of an operating certificate and may, at his discretion, renew a temporary operating certificate or tunneling permit for an additional period not to exceed 60 days.

Section 1403.3—7.13 **Conditions of certificates or tunneling permits to be observed**

The holder of a certificate or of a tunneling permit shall comply with the conditions and terms contained in his certificate or tunneling permit as well as all applicable provisions of this code.

Section 1403.3—7.15 **Suspension or revocation of certificates or tunneling permits**

(a) The administrator shall suspend or revoke a tunneling permit or certificate when ordered to do so by the board pursuant to article VIII of this code.

(b) Suspension or revocation of a certificate or tunneling permit shall become final five days after service of notice, exclusive of the day of service, on the holder of the certificate or tunneling permit.

Section 1403.3—7.17 **Surrender of certificates or tunneling permits**

A certificate or tunneling permit which has been cancelled or revoked pursuant to this code shall be surrendered forthwith to the administrator.

Section 1403.3—7.19 **Transfer of certificates**

Any purported or attempted transfer of a certificate automatically revokes the certificate, except that upon a conveyance of the premises in which the device is located a certificate may be transferred to a person other than the person named in the certificate.

Section 1403.3—7.21 **Operating certificate or tunneling permit fees**

(a) A person applying for an operating certificate, or a renewal of an operating certificate shall pay a fee of thirty dollars;

(b) A person applying for a tunneling permit shall pay a fee of two hundred and fifty dollars.

Section 1403.3—7.23 **Administration publication fees**

The administration may charge for a copy of its publications a fee in an amount not to exceed the unit cost of the preparation and distribution of the publication.

ARTICLE VIII

ENFORCEMENT

Section 1403.3—8.01 **Powers of the board**

(a) The board, in addition to other duties assigned to it by law, shall have the power to conduct hearings pursuant to this article and, by the issuance of a subpoena, compel the attendance of witnesses and the production of any books, papers or other things relating to the matter under investigation.

(b) The board may, upon notice pursuant to section 8.05 of this code, and after a hearing pursuant to section 8.13 of this code, or in default thereof pursuant to section 8.15 of this code:

(1) Order the administrator to revoke or suspend a certificate or tunneling permit issued pursuant to this code for any device or activity where such device or activity causes, or is maintained or operated so as to cause a violation of any provision of this code or order or regulation promulgated by the administrator or the board;

(2) Order the owner of any device which causes or is maintained or operated so as to cause a violation of any provision of this code or any order or regulation promulgated by the administrator or the board to install any apparatus which can reasonably be expected to correct the violation, or to repair, properly maintain, replace or alter such device in a manner which can reasonably be expected to correct the violation;

(3) Seal any device which causes or is maintained or operated so as to cause a violation of any provision of this code or order or regulation promulgated by the administrator or the board, except as provided in subsection (c) of this section;

(4) Order any person to cease and desist from any activity which causes or is conducted so as to cause, a violation of any provision of this code or any order or regulation promulgated by the administrator or the board, except as provided in subsection (c) of this section;

(5) Impose a civil penalty in each instance in an amount no greater than as set out in table V against any person who violates a provision of this code, or any order or regulation promulgated by the administrator or the board.

Table V

Violation related to section or regulation thereunder or order	Civil penalty	
2.25(d)	$1,000 00	
3.01	$250 00	
4.03(a)	$50 00	
4.03(b)	$500 00	
4.03(c)	$50 00	
4.05(1)	$50 00	for a first violation, $100 for a second violation and $250 for a third or subsequent violation
4.05(2), (3), (4), (5)	$250 00	
4.07	$50 00	
4.09	$250 00	
4.11	$1,000 00	
4.13	$500 00	
4.15	$500 00	
4.17	$500 00	
4.19	$250 00	
4.21	$500 00	
5.03, except that this $500.00 civil penalty shall apply only to a violation by a person operating motor vehicles listed in Column I, subdivisions (1) and (2), and Column II, subdivisions (1) and (2) of Table I.	$500 00	
5.03, except that this $100.00 civil penalty shall apply only to a violation by a person operating motor vehicles listed in Column I, subdivision (3), and Column II, subdivision (3) of Table I.	$100 00	
5.07	$1,000 00	
5.11	$500 00	
5.13, except that this $500.00 civil penalty shall apply only to a violation by a person operating a circulation device with a rated capacity in excess of 50,000 british thermal units per hour or its equivalent.	$500 00	
5.13, except that this $100.00 civil penalty shall apply only to a violation by a person operating a circulation device with a rated capacity of less than 50,000 british thermal units per hour or its equivalent.	$100 00	
5.15	$500 00	
5.17	$100 00	
5.19	$500 00	
5.21	$500 00	
6.03	$500 00	
7.01	$1,000 00	
All remaining sections	$250 00	

Each day during which such violation continues shall constitute a separate violation. The board may remit, in whole or in part, such a civil penalty if, at the conclusion of the hearing, the respondent is no longer in violation of a provision of this code, or any order or regulation promulgated by the administrator or the board;

(6) Impose a civil penalty in the sum of seventy-five dollars on any owner of a device for each day such equipment is sealed pursuant to this section;

(7) Impose a civil penalty in the sum of five hundred dollars on any person who willfully breaks a seal placed on a device pursuant to this section.

(c) The board may, upon notice pursuant to section 8.05 of this code:

(1) order any person to cease and desist from the operation of any listed device without a certificate as required by section 7.01 of this code and the board may also seal such device;

(2) order any person to cease and desist from tunneling without a tunneling permit as required by section 7.01 of this code and the board may also seal any device used in such tunneling;

(3) order any person not in possession of a variance issued pursuant to section 4.11(b) of this code to cease and desist from construction activities other than during the permissible hours specified in section 4.11(a) of this code and the board may also seal any device used in such construction activities;

(4) order any person to cease and desist from the operation of a device without registration required by section 2.09 of this code and the board may also seal such device.

(d) The board may order the administrator to install any apparatus or to repair or alter any device or apparatus which causes or is maintained or operated so as to cause a violation of an order issued pursuant to paragraph (2) of subsection (b) of this section, where such repairing or alteration can reasonably be expected to correct such a violation. Any work required under such an order may be executed by the administrator through the officers, agents or contractors of the administration. The administration shall be reimbursed promptly for all costs and expenses of such work by the owner of the device to which the order relates and in respect to which such expenses were incurred. Such expenses may be recovered in a civil action brought in the name of the administrator.

(e) If an order of the board issued pursuant to subsection (b) and (c) of this section provides for a period of time during which a person subject to the order is permitted to correct a violation, the board may require the respondent to post a performance bond or other security with the administration in a form and amount sufficient to assure the correction of such violation within the prescribed time. In the event of a failure to meet the schedule prescribed by the board, the sum named in the bond or other security shall be forfeited and shall be paid to the administrator.

(f) (1) The board may order any person to cease and desist from an activity which it reasonably believes causes unnecessary noise which creates imminent peril to the public health and well-being, or to cease and desist from an activity which it reasonably believes constitutes a wilful or continued violation of any provision of this code or order or regulation, promulgated by the administrator or board. Such order shall be effective upon service thereof. Any party affected by such an order may request a hearing on written notice, and he shall be afforded a hearing, within 24 hours after service of such request, pursuant to section 8.13 of this code. If such an accelerated hearing is not requested, then a hearing shall be afforded within 10 days of the issuance of the order. The board shall issue its final decision and order thereon within three days from the conclusion of a hearing held pursuant to this subsection.

(2) The board may rescind in whole or in part a variance issued by an agency of the city of New York pursuant to section 4.11(b) of this code. Such order shall be effective upon service thereof upon such agency and upon the person to whom such variance was issued.

Section 1403.3—8.03 **The board**

(a) The board shall be convened by the chairman or in his absence the commissioner of air resources or at the request of any three members thereof.

(b) If a member of the board has presided over the initial hearing, he shall not be disqualified from reviewing the hearing.

(c) Three members of the board shall constitute a quorum, except that on or after thirty days from the effective date of this code, five members of the board, at least two of whom shall not be city officials, shall constitute a quorum.

Section 1403.3—8.05 **Notice of violation**

(a) Notice, required by this article, shall be given by issuance of a notice of violation.

(b) Whenever the administrator has reasonable cause to believe that a violation of any provision of this code or any order or regulation promulgated by the administrator or the board may exist, he may cause to have a notice of violation issued and served on:

(1) The person in violation; or
(2) An owner with an equity interest in the device in violation, if any; or
(3) If an owner with an equity interest in the device in violation cannot be located with due diligence, any other owner of said device.

(c) A notice of violation shall:
(1) Specify the section or sections of this code, order, or regulation that such person or device is in violation of; and
(2) Indicate the amount of the civil penalty that such person is subject to; and
(3) Contain a brief statement of the nature of the violation; and
(4) Require a written response that conforms to section 8.07 of this code; and
(5) Require such person or owner of a device unless a hearing is not required by section 8.01 of this code, to answer the allegations in the notice of violation at a time and place designated either in or with the notice of violation or in a subsequent notice to such person or owner.

Section 1403.3—8.07 **Written response**

(a) A written response in a form prescribed by the board shall be served upon the administration and filed with the board within 5 days of receipt of the notice of violation.

(b) If the allegation in the notice of violation is one for which a hearing is not required by section 8.01 of this code, and is contested, then the respondent must either:
(1) Include a copy of any tunneling permit or certificate that the respondent asserts was issued by the administration; or
(2) Deny that such tunneling permit or certificate is required by law.

(c) If any of the allegations in the notice of violation are those for which a hearing is required by section 8.01 of this code, and are contested, the written response shall contain a concise statement of the facts constituting each ground of defense.

(d) If allegations in the notice of violation are admitted the written response of the respondent shall consist of:
(1) A statement that he admits all of the material allegations to be true; and
(2) A statement of any attempts subsequent to service of the notice of violation to comply with this code or with the order or regulation.

(e) Failure of the respondent to serve a written response within the time provided shall be deemed to constitute a waiver of his right to appear and contest the allegations in the notice.

Section 1403.3—8.09 **Citizen's complaint**

(a) Any person other than personnel of the administration and employees of the city of New York authorized by law to serve summonses for violation of the administrative code may serve upon the administration a complaint in a form prescribed by the administrator alleging that a person has violated a provision of this code set forth in Table VI, below, or an order or regulation promulgated under such provision, together with evidence of such violation.

Table V

Violation related to section or subdivision and order or regulation thereunder
2.09
2.25
4.03(b)
4.11
5.03 except that the provisions of this section 8.09 shall apply only to violations by persons operating motor vehicles listed in Column I, subdivision (1) and (2) and Column II, subdivision (1) and (2) of Table I.
5.07
5.11
5.13 except that the provisions of this section 8.09 shall apply only to a violation by a person operating a circulation device with a rated capacity in excess of 50,000 British thermal units per hour or its equivalent.
5.15
5.19
5.21
6.03
7.01

(b) A person who has served a complaint pursuant to subdivision (a) of this section may serve upon the person allegedly in violation and upon the board a notice of violation in a form prescribed by the board if within 30 days from service of such complaint:
(1) The administration has failed to serve a notice of violation, pursuant to section 8.05 of this code, for the violation alleged in a complaint purspant to subdivision (a) of this section; or
(2) The administration fails to serve a written notice upon the complainant of its determination that his complaint is frivolous or duplicitous.

(c) A person commencing a proceeding before the board pursuant to this section, shall prosecute such proceeding at his own expense. The administration may intervene in such a proceeding at any time.

(d) In any proceeding brought by the administration after receiving a complaint pursuant to subdivision (a) of this section, the board shall award the complainant, out of the proceeds collected, fair and reasonable compensation, which shall not exceed 25 per cent of the proceeds collected, for disclosure of information or evidence not in the possession of the administration, which leads to the imposition of the civil penalty.

(e) In any proceeding brought by a complainant, the board shall award, out of the proceeds collected, 50 per cent of any civil penalty as fair and reasonable compensation to such person.

Section 1403.3—8.11 **Settlement of proceedings**

The board may settle any proceeding by stipulation and may exercise any or all of its powers under section 8.01 of this code thereby, at any time prior to the issuance of a decision pursuant to section 8.19 of this code.

Section 1403.3—8.13 **Hearings**

(a) The chairman of the board shall designate a hearing officer or at least one member of the board to preside over hearings held pursuant to this article. In any hearing in which a quorum of the board is present, such members shall be deemed to be sitting as the board.

(b) All such hearings shall be open to the public.

(c) At the request of any party to such a hearing, the board shall by the issuance of a subpoena compel the attendance of such witnesses and shall require the production of any such books, papers, or other things relating to the matter under investigation if such a request reasonably relates to such hearing.

(d) Any party to a hearing may be represented by counsel, may make oral and written argument and cross-examine witnesses. All testimony taken before the board or the designated hearing officer shall be under oath and shall be recorded. The record shall be open to public inspection, and copies thereof shall be made available to any person upon payment of the actual cost of reproduction.

Section 1403.3—8.15 **Default; vacating a default order**

(a) A respondent shall be in default when the respondent has:
(1) Failed to serve a written response pursuant to section 8.07 of this code; or
(2) Failed to appear at the designated time and place as required by the notice of violation or subsequent notice pursuant to section 8.05 or 8.09 of this code; or
(3) Neglected to proceed in a manner ordered by the board.

(b) Within 60 days of a decision and order of the board issued pursuant to section 8.19 (c) (2), the respondent may request the board to grant a stay of such order of the board and schedule a hearing. If the respondent has shown good cause and a meritorious defense, the board may grant such a request and hold a hearing pursuant to section 8.13 of this code. At the conclusion of the hearing, the board may adopt, amend or rescind its decision and order.

Section 1403.3—8.17 **Hearing officer's decision**

(a) At the conclusion of the hearing, the hearing officer or member of the board conducting the hearing shall prepare a decision stating findings of fact and conclusions, as well as reasons for his determination on all material issues, and making recommendations as to action which should be taken in the matter.

(b) The hearing officer or member of the board conducting the hearing shall file his decision with the board and send copies by mail to the parties. Any party may file exceptions with the board within 20 days after service of such decision. If no exceptions have been filed within the described time the recommendations of the hearing officer or member of the board conducting the hearing shall automatically become the decision of the board and shall constitute its findings, conclusions and order.

(c) At the conclusion of a hearing conducted by the board, the board shall issue its

decision and order. The decision of the board shall conform to the requirements of subdivisions (b) and (c) of section 8.19 of this code.

Section 1403.3—8.19 **Board decision and order**

(a) If any party files exceptions to the decision of the hearing officer or member of the board conducting a hearing within the prescribed time the board shall review the record and issue its decision and order in which it may adopt, modify or reject the findings, conclusions and recommendations of the hearing officer or member of the board who conducted the hearing.

(b) The decision of the board shall contain findings of fact, conclusions of law and reasons for the decision on all material issues raised, and an order either dismissing the allegations of the notice of violation or sustaining them in whole or in part.

(c) The board may exercise one or more of its powers pursuant to section 8.01 of this code, as it deems appropriate if:

(1) The allegations in the notice of violation are sustained in whole or in part;

(2) The respondent is in default under section 8.15 of this code.

(d) The decision and order of the board shall be its final determination. A judicial proceeding must be commenced within two months after the service of such decision and order.

Section 1403.3—8.21 **Compliance with board decisions; orders and civil penalties**

(a) If the respondent fails or refuses to comply with the board's order, or the board otherwise deems it necessary, the corporation counsel for the city of New York, acting in the name of the city, may maintain an action or proceeding in a court of competent jurisdiction to compel compliance with or restrain by injunction the violation of any order of the board.

(b) A civil penalty imposed by the board pursuant to section 8.01 of this code may be collected in an action brought in the name of the city of New York.

Section 1403.3—8.23 **Procedural rules**

The board shall have authority from time to time to make, amend and rescind such procedural rules as may be necessary to carry out the provisions of this article.

Section 1403.3—8.25 **Criminal penalties**

(a) Any person who shall knowingly make a false statement or who shall knowingly falsify or allow to be falsified any certification, registration, form, signed statement, application or report required under the provisions of this code or regulation promulgated by the administrator or the board shall be guilty of a misdemeanor and, upon conviction thereof, shall be punished by a fine of not less than one hundred dollars, nor more than one thousand dollars, or by imprisonment not to exceed five months, or both.

(b) Any person, other than a corporation, who violates any order of the administrator or the board or any provision of section 7.01 of this code or who illegally breaks a seal on equipment, upon conviction shall be punished for each offense by a fine of not less than fifty dollars nor more than five hundred dollars or by imprisonment for not more than thirty days or by both.

Any corporation which violates any order of the administrator or the board or any provision of section 7.01 of this code, or which illegally causes a seal to be broken upon conviction shall be punished for each offense by a fine of not less than one hundred dollars nor more than two thousand dollars.

Every day during which such violation occurs constitutes a separate offense.

(c) Any person, other than a corporation, convicted of willful failure to pay a civil penalty imposed by the board pursuant to section 8.01 of this code shall be punished by a fine of double the amount of the civil penalty imposed by the board or by imprisonment of not more than sixty days or by both.

Any corporation convicted of wilful failure to pay a civil penalty imposed by the board pursuant to section 8.01 of this code shall be punished by a fine of double the amount of the civil penalty imposed by the board, but not more than two thousand dollars.

(d) The failure of any person or corporation against whom an action has been brought to collect a civil penalty pursuant to section 8.21(b) of this code, who has been found liable by a court for such civil penalty and who does not pay such penalty after the judgment of such becomes final, shall be deemed guilty of a willful failure to pay a civil penalty.

(e) Any person convicted of violating any of the provisions of this code or any regulation of the board not otherwise provided for by this section shall be punished by a fine of not less than fifty dollars nor more than five hundred dollars for the first offense, or by imprisonment for twenty days or both, and by a fine of not less than one hundred dollars nor more than one thousand dollars or by imprisoment for not more than thirty days or both, for a second offense, and by a fine of not less than four hundred dollars nor more than five thousand dollars or by imprisonment for not more than four months or both for a third or subsequent offense.

(f) Twenty-five per cent of any fine that is imposed pursuant to this section may be paid to the person or persons giving information which shall lead to conviction.

§ 3. Section fourteen hundred four of the New York city charter, as amended by local law forty-nine for the year nineteen hundred seventy-one, is hereby amended to read as follows:

§ 1404. **Environmental control board**

1. There shall be in the administration an environmental control board consisting of the administrator, who shall be chairman, the commissioner in the administration who is responsible for air pollution control, the commissioner in the administration who is responsible for water pollution control, the commissioner in the administration who is responsible for sanitation, the commissioner of the department of buildings of the housing and development administration and four persons, to be appointed by the mayor, with the advice and consent of the city council, who are not officers in the administration at least one to be possessed of a broad general background and experience in the field of air pollution control [and], one with such background and experience in the field of water pollution control, *and one with such background and experience in the field of noise pollution control,* and who shall serve for four-year terms except that two of the first of such persons taking office shall be appointed for a two-year term. These four members shall be compensated at the rate of one hundred dollars per day when performing the work of the board. Within its appropriation, the board may appoint an executive [assistant] *director* and such hearing officers, including non-salaried hearing officers, and other employees as it may from time to time find necessary for the proper performance of its duties.

2. The environmental control board shall have jurisdiction to adopt and amend rules not inconsistent with any provisions of law:

(a) regulating or prohibiting the emission into the open air from any source, whether fixed or movable, and whether on land or water of any harmful or objectionable substances, including, but not limited to, smoke, soot, fly ash, dust, fumes, gas vapors and odors, and the installation, construction or alteration of equipment giving forth such emissions into the open air insofar as such emissions are affected thereby; and

(b) regulating or prohibiting the emissions into the waters within and about the city of New York from any source whether fixed or movable and whether on land or water of any harmful or objectionable substances, contaminants and pollutants.

3. The environmental control board shall enforce the provisions of the charter and the administrative code, and any rules and regulations made thereunder, which relate to the cleanliness of the streets, the disposal of wastes, the provision of a pure, wholesome and adequate supply of water, and the prevention of air [and], water *and noise* pollution [and of noise disturbance]. The board shall have authority from time to time to make, amend and rescind such rules and regulations as may be necessary to carry out its duties under this subdivision.

§ 4. Section 1403.2—15.03 of chapter 57 of the administrative code as added by local law 49 for the year 1971 is hereby amended as follows:

§ 1403.2—15.03 **The board**

(a) The board shall be convened by the chairman or in his absence the commisisoner of air resources or at the request of any [three] *five* members thereof.

(b) If a member of the board has presided over the initial hearing, he shall not be disqualified from reviewing the hearing.

(c) Three members of the board shall constitute a quorum [.], *except that on or after thirty days from the effective date of section 1403.3—8.03 of this chapter, five members of the board, at least two of whom shall not be city officials, shall constitute a quorum.*

§ 5. Section 1403.2—15.13 of such chapter of such code as added by such local law is hereby amended as follows:

§ 1403.2—15.13 **Hearings**

(a) The chairman of the board shall designate a hearing officer or at least one member of the board to preside over hearings held pursuant to this article. In any hearing in which [five or more members of the board preside,] *a quorum of the board is present* such members shall be deemed to be sitting as the board.

(b) All such hearings shall be open to the public.

(c) At the request of any party to such a hearing, the board shall by the issuance of a subpoena compel the attendance of such witnesses and shall require the production

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of any such books, papers, or other things relating to the matter under investigation if such a request reasonably relates to such hearing.

(d) Any party to a hearing may be represented by counsel, may make oral and written argument and cross-examine witnesses. All testimony taken before the board or the designated hearing officer shall be under oath and shall be recorded. The record shall be open to public inspection, and copies thereof shall be made available to any person upon payment of the actual cost of reproduction.

§ 6. This local law shall take effect September 1, 1972.

THEODORE S. WEISS, Chairman; CAROL GREITZER, CARTER BURDEN, HOWARD GOLDEN, LEON A. KATZ, ROBERT I. POSTEL, THEODORE SILVERMAN, MORTON POVMAN, A. JOSEPH RIBUSTELLO, KENNETH HABER, Committee on Environmental Protection, June 28, 1972.

On motion of the Vice-Chairman (Mr. Cuite), and adopted, the foregoing matter was made a General Order for the day and at the request of Mr. Weiss was laid aside for discussion. (See ROLL CALL ON ITEMS LAID ASIDE.)

ROLL CALL ON ITEM LAID ASIDE

The Vice-Chairman (Mr. Cuite) moved that the following General Order for the day previously laid aside be adopted.

(19) G.O. No. 69, Int. No. 661-A—Noise control.

Mr. Weiss then spoke on Int. No. 661-A.

At this point Mr. Gelfand moved to recommit Intro. No. 661A to the Commitee on Environmental Protection for further study.

Mr. Gelfand then spoke in support of his motion. Councilmen Lerner, De Marco, Silverman and Mrs. Stromberg spoke on the motion to recommit.

The President put the question whether the Council would agree with and adopt such motion to recommit which was decided in the *negative* by the following vote:

Negative—Arculeo, Burden, Clingan, Cohen, DiBlasi, Frankenberg, Friedland, Golden, Mrs. Greitzer, Haber, Katz, Katzman, Manton, Merola, Postel, Ribustello, Sadowsky, Salman, Scholnick, Sharison, Silverman, Taylor, Thompson, Weiss, and the Vice-Chairman (Mr. Cuite)—25.

Affirmative—Biondolillo, DeMarco, Gelfand, Mrs. Lerner, Mastropieri, Povman, Mrs. Ryan, Smith, Mrs. Stromberg, Troy, Ward—11.

Motion to recommit lost.

The President put the question whether the Council would agree with and adopt such report which was decided in the *affirmative* by the following vote:

Affirmative—Arculeo, Burden, Clingan, Cohen, DeMarco, DiBlasi, Frankenberg, Friedland, Golden, Mrs. Greitzer, Haber, Katz, Katzman, Manton, Mastropieri, Merola, Postel, Povman, Ribustello, Mrs. Ryan, Sadowsky, Salman, Scholnick, Sharison, Silverman, Mrs. Stromberg, Taylor, Thompson, Ward, Weiss, and the Vice-Chairman (Mr. Cuite)—31.

Negative—Biondolillo, Gelfand, Mrs. Lerner, Smith, Troy—5.

Noise Control Bill adopted.

APPENDIX E

PROVINCE OF ONTARIO EXPROPRIATIONS ACT

AS AMENDED IN 1971

ONTARIO

The Expropriations Act

Revised Statutes of Ontario, 1970

CHAPTER 154

as amended by

1971, Chapter 12

– and –

Regulations 285 and 286

Revised Regulations of Ontario, 1970

and

Ontario Regulation 491/71

DECEMBER

1971

TORONTO

PRINTED AND PUBLISHED BY WILLIAM KINMOND, QUEEN'S PRINTER AND PUBLISHER

CHAPTER 154

The Expropriations Act

Interpretation

1.—(1) In this Act,

(a) "approving authority" means the approving authority as determined under section 5;

(b) "Board" means the Land Compensation Board established under section 28;

(c) "expropriate" means the taking of land without the consent of the owner by an expropriating authority in the exercise of its statutory powers, but does not include the taking of land for the widening of a highway where entry is deferred under section 339 of *The Municipal Act*; R.S.O. 1970, c. 284

(d) "expropriating authority" means the Crown or any person empowered by statute to expropriate land;

(e) "injurious affection" means,

(i) where a statutory authority acquires part of the land of an owner,

a. the reduction in market value thereby caused to the remaining land of the owner by the acquisition or by the construction of the works thereon or by the use of the works thereon or any combination of them, and

b. such personal and business damages, resulting from the construction or use, or both, of the works as the statutory authority would be liable for if the construction or use were not under the authority of a statute,

(ii) where the statutory authority does not acquire part of the land of an owner,

a. such reduction in the market value of the land of the owner, and

b. such personal and business damages,

resulting from the construction and not the use of the works by the statutory authority, as the statutory authority would be liable for if the construction were not under the authority of a statute,

and for the purposes of this clause, part of the lands of an owner shall be deemed to have been acquired where the owner from whom lands are acquired retains lands contiguous to those acquired or retains lands of which the use is enhanced by unified ownership with those acquired;

(f) "judge", except where otherwise described, means a judge of the county or district court of the county or district in which the land or the greater part of it is situate;

(g) "land" includes any estate, term, easement, right or interest in, to, over or affecting land;

(h) "owner" includes a mortgagee, tenant, execution creditor, a person entitled to a limited estate or interest in land, a committee of the estate of a mentally incompetent person or of a person incapable of managing his affairs, and a guardian, executor, administrator or trustee in whom land is vested;

(i) "prescribed" means prescribed by the regulations made under this Act;

(j) "purchase-money mortgage" means a mortgage given by a purchaser of land to the vendor of the land or his nominee as security for the payment of all or part of the consideration for the sale;

(k) "registered owner" means an owner of land whose interest in the land is defined and whose name is specified in an instrument in the proper registry, land titles or sheriff's office, and includes a person shown as a tenant of land on the last revised assessment roll;

(l) "security holder" means a person who has an interest in land as security for the payment of money;

(m) "statutory authority" means the Crown or any person empowered by statute to expropriate land or cause injurious affection;

(n) "tenant" includes a lessee or occupant occupying premises under any tenancy whether written, oral or implied.

Service

(2) Any document required by this Act to be served may be served personally or by registered mail addressed to the person to be served at his last known address, or if that person or his address is unknown, by publication once a week for three weeks in a newspaper having general circulation in the locality in which the land concerned is situate and service shall be deemed to be made,

(a) in the case of service by registered mail, on the second day after the day of mailing; and

(b) in the case of service by publication, on the date of the third publication. R.S.O. 1970, c. 154, s. 1.

Application of Act

2.—(1) Notwithstanding any general or special Act, where land is expropriated or injurious affection is caused by a statutory authority, this Act applies.

(2) The provisions of any general or special Act providing procedures with respect to the expropriation of land or the compensation payable for land expropriated or for injurious affection that refer to *The Municipal Act*, *The Public Works Act* or any other Act shall be deemed to refer to this Act and not to *The Municipal Act*, *The Public Works Act* or other Act, as the case may be. References in other Acts to R.S.O. 1970, cc. 284, 393 deemed references to this Act

(3) This Act does not apply to the use of or injury to land authorized under *The Drainage Act* for the purposes of a drainage works constructed under that Act or to any proceedings in connection therewith. Application to R.S.O. 1970 c. 136

(4) Where there is conflict between a provision of this Act and a provision of any other general or special Act, the provision of this Act prevails. R.S.O. 1970, c. 154, s. 2. Conflict

3. This Act binds the Crown. R.S.O. 1970, c. 154, s. 3. Crown bound by Act

4.—(1) An expropriating authority shall not expropriate land without the approval of the approving authority as determined under section 5. Approval of intention to expropriate

(2) Subsection 1 does not apply to an authorization of the Ontario Energy Board under *The Ontario Energy Board Act* in respect of storage of gas in a gas storage area or to an expropriation authorized under section 41 of that Act. R.S.O. 1970, c. 154, s. 4. Gas storage areas excepted R.S.O. 1970, c. 312

5.—(1) Subject to subsections 3, 4 and 5, the approving authority in respect of an expropriation shall be the Minister responsible for the administration of the Act in which the power to expropriate is granted, except that, Approving authority

(*a*) where a municipality or a local board thereof, other than an elected school board, expropriates lands for municipal purposes, the approving authority shall be the council of the municipality; and

(*b*) where an elected school board expropriates lands, the approving authority shall be the school board. R.S.O. 1970, c. 154, s. 5 (1).

(1*a*) For the purposes of clause *b* of subsection 1, the Metropolitan Toronto School Board shall be deemed to be an elected school board. 1971, c. 12, s. 1. Idem, Metropolitan Toronto School Board

(2) Where the power to expropriate is granted in a private Act, the approving authority shall be, Idem, private Acts

(*a*) in the case of universities or other educational institutions, the Minister of University Affairs;

(*b*) in the case of hospitals or other medical or health institutions, the Minister of Health; and

(*c*) in the case of all other corporations, the Provincial Secretary and Minister of Citizenship.

Idem, public works R.S.O. 1970, c. 393

(3) Where an expropriation is made under *The Public Works Act* for the benefit of a department or agency of the Ontario Government, the approving authority shall be the Minister for the department or responsible for the agency for the benefit of which the land is expropriated.

Idem, Power Commission R.S.O. 1970, c. 354

(4) Where an expropriation is made under *The Power Commission Act*, the approving authority shall be the Minister of Energy and Resources Management.

Idem, other cases

(5) The approving authority in any case not provided for in this section shall be the Minister of Justice and Attorney General. R.S.O. 1970, c. 154, s. 5 (2-5).

Notice of intention to expropriate

6.—(1) Upon applying for an approval under section 4, an expropriating authority shall serve a notice of its application for approval to expropriate upon each registered owner of the lands to be expropriated and shall publish the notice once a week for three consecutive weeks in a newspaper having general circulation in the locality in which the lands are situate.

Notification for hearing

(2) Any owner of lands in respect of which notice is given under subsection 1 who desires a hearing shall so notify the approving authority in writing,

(*a*) in the case of a registered owner, served personally or by registered mail within thirty days after he is served with the notice, or, where he is being served with the notice by publication, within thirty days after the first publication of the notice;

(*b*) in the case of an owner who is not a registered owner, within thirty days after the first publication of the notice.

Order dispensing with inquiry

(3) The Lieutenant Governor in Council may, in special circumstances where he considers it necessary or expedient in the public interest to do so, direct that an intended expropriation shall proceed without the inquiry procedure and thereupon subsections 1 and 2 of this section, section 7 and subsections 1 and 2 of section 8 do not apply thereto.

Service of order

(4) Where an order is made under subsection 3, the expropriating authority shall forthwith serve a copy of the order on each registered owner affected by the intended expropriation.

Report to Assembly

(5) The Minister of Justice and Attorney General shall, within thirty days after the commencement of each session of the Legislative Assembly, lay before the Assembly a copy of each

order made theretofore under subsection 3 and not previously laid before the Assembly. R.S.O. 1970, c. 154, s. 6.

Appointment of inquiry officers

7.—(1) The Minister of Justice and Attorney General shall appoint a chief inquiry officer and such inquiry officers as he considers necessary.

Duties of chief inquiry officer

(2) The chief inquiry officer shall have general supervision and direction over inquiry officers and the assignment of their duties.

Hearing

(3) Where a notification is made under subsection 2 of section 6, the approving authority shall refer the matter to the chief inquiry officer who shall forthwith assign an inquiry officer who shall fix a time and place for a hearing and who shall cause notice of the hearing to be served upon each party to the inquiry.

Notice of grounds

(4) At least five days before the date fixed for the hearing, the expropriating authority shall serve upon each party to the inquiry a notice indicating the grounds upon which it intends to rely at the hearing and shall make available for inspection by the parties any documents, including maps and plans, that the expropriating authority intends to use at the hearing.

Inquiry

(5) The hearing shall be by means of an inquiry conducted by the inquiry officer who shall inquire into whether the taking of the lands or any part of the lands of an owner or of more than one owner of the same lands is fair, sound and reasonably necessary in the achievement of the objectives of the expropriating authority.

Report

(6) The inquiry officer shall report to the approving authority a summary of the evidence and arguments advanced by the parties, the inquiry officer's findings of fact, and his opinion on the merits of the application for approval with his reasons therefor.

Combined inquiries

(7) The inquiry officer may combine two or more related inquiries and conduct them in all respects and for all purposes as one inquiry.

Parties

(8) The expropriating authority, each owner who notifies the approving authority that he desires a hearing in respect of the lands intended to be expropriated and any owner added as a party by the inquiry officer are parties to the inquiry.

Powers and duties of inquiry officer

(9) The inquiry officer,

(*a*) may add any owner whose land would be affected by the expropriation of the lands concerned in the inquiry or any modification thereof as a party to the inquiry;

(*b*) shall give every party to the inquiry an opportunity to present evidence and argument and to examine and cross-examine witnesses, either personally or by his counsel or agent;

(*c*) is not bound by the technical or legal rules of evidence; and

(*d*) may inspect the lands concerned either alone or in the presence of the parties.

Costs

(10) The inquiry officer may recommend to the approving authority that a party to the inquiry be paid a fixed amount for his costs of the inquiry not to exceed $200 and the approving authority may in its discretion order the expropriating authority to pay such costs forthwith. R.S.O. 1970, c. 154, s. 7.

Powers and duties of approving authority

8.—(1) The approving authority shall consider the report of the inquiry officer and shall approve or not approve the proposed expropriation or approve the proposed expropriation with such modifications as the approving authority considers proper, but an approval with modifications shall not affect the lands of a registered owner who is not or has not been made a party to the hearing.

Reasons

(2) The approving authority shall give written reasons for its decision and shall cause its decision and the reasons therefor to be served upon all the parties within ninety days after the date upon which the report of the inquiry officer is received by the approving authority.

Certificate

(3) The approving authority shall certify its approval in the prescribed form. R.S.O. 1970, c. 154, s. 8.

Registration of plan
R.S.O. 1970, c. 312

9.—(1) Where a proposed expropriation has been approved under this Act or under *The Ontario Energy Board Act*, the expropriating authority shall register, within three months after the granting of the approval, in the proper registry or land titles office a plan of the land signed by the expropriating authority and by an Ontario land surveyor, and thereupon, but not otherwise, the land vests in the expropriating authority.

Where land required temporarily, etc.

(2) Where the land is required for a limited time only or only a limited estate, right or interest therein is required, the plan registered under this section shall indicate by appropriate words thereon that the land is taken for such limited time only or that only such limited estate, right or interest therein is taken, and, by the registration in such case, the land for such limited time or such limited estate, right or interest therein vests in the expropriating authority.

Correction of errors

(3) In the case of an omission, misstatement or erroneous description in a plan registered under this section, the expropriating authority may register in the proper registry or land titles office a plan replacing or amending the original plan and signed by the expropriating authority and by an Ontario land surveyor, and a plan registered under this subsection shall be marked to show the nature of the replacement or amendment and is of the same

force and effect as, and is in substitution for, the original plan to the extent that such plan is replaced or amended thereby.

Presumption as to signing

(4) Where a plan purports to have been signed by an expropriating authority under this section, it shall be presumed to have been signed by the expropriating authority without proof of the signature or official character of the person appearing to have signed it, unless otherwise directed by a court or the Board.

Ontario Hydro R.S.O. 1970, c. 354

(5) Where a limited estate, right or interest in land is being taken under *The Power Commission Act* for an electrical transmission or distribution line carried on single poles, The Hydro-Electric Power Commission of Ontario may, before registering a plan under subsection 1, register in the proper registry or land titles office a preliminary plan, to be known as and marked "Preliminary Plan" and being a plan with or without local description, signed by the secretary of the Commission and illustrating the location of the proposed line and indicating by appropriate words thereon the nature of the estate, right or interest being taken, and such preliminary plan when registered has the same force and effect as a plan registered under subsection 1, but a plan in accordance with subsection 1 shall be registered within two years after the registration of the preliminary plan in substitution for the preliminary plan. R.S.O. 1970, c. 154, s. 9.

Notice of expropriation

10.—(1) Where a plan has been registered under section 9 and no agreement as to compensation has been made with the owner, the expropriating authority may serve the owner, and shall serve the registered owner, within thirty days after the date of registration of the plan, with a notice of expropriation of his land, in the prescribed form, but failure to serve the notice does not invalidate the expropriation.

Election of date for compensation

(2) Where a plan has been registered under section 9, the registered owner may elect, by notice in writing served upon the expropriating authority, within thirty days after the owner was served with the notice under subsection 1, to have the compensation to which he is entitled assessed,

(*a*) where there has been an inquiry, as of the date the notice of hearing before the inquiry officer was served;

(*b*) as of the date of the registration of the plan; or

(*c*) as of the date on which he was served with the notice of expropriation,

and, where the election is not made within the prescribed time, the owner shall be deemed to have elected to have the compensation assessed as of the date of the registration of the plan.

Entry on land for appraisal

(3) An expropriating authority may, after it has served notice of expropriation on the owner in possession of the lands expropriated, and with the consent of the said owner, enter on the

expropriated lands for the purposes of viewing for appraisal, but, where the consent of the owner is not given, the expropriating authority may apply to the Board which may, by order, authorise the entry upon such terms and conditions as may be specified in the order. R.S.O. 1970, c. 154, s. 10.

Reparation

11. Where land is expropriated or is injuriously affected by a statutory authority, the statutory authority may, before the compensation is agreed upon or determined, undertake to make alterations or additions or to construct additional work or to grant other lands, in which case, the compensation shall be determined having regard to such undertaking, and, if the undertaking has not already been carried out, the Board may declare that, in addition to the compensation determined, if any, the owner is entitled to have such alteration or addition made or such additional work constructed or such grant made to him. R.S.O. 1970, c. 154, s. 11.

Gas storage areas R.S.O. 1970, c. 312

12. Section 21 of *The Ontario Energy Board Act* applies in respect of the use of designated gas storage areas. R.S.O. 1970, c. 154, s. 12.

Compensation

13.—(1) Where land is expropriated, the expropriating authority shall pay the owner such compensation as is determined in accordance with this Act.

Idem

(2) Where the land of an owner is expropriated, the compensation payable to the owner shall be based upon,

(*a*) the market value of the land;

(*b*) the damages attributable to disturbance;

(*c*) damages for injurious affection; and

(*d*) any special difficulties in relocation,

but, where the market value is based upon a use of the land other than the existing use, no compensation shall be paid under clause *b* for damages attributable to disturbance that would have been incurred by the owner in using the land for such other use. R.S.O. 1970, c. 154, s. 13.

Market value

14.—(1) The market value of land expropriated is the amount that the land might be expected to realize if sold in the open market by a willing seller to a willing buyer.

Idem

(2) Where the land expropriated is devoted to a purpose of such a nature that there is no general demand or market for land for that purpose, and the owner intends in good faith to relocate in similar premises, the market value shall be deemed to be the reasonable cost of equivalent reinstatement.

(3) Where only part of the land of an owner is taken and such part is of a size, shape or nature for which there is no general demand or market, the market value and the injurious affection caused by the taking may be determined by determining the market value of the whole of the owner's land and deducting therefrom the market value of the owner's land after the taking. Idem

(4) In determining the market value of land, no account shall be taken of, Idem

(a) the special use to which the expropriating authority will put the land;

(b) any increase of decrease in the value of the land resulting from the imminence of the development in respect of which the expropriation is made or from any imminent prospect of expropriation; or

(c) any increase in the value of the land resulting from the land being put to a use that could be restrained by any court or is contrary to law or is detrimental to the health of the occupants of the land or to the public health. R.S.O. 1970, c. 154, s. 14.

15. Upon application therefor, the Board shall, by order, after fixing the market value of lands used for residential purposes of the owner under subsection 1 of section 14, award such additional amount of compensation as, in the opinion of the Board, is necessary to enable the owner to relocate his residence in accommodation that is at least equivalent to the accommodation expropriated. R.S.O. 1970, c. 154, s. 15. Increase by Board

16. Where there are more separate interests than one in land, other than the interest of a security holder or a vendor under an agreement for sale, the market value of each such separate interest shall be valued separately. R.S.O. 1970, c. 154, s. 16. Separate interests

17.—(1) In this section, "bonus" means the amount by which the amount secured under a mortgage exceeds the amount actually advanced. Interpretation

(2) Where land is subject to a security interest, Security holders

(a) the value of the interest of the security holder shall be determined in accordance with this section and section 20 and not otherwise; and

(b) the market value of the land shall be determined without regard to the interest of the security holder and the amount of such market value plus any damages for injurious affection shall stand in place of the land for the purposes of the security.

Payment out of market value

(3) Security holders shall be paid the amount of principal and interest outstanding against the security out of the market value of the land and any damages for injurious affection payable in respect of the land subject to the security, in accordance with their priorities, whether or not such principal and interest is due, and subject to subsections 4 and 5.

Bonus

(4) Where the land is subject to a mortgage and the amount payable to the mortgagee under subsection 3 is insufficient to satisfy the mortgage in full,

(a) where the mortgage is a purchase-money mortgage, the mortgage shall be deemed to be fully paid, satisfied and discharged for all purposes; and

(b) where the mortgage is not a purchase-money mortgage and includes a bonus,

(i) the amount by which the amount payable to the mortgagee under subsection 3 is insufficient to pay the amount remaining unpaid under the mortgage, or

(ii) the amount of the bonus,

whichever is the lesser, shall be deemed to be fully paid and satisfied for all purposes.

Idem

(5) No amount shall be paid in respect of a bonus until all security holders have been paid all amounts payable other than any bonus.

Idem

(6) Where land held as security is expropriated in part or is injuriously affected, a security holder is entitled to be paid to the extent possible in accordance with his priority, out of the market value portion of the compensation and any damages for injurious affection therefor, as the case may be, a sum that is in the same ratio to such portion of the compensation and damages as the balance outstanding on the security at the date of the expropriation or injurious affection is to the market value of the entire land, provided however that the sum so determined shall be reduced by the amount of any payments made to the security holder by the owner after the date of expropriation or injurious affection. R.S.O. 1970, c. 154, s. 17.

Allowance for disturbance: owner other than tenant

18.—(1) The expropriating authority shall pay to an owner other than a tenant, in respect of disturbance, such reasonable costs as are the natural and reasonable consequences of the expropriation, including,

(a) where the premises taken include the owner's residence,

(i) an allowance to compensate for inconvenience and the cost of finding another residence of 5 per cent of the compensation payable in respect of the market value of that part of the land expropriated that is

used by the owner for residential purposes, provided that such part was not being offered for sale on the date of the expropriation, and

(ii) an allowance for improvements the value of which is not reflected in the market value of the land;

(*b*) where the premises taken do not include the owner's residence, the owner's costs of finding premises to replace those expropriated, provided that the lands were not being offered for sale on the date of expropriation; and

(*c*) relocation costs, including,

(i) the moving costs, and

(ii) the legal and survey costs and other non-recoverable expenditures incurred in acquiring other premises.

(2) The expropriating authority shall pay to a tenant occupying expropriated land in respect of disturbance so much of the cost referred to in subsection 1 as is appropriate having regard to, tenant

(*a*) the length of the term;

(*b*) the portion of the term remaining;

(*c*) any rights to renew the tenancy or the reasonable prospects of renewal;

(*d*) in the case of a business, the nature of the business; and

(*e*) the extent of the tenant's investment in the land. R.S.O. 1970, c. 154, s. 18.

19.—(1) Where a business is located on the land expropriated, the expropriating authority shall pay compensation for business loss resulting from the relocation of the business made necessary by the expropriation and, unless the owner and the expropriating authority otherwise agree, the business losses shall not be determined until the business has moved and been in operation for six months or until a three-year period has elapsed, whichever occurs first. Business loss

(2) The Board may, in determining compensation on the application of the expropriating authority or an owner, include an amount not exceeding the value of the good will of a business where the land is valued on the basis of its existing use and, in the opinion of the Board, it is not feasible for the owner to relocate. R.S.O. 1970, c. 154, s. 19. Good will

20. Where a statutory authority prepays a mortgage in whole or in part, the statutory authority, Prepayment of mortgage

(*a*) shall pay to the mortgagee a bonus in respect of the prepayment amounting to,

(i) three months interest on the amount of principal prepaid at the rate of 6 per cent a year or at such other rate as is prescribed by the Lieutenant Governor in Council by regulation, or

(ii) the value of any notice or bonus for prepayment provided for in the mortgage,

whichever is the lesser;

(*b*) shall pay to the mortgagee where,

(i) the prevailing interest rate for an equivalent investment is lower than the rate under the mortgage, and

(ii) there is no provision in the mortgage permitting prepayment at the date of the expropriation,

an amount to compensate for the difference in the interest rates for the period for which the amount of principal prepaid has been advanced, not to exceed five years; and

(*c*) shall pay to the mortgagor whose interest is expropriated an amount to compensate for any loss incurred by reason of a difference in the interest rates during the period for which the payment of principal provided for in the mortgage has been advanced, but such difference shall not be calculated on a new interest rate any greater than the prevailing interest rate for an equivalent mortgage. R.S.O. 1970, c. 154, s. 20.

Compensation for injurious affection

21. A statutory authority shall compensate the owner of land for loss or damage caused by injurious affection. R.S.O. 1970, c. 154, s. 21.

Claim for compensation for injurious affection

22.—(1) Subject to subsection 2, a claim for compensation for injurious affection shall be made by the person suffering the damage or loss in writing with particulars of the claim within one year after the damage was sustained or after it became known to him, and, if not so made, the right to compensation is forever barred.

Idem, where owner under disability

(2) Where the person who is injuriously affected is an infant, a mental incompetent or a person incapable of managing his affairs, his claim for compensation shall be made within one year after he ceased to be under the disability or, in the case of his death while under the disability, within one year after his death, and, if not so made, the right to compensation is forever barred. R.S.O. 1970, c. 154, s. 22.

Set-off against damages

23. The value of any advantage to the land or remaining land of an owner derived from any work for which land was expropriated or by which land was injuriously affected shall be set off only

against the amount of the damages for injurious affection to the owner's land or remaining lands. R.S.O. 1970, c. 154, s. 23.

Agreements

24. A statutory authority has the authority to make and perform an agreement with an owner in respect of any claim of the owner under this Act, including any costs of the owner and notwithstanding that this Act requires the claim to be determined by the Board. R.S.O. 1970, c. 154, s. 24.

Offer

25.—(1) Where no agreement as to compensation has been made with the owner, the expropriating authority shall, within three months after the registration of a plan under section 9 and before taking possession of the land,

(*a*) serve upon the registered owner,

(i) an offer of an amount in full compensation for his interest, and

(ii) where the registered owner is not a tenant, a statement of the total compensation being offered for all interests in the land,

excepting compensation for business loss for which the determination is postponed under subsection 1 of section 19; and

(*b*) offer the registered owner immediate payment of 100 per cent of the amount of the market value of the owner's land as estimated by the expropriating authority, and the payment and receipt of that sum is without prejudice to the rights conferred by this Act in respect of the determination of compensation and is subject to adjustment in accordance with any compensation that may subsequently be determined in accordance with this Act or agreed upon.

Furnishing appraisal report

(2) The expropriating authority shall base its offer of compensation made under subsection 1 upon a report appraising the market value of the lands being taken and damages for injurious affection, and shall serve a copy of the appraisal report upon the owner at the time the offer is made.

Extension of time

(3) The expropriating authority may, within the period mentioned in subsection 1 and before taking possession of the land, upon giving at least two days notice to the registered owner, apply to the judge for an order extending any time referred to in subsection 1, and the judge may in his order authorize the statutory authority to take possession of the land before the expiration of the extended time for serving the offer or statement under clause *a* of subsection 1 upon such conditions as may be specified in the order.

Failure to serve

(4) If any registered owner is not served with the offer required to be served on him under subsection 1 within the time limited by

subsection 1 or by an order of a judge under subsection 3 or by agreement, the failure does not invalidate the expropriation but interest upon the unpaid portion of any compensation payable to such registered owner shall be calculated from the date of registration of the plan. R.S.O. 1970, c. 154, s. 25.

Choice of proceedings, negotiation or arbitration

26. Where the statutory authority and the owner have not agreed upon the compensation payable under this Act and, in the case of injurious affection, section 22 has been complied with, or, in the case of expropriation, section 25 has been complied with, or the time for complying therewith has expired,

(*a*) the statutory authority or the owner may serve notice of negotiation upon the other of them and upon the board of negotiation stating that it or he, as the case may be, requires the compensation to be negotiated under section 27; or

(*b*) where the statutory authority and the owner have agreed to dispense with negotiation proceedings, the statutory authority or the owner may serve notice of arbitration upon the other of them and upon the Board to have the compensation determined by arbitration. R.S.O. 1970, c. 154, s. 26.

Board of negotiation

27.—(1) A board of negotiation shall be established consisting of two or more members appointed by the Lieutenant Governor in Council, one of whom may be designated as chairman.

Quorum

(2) Any two of the members of the board of negotiation constitute a quorum and are sufficient to perform all the functions of the board on behalf of the board.

Place of sitting

(3) The board of negotiation may sit at any place in Ontario.

Negotiation of amount of compensation

(4) In any case in which a notice of negotiation is served, the board of negotiation shall, upon reasonable notice to the statutory authority and the owner, meet with them and, without prejudice to any subsequent proceedings, proceed in a summary and informal manner to negotiate a settlement of the compensation.

Inspection of land

(5) Before or during the negotiation proceedings, the board of negotiation shall inspect the land that has been expropriated or injuriously affected.

Where no settlement reached

(6) If the negotiation proceedings do not result in a settlement of the compensation, the statutory authority or the owner may serve notice of arbitration upon the other of them, and upon the Board, stating that it or he, as the case may be, requires the compensation to be determined by arbitration as though the negotiation proceedings had not taken place. R.S.O. 1970, c. 154, s. 27.

Land Compensation Board

22.—(1) The Land Compensation Board is continued and shall be composed of a chairman and such number of vice-chairmen and other members as the Lieutenant Governor in Council considers advisable, all of whom shall be appointed by the Lieutenant Governor in Council.

Qualifications of chairman and vice-chairmen

(2) The chairman and vice-chairmen shall be members of the bar of one of the provinces of Canada.

Quorum

(3) The chairman or a vice-chairman and two other members of the Board constitute a quorum and are sufficient for the exercise of all the jurisdiction and powers of the Board, except that in matters respecting a claim for compensation not exceeding $1,000, one member of the Board constitutes a quorum and is sufficient for the exercise of all the jurisdiction of the Board.

Powers of Board

(4) The Board may,

(a) administer oaths to witnesses and require them to give evidence under oath;

(b) issue summonses requiring the attendance of witnesses and the production of documents and things;

(c) hold sittings at any place in Ontario and in more than one place at the same time.

Enforcement of summons

(5) If any person,

(a) on being duly summoned as a witness before the Board makes default in attending; or

(b) being in attendance as a witness refuses to take an oath legally required by the Board to be taken, or to produce any document or thing in his power or control legally required by the Board to be produced by him, or to answer any question to which the Board may legally require an answer; or

(c) does any other thing that would, if the Board had been a court of law having power to commit for contempt, have been contempt of that court,

a member of the Board may certify the offence of that person under his hand to the High Court, and the court may thereupon inquire into the alleged offence and after hearing any witnesses who may be produced against or on behalf of the person charged with the offence, and after hearing any statement that may be offered in defence, punish or take steps for the punishment of that person in like manner as if he had been guilty of contempt of the court.

Practice and procedure

(6) Subject to the approval of the Lieutenant Governor in Council, the Board shall make rules governing its practice and procedure and the exercise of its powers.

Registrar and employees R.S.O. 1970, c. 386

(7) A registrar and such other officers and employees of the Board as are considered necessary shall be appointed under *The Public Service Act*. R.S.O. 1970, c. 154, s. 28.

Service of appraisal reports

29.—(1) At least fifteen days before the date fixed for the hearing of an application before the Board, any party to the application shall serve upon each other party a copy of any appraisal report upon which it intends to rely at the hearing.

Expert evidence as to compensation

(2) Where it is intended by a party to adduce evidence as to compensation by persons entitled by law or custom to give opinion evidence, not more than three such persons may be called by either party without the leave of the Board. R.S.O. 1970, c. 154, s. 29.

Duties of Board

30.—(1) The Board shall determine any compensation in respect of which a notice of arbitration has been served upon it under section 26 or 27, and, in the absence of agreement, determine any other matter required by this or any other Act to be determined by the Board.

Record

(2) All oral evidence submitted before the Board shall be taken down in writing and, together with such documentary evidence and things as are received in evidence by the Board, form the record.

Reasons

(3) The Board shall prepare and furnish the parties to an application with written reasons for its decision.

Reports

(4) The Board may prepare and periodically publish a summary of such of its decisions and the reasons therefor as the Board considers to be of general public significance. R.S.O. 1970, c. 154, s. 30.

Stated case

31.—(1) Where the jurisdiction of the Board or the validity of any decision, order, direction or other act of the Board is called into question by any person affected, the Board, upon the request of such person, shall state a case in writing to the Court of Appeal setting forth the material facts and the decision of the court thereon is final and binding.

Order directing stated case

(2) If the Board refuses to state a case, any person affected may apply to the Court of Appeal for an order directing the Board to state a case.

Proceedings stayed until case determined

(3) Pending the decision of the stated case, no further proceedings in respect of the application shall be taken by the Board. R.S.O. 1970, c. 154, s. 31.

Appeals

32.—(1) An appeal lies to the Court of Appeal from any determination or order of the Board.

Idem

(2) The practice and procedure as to the appeal and proceedings incidental thereto are the same *mutatis mutandis* as upon an appeal from the High Court, except that the appeal may be taken at any time within six weeks from the day the determination or order was served on the parties, and the period of any vacation of the Supreme Court shall not be reckoned in computing such six weeks.

Powers of Court of appeal

(3) An appeal under subsection 1 may be made on questions of law or fact or both and the Court of Appeal,

(*a*) may refer any matter back to the Board; or

(*b*) may make any decision or order that the Board has power to make,

and may exercise the same powers as it exercises on an appeal from a judge of the High Court sitting without a jury.

Extension of time for appeal

(4) A judge of the Court of Appeal may extend the time for appeal for such period as he considers proper. R.S.O. 1970, c. 154, s. 32.

Costs

33.—(1) Where the amount to which an owner is entitled upon an expropriation or claim for injurious affection is determined by the Board and the amount awarded by the Board is 85 per cent, or more, of the amount offered by the statutory authority, the Board shall make an order directing the statutory authority to pay the reasonable legal, appraisal and other costs actually incurred by the owner for the purposes of determining the compensation payable, and may fix the costs in a lump sum or may order that the determination of the amount of such costs be referred to a taxing officer of the Supreme Court who shall tax and allow the costs in accordance with this subsection and the tariffs and rules prescribed under clause *d* of section 45.

Idem

(2) Where the amount to which an owner is entitled upon an expropriation or claim for injurious affection is determined by the Board and the amount awarded by the Board is less than 85 per cent of the amount offered by the statutory authority, the Board may make such order, if any, for the payment of costs as it considers appropriate, and may fix the costs in a lump sum or may order that the determination of the amount of such costs be referred to a taxing officer of the Supreme Court who shall tax and allow the costs in accordance with the order and the tariffs and rules prescribed under clause *d* of section 45 in like manner to the taxation of costs awarded on a party and party basis. 1971, c. 12, s. 2.

Interest

34.—(1) Subject to subsection 4 of section 25, the owner of lands expropriated is entitled to be paid interest on the portion of the market value of his interest in the land and on the portion of any allowance for injurious affection to which he is entitled, outstanding from time to time, at the rate of 6 per cent a year calculated from the date the owner ceases to reside on or make productive use of the lands.

Variation of interest

(2) Subject to subsection 3, where the Board is of the opinion that any delay in determining the compensation is attributable in whole or in part to the owner, it may refuse to allow him interest for the whole or any part of the time for which he might otherwise be entitled to interest, or may allow interest at such rate less than 6 per cent a year as appears reasonable.

Idem

(3) The interest to which an owner is entitled under subsection 1 shall not be reduced for the reason only that the owner did not accept the offer made by the expropriating authority, notwithstanding that the compensation as finally determined is less than the offer.

Idem

(4) Where the Board is of the opinion that any delay in determining compensation is attributable in whole or in part to the expropriating authority, the Board may order the expropriating authority to pay to the owner interest under subsection 1 at a rate exceeding 6 per cent a year but not exceeding 12 per cent a year. R.S.O. 1970, c. 154, s. 34.

Abatement of rent

35.—(1) Subject to subsection 2, where only part of the interest of a lessee is expropriated, the lessee's obligation to pay rent under the lease shall be abated *pro tanto*, as determined by the Board.

Frustration of lease

(2) Where all the interest of a lessee in land is expropriated or where part of the lessee's interest is expropriated and the expropriation renders the remaining part of the lessee's interest unfit for the purposes of the lease, as determined by the Board, the lease shall be deemed to be frustrated from the date of the expropriation. R.S.O. 1970, c. 154, s. 35.

Character of compensation

36. Where land has been expropriated, the compensation stands in the stead of the land, and any claim to or encumbrance on the land is, as respects the expropriating authority, converted into a claim to or upon the compensation and no longer affects the land. R.S.O. 1970, c. 154, s. 36.

Payment of compensation not exceeding $1,000

37. Where the owner who is entitled to convey the land that has been expropriated or injuriously affected and the statutory authority agree as to the compensation or the compensation has been determined and in either case it does not exceed $1,000, the statutory authority may pay the compensation to the owner who is entitled to convey the land, saving always the rights of any

other person to the compensation as against the person receiving it, and such payment discharges the statutory authority from all liability in respect of the compensation. R.S.O. 1970, c. 154, s. 37.

Representative

38. Where an owner of the land is unknown, is under a disability or for any other reason is not represented, a judge of the Supreme Court may, after due notice to the persons interested, appoint a person to represent such owner for any of the purposes of this Act, and any action of a person so appointed is binding on the person whom he represents. R.S.O. 1970, c. 154, s. 38.

Payment into court

39.—(1) In any case where the statutory authority considers it advisable, it may without an order, pay the compensation agreed upon or determined into the office of the Accountant of the Supreme Court together with a sum equal to the interest thereon at the rate of 6 per cent a year for six months.

Payment out of court

(2) Upon an application for payment out of court of compensation paid into court, a judge of the Supreme Court may direct that such notice of the application be given by publication or otherwise as he considers proper and may direct the trial of an issue or make such order with respect to the payment out of court of compensation and as to costs as he considers reasonable.

Adjustment of interest

(3) Where an order is obtained under subsection 2 in less than six months after the payment of the compensation into court, the judge making the order may direct that a proportionate part of the interest be returned to the statutory authority.

Where unborn issue interested

(4) Where unborn issue or an unascertained person or class is interested in compensation paid into court, a judge of the Supreme Court may appoint such person as he considers proper to represent them, and any order made under this section is binding on them. R.S.O. 1970, c. 154, s. 39.

Possession of expropriated land

40.—(1) Where land that has been expropriated is vested in an expropriating authority and the expropriating authority has served the registered owner with a notice that it requires possession of the land on the date specified therein, the expropriating authority, subject to any agreement to the contrary and if no application is made under subsection 3, shall take possession of the land on the date specified in the notice.

Date for possession

(2) Subject to subsection 3, the date for possession shall be at least three months after the date of the serving of the notice of possession.

Application for postponement of possession

(3) A registered owner or an expropriating authority may, upon such notice as the judge may direct, apply to a judge for an adjustment of the date for possession specified in the notice of possession, and the judge, if he considers that under all the

circumstances the application should be granted, may order that the date for possession shall be on such earlier or later date as he may specify in the order. R.S.O. 1970, c. 154, s. 40.

Warrant to put down resistance to entry, etc.

41.—(1) Where resistance or opposition is made to the expropriating authority or any person authorized by it in entering upon, using or taking possession of land when it is entitled so to do, it may apply to a judge for a warrant directing the sheriff to put down the resistance or opposition.

Hearing

(2) The judge shall, in writing, appoint a time and place for the hearing of the application and in his appointment may direct that it shall be served upon such person as he may prescribe.

Issue of warrant

(3) On proof of the resistance or opposition, the judge may issue a warrant.

Return

(4) The sheriff shall forthwith execute the warrant and make a return to the judge of the execution thereof. R.S.O. 1970, c. 154, s. 41.

Abandonment of expropriated land

42.—(1) Where, at any time before the compensation upon an expropriation is paid in full, the land or any part thereof is found to be unnecessary for the purposes of the expropriating authority or if it is found that a more limited estate or interest therein only is required, the expropriating authority shall so notify each owner of the abandoned land, or estate or interest, who is served or entitled to be served with the notice of expropriation, who may, by election in writing,

(*a*) take the land, estate or interest back, in which case he has the right to compensation for consequential damages; or

(*b*) require the expropriating authority to retain the land, estate or interest, in which case he has the right to full compensation therefor.

Revesting

(2) Where all the owners elect to take the land, estate or interest back under clause *a* of subsection 1, the expropriating authority may, by an instrument signed by it and registered in the proper registry or land titles office and served on each owner, declare that the land or part thereof is not required and is abandoned by the expropriating authority or that it is intended to retain only such limited estate or interest as is mentioned in the instrument, and thereupon,

(*a*) the land declared to be abandoned revests in the owner from whom it was expropriated and those entitled to claim under him; or

(*b*) in the event of a limited estate or interest only being retained by the expropriating authority, the land so revests subject to such limited estate or interest. R.S.O. 1970, c. 154, s. 42.

43. Where lands that have been expropriated and are in the possession of the expropriating authority are found by the expropriating authority to be no longer required for its purposes, the expropriating authority shall not, without the approval of the approving authority, dispose of the lands without giving the owners from whom the land was taken the first chance to repurchase the lands on the terms of the best offer received by the expropriating authority. R.S.O. 1970, c. 154, s. 43. Disposal of expropriated lands

44. Any application to set aside or quash any proceeding or step taken under this Act shall be made within thirty days after the proceeding or step in respect of which the application is made, but this section does not apply where the applicant was entitled to and not given notice of the proceeding or step or where the proceeding or step was a nullity. R.S.O. 1970, c. 154, s. 44. Time for application

45. The Lieutenant Governor in Council may make regulations, Regulations

(*a*) prescribing rates of interest for the purposes of section 20;

(*b*) prescribing forms for the purposes of this Act and providing for their use;

(*c*) prescribing procedures respecting applications to and hearings by inquiry officers and boards of negotiation;

(*d*) prescribing tariffs of costs and rules to be applied by taxing officers for the purposes of section 33. R.S.O. 1970, c. 154, s. 45; 1971, c. 12, s. 3.

46.—(1) This Act applies in respect of expropriations for which a plan has not been registered under section 4 of *The Expropriation Procedures Act, 1962-63* before the 20th day of December, 1968, and an expropriation for which a plan has been registered under section 4 of the said Act before the 20th day of December, 1968, shall be continued in accordance with *The Expropriation Procedures Act, 1962-63*, except that where the compensation has not been agreed upon between the parties and no evidence has been heard by a tribunal under *The Expropriation Procedures Act, 1962-63*, other than the board of negotiation, sections 13 to 21, 23, 24, 29, 33, 34, 35 and 42 apply thereto. R.S.O. 1970, c. 154, s. 46. Application to existing proceedings 1962-63, c. 43

(2) Notwithstanding subsection 1, on and after the 1st day of December, 1970 the Land Compensation Board appointed under section 28 has jurisdiction, and on and after the 1st day of April, 1971 has sole jurisdiction, to determine compensation by arbitration in respect of every expropriation whether commenced under this or any other Act, except that where a tribunal under this or any other Act, has heard any evidence in a proceeding to Jurisdiction of tribunals

determine compensation by arbitration, such tribunal retains jurisdiction for the purpose of completing the proceedings and for the purpose of dealing with matters referred to it under clause *a* of subsection 3 of section 32.

(3) Where a notice of arbitration or an application for arbitration under this or any other Act was filed before the 1st day of April, 1971 with a tribunal other than the Land Compensation Board and no evidence has been heard in respect of the arbitration, the notice or application and any documents relating thereto shall be deemed to have been filed with the Land Compensation Board. 1971, c. 12, s. 4. Transmission of material

BILL 6 **1972**

An Act to amend The Expropriations Act

HER MAJESTY, by and with the advice and consent of the Legislative Assembly of the Province of Ontario, enacts as follows:

1.—(1) Clause *b* of subsection 4 of section 14 of *The Expropriations Act*, being chapter 154 of the Revised Statutes of Ontario, 1970, is repealed and the following substituted therefor: s. 14 (4) (*b*), re-enacted

(*b*) any increase or decrease in the value of the land resulting from the development or the imminence of the development in respect of which the expropriation is made or from any expropriation or imminent prospect of expropriation.

(2) The said section 14 is amended by adding thereto the following subsections: s. 14, amended

(5) Where two or more expropriating authorities, including Her Majesty the Queen in right of Canada, participate in a development or a number of related developments, the Lieutenant Governor in Council may, by regulation, designate such development or developments as a co-operative development and subsection 4 shall apply to the determination of the market value of any land expropriated by any of the participating provincial expropriating authorities for any aspect or part of the co-operative development as if the entire co-operative development was a single development being carried out by that expropriating authority. Co-operative developments

(6) Any regulation made under subsection 5 and filed under *The Regulations Act* in the year 1972 may be retroactive in its application and may provide that it comes into force and has effect on and after a day not earlier than the 2nd day of March, 1972. Regulations, effective date R.S.O. 1970, c. 410

Commencement **2.** This Act shall be deemed to have come into force on the 2nd day of March, 1972.

Short title **3.** This Act may be cited as *The Expropriations Amendment Act, 1972*.