Integrating Harvesting Values with Community: Planning for Mineral Aggregate Extraction in the City of Prince George

Integrating Harvesting Values with Community: Planning for Mineral Aggregate Extraction in the City of Prince George

by

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Abstract

Mineral aggregate extraction disturbs and alienates more land area than any other type of mining activity in Canada. It is a form of surface mining that generates environmental and social impacts in communities where there is an abundance of excavation taking place. In this thesis, I develop a conceptual model for aggregate resources management at the local level based on the normative theories of environmental planning and environmental impact assessment. The objective of the research is to develop a process by which resource harvesting values may be integrated with those of communities where extraction takes place. Using the City of Prince George as a case study, the municipal management of mineral aggregate resources is examined. The state of the planning and permitting process, impacts generated from operations, reclamation and relationships among stakeholder groups is determined through the case study research. Major findings from the case study research indicate that 1) there is a lack of provincial direction to municipalities as to how aggregate resources should be managed locally, 2) conflict exists between the City of Prince George and MEMPR, 3) the Official Community Plan (OCP) and Soil Removal By-law #3000 are in effective at planning for, and regulating operations throughout the city, 4) impacts such as noise, dust, public safety and visual disturbance require mitigation in areas throughout the city, 5) the lack of reclamation of disturbed areas is a primary concern among stakeholder groups and 6) there is a need to involve the public throughout the planning process. Incorporating these findings into the aggregate resource management model, a series of recommendations are made to the City. The principal recommendations are 1) aggregate resource and natural feature inventories should be undertaken, 2) OCP policies should be consolidated to include an expressed management approach for mineral aggregates, 3) supply and demand models should be used to determine the location of aggregate reserve areas in the city, 4) in assessing applications the City should employ the use of impact checklists, rating criteria and land disturbance targets and 5) the City should establish a Resource Planning Committee comprised of stakeholder groups. If these recommendation are implemented improvements in how decisions are made about aggregate resources management in Prince George will improve, the impacts from the industry will be mitigated throughout the city, and conflict among stakeholder groups will be reduced. The attainment of these objectives can contribute to meeting the goals of sustainability and community health in the use of our local land resources.

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Introduction: Planning for Mineral Aggregate Extraction

1.0 Introduction

On Tuesday May 31st, 1808, Simon Fraser made an entry into his journal describing the land before him as he canoed down what is now the Fraser River, just south of Fort George. He noted that: "There are almost continual banks on both sides of the River and the wood...is scanty, neither does the soil appear to be good, being generally sand on gravel" (Cole and Lockner, 1989, 136). At that time, Fraser was commenting on the limited potential of the soil for farming. Despite the inadequacy of the soils close to the river bank for this purpose, settlers did find organic soils further from the river upon the plateau, the result of richer sediments deposited there during the last glacial retreat (Tipper, 1971). Almost two centuries since that journal entry, the City of Prince George has developed into the fourth largest settlement in the Province of British Columbia. As the area developed and trade and commerce began to thrive, industry also made an appearance. Accompanying these developments was the infrastructure needed to sustain the productivity of the region and in turn, the materials used in its construction. The soils along the river banks, once perceived to be of little use, have become an instrumental resource in developing and maintaining the settlement Simon Fraser founded so long ago.

The purpose of this thesis is to develop a prescribed management directive for mineral aggregate extraction at the local planning level based upon the normative planning theories of environmental planning and environmental impact assessment. Mineral aggregates are consolidated and unconsolidated earth materials such as gravel, sand, clay, and limestone, and comprise one of the necessary elements in the production of construction materials such as concrete, asphalt and brick. In Canada, the mining and processing of sand and gravel for structural

material exceeds that of gold and silver in terms of annual value, and takes place in all ten provinces (Statistics Canada, 1994). In the United States, the production (tonnage) of sand and gravel ranks second among all non fuel minerals. In addition, it is the only mineral commodity produced in all 50 states (Doolittle and Hossner, 1985). Clearly, mineral aggregates are a vitally important resource to industrialized societies.

Because of this importance, the accessing, removing, processing and delivery of mined aggregates is a contentious land use issue, particularly in settlements with an abundance of the material. The impacts generated through its extraction have brought a great deal of unsolicited attention to the industry; accusations include environmental degradation, declining quality of life standards and health, and safety issues in communities where mineral aggregate extraction is occurring. The spatial and economic nature of the aggregate industry compounds this negative perception when deposits occur amongst environmentally sensitive areas such as; river terraces, and when excavation sites are located close to the demand centre to accommodate the high bulk and low unit value of the commodity. As a result, extractive activity is highly visible in the communities where it occurs and the impacts are readily apparent to residents of the area.

Administering the exploitation of mineral aggregate resources is often a challenge to both local and provincial planning jurisdictions. In one sense, the resource is required to facilitate growth as well as maintain existing infrastructure, while in another, support of the industry can be a politically cumbersome endeavor because of the negative image it precipitates. Consequently, as many communities have grown, a polarity has developed between residents and aggregate producers as well as the administrative bodies assigned to aggregate management.

The growth of communities, particularly after the World War II, increased the demand for the resource dramatically. Regulation of the industry was not quick to follow and, left to its own devices, the aggregate industry acquired a negative

image from the perspective of residents and local planning jurisdictions alike. Fostering this image is the fact that the mining of aggregates is responsible for more land disturbance and abandonment than any other mining sector in Canada (Marshall, 1982).

The aggregate industry's past disregard for local lands and resource values, in conjunction with the disruption associated with ongoing operations such as traffic, noise and dust, has created persistent opposition to the siting of new operations in many communities across Canada. Such land use conflict can be an impediment to finding optimum solutions in utilizing aggregate resources before they are lost to urban and commercial development (Westman, 1985). Methods are needed whereby aggregate resources and local land resources may be considered in conjunction with one another in plan and policy development. Local planning requires a management approach that will temper the impacts of the industry and facilitate a sequential and compatible use of the local land resources upon which extraction takes place.

Recent efforts at "greening" planning, or applying an "ecosystems approach" to land management have involved integrating environmental impact assessment methodologies with local planning processes as a means to forward the objectives of sustainability. Literature on this subject (Burdge et al., 1995, Webler et al., 1995; Whitney & Maclaren, 1985) presents the value of combining the process of impact assessment with environmental planning. In such approaches, the technical aspects, or impacts, associated with plans, policy or projects implemented at the local level may be addressed in conjunction with the social perspectives of the community in which the activity takes place. In turn, the rigour of local resource management decisions is increased as well as the legitimacy of the decisions that are made (Webler et al., 1995). These processes serve to integrate the consideration of impacts upon the environment, and to provide social constructs that define how specific environments will be used.

Mineral aggregate management provides an excellent opportunity to explore these new planning methods. The exploitation of the resource is a necessary element to the growth and maintenance of a community and occurs in proximity to the market place. Also, the impacts generated from extraction are consistent points of conflict among residents, aggregate producers and local planning authorities alike. Efforts directed at ensuring that local land resources are returned to productive capacity provides an opportunity to apply a sequential and compatible planning approach to the activity of mineral resources extraction. In the long term, integration of impact assessment at the local planning level could eliminate the polarity among stakeholders of aggregate extraction and provide for a more sustainable use of local land resources. Through methods of case study research, this thesis evaluates and proposes an integrated resource management approach based upon the latest planning and impact assessment theories.

In Chapter Two, I address the state of aggregate resources in Canada, and in particular, British Columbia. The purpose is to provide a complete understanding of the character of mineral aggregate resources ranging from their physical composition to the regulation pertinent to the resource's exploitation. Specifically, I define the geologic nature of aggregate resources and how they are addressed in the relevant literature and regulations. This serves to establish the parameters of the subject resource under study. The distribution and occurrence of mineral aggregates is also a component of this chapter. An overview of glaciation and glacial deposition provides background into the formation of deposits and the associated landforms in which mineral aggregate deposits are found. In addition, the mining of aggregates is addressed followed by the regulatory regime within which such activity takes place. I also explore various extractive techniques as well as the processing, analysis and classification of products derived from aggregate extraction. Finally, the roles of the federal, provincial and local authorities are reviewed including the legislative doctrines guiding aggregate management in British Columbia.

In Chapter Three, I propose an environmental resource management model for local planning jurisdictions. An analysis of the theoretical basis of planning and the founding principles of environmental planning and environmental impact assessment is conducted. I review the relevant literature in these subject areas to provide an understanding of the changes taking place in the planning profession today. Discussion regarding the models of planning theory from the 'Rationale Comprehensive' approach to 'Social Action' addresses the relationship between administrators and the public interest and the quantitative and qualitative approaches applied in planning methods (Friedman, 1987). In addition, I review the founding principles of environmental planning and environmental impact assessment and include a critique of the models upon which these processes are based. Finally, I assimilate the preceding discussion in the development of a model reflective of new approaches presently underway for planning and environmental impact assessment that can be applied at the local planning level. A conceptual model is developed for integrated resources management founded upon planning and impacts assessment principles. The findings from the case study are applied to this theoretical framework at the conclusion of the thesis.

Chapter Four, entitled "Prince George: A Case Study" has two purposes. First I provide a detailed description of the City itself. Second, I introduce the case study approach that is undertaken in the chapters that follow. The description of Prince George incorporates elements of the natural, social, cultural and administrative characteristics of the area. I include discussion on the formation of the City in a social sense, and how land use and resources are presently managed in the area by the local government. A glacial history of the area is explained to provide insight into the spatial distribution of potential mineral aggregate deposits in the city and the identification of significant landforms and existing extractive land use

designations. The case study approach introduces three objectives of the research:

- identify how mineral aggregates have been and are presently being managed in Prince George, including identification of existing activity, land areas disturbed, the magnitude of impacts throughout the area and the processing of applications;
- determine the strengths and weaknesses of regulatory system in Prince George and identify the concerns, perceptions and values of relevant stakeholder groups; and
- derive what elements of the community landscape are impacted most by aggregate extraction, which elements are in greatest need of protection, what the main issues are in permitting, operating and reclaiming these areas.

The methods I use in the case study research are defined in Chapter Four. Techniques of document review, participant observation, site analysis, interviewing and survey questionnaires are explained here along with their application in the research.

In Chapter Five, I report the findings of the research in relation to the study objectives. Results of document review, participant observation and site analysis are reported. Specifically, the Official Community Plan, Soil Removal By-law, and approximately sixty soil removal permit files are analyzed here. This analysis provides a historical and current overview of the establishment and management of pits in Prince George over a seventeen year period (1979-1996). Techniques of participant observation combined with document review provide a more detailed look at selected permit applications and the processes through which they were approved or denied by the city. The rationale and factors influencing these decisions are emphasized. I conclude the case study with a descriptive review and analysis of selected removal sites in the city.

In Chapter Six, I present the results of the case study on the identification of the concerns, perceptions and valued environmental components with respect to extraction in the area. Results are presented from interviews conducted with relevant stakeholders, survey questionnaires, and observations from relevant planning committees in Prince George. The interviews and questionnaire broach

the issues of planning and permitting of extraction, identify impacts of extractive operations and the state of reclamation in Prince George. Both methods ask subjects to identify the elements of the community for which they have concerns or preferences in terms of land use, social/cultural elements and/or the natural environment. Observation techniques with the Soil Removal By-law Committee and the Aggregate Inventory Advisory Group also provide insight into some of the recent initiatives by the City to address aggregate extraction issues in the city. I identify the strengths and weaknesses of aggregate management in Prince George, and define the related impact issues that need to be addressed with a new management approach.

Chapter Seven concludes the thesis. I synthesize the results of the preceding chapters and present a list of management needs for aggregate resources management in Prince George. This chapter assesses needs on the basis of: 1) the identified weaknesses of the City's existing regulatory framework; 2) operational impacts identified by stakeholder groups; 3) reclamation opportunities; and 4) elements of the community for which subjects have indicated a professional or public concern. These needs and concerns are then incorporated into the integrated resource management approach model described in Chapter Three. With the integration of the case study research and the management model I demonstrate a management directive for mineral aggregates within a Prince George context. Items such as policy directives, by-law implementation and supply and demand models are discussed as well as mapping and review committee options that are available to the City. Finally, I present a series of recommendations to the City of Prince George. If these recommendations are implemented, the City could move closer to the sustainable management of aggregate resources.

Chapter Two

The State of Aggregate Resources: Physical Attributes and Resource Management

2.0 Introduction

The harvesting of aggregate resources commonly occurs on the fringe of urbanized areas. Despite its presence and visibility, aggregate extraction is a poorly understood resource use. Misunderstanding often results in local land use conflicts between residents and operators, and in some instances, poor management of the resource by local governments. The purpose of this chapter is to develop an understanding of aggregate resources from two standpoints. First, I examine the nature of aggregate resources from a physical perspective. Second, I investigate the management regime in which aggregate resources are exploited in Canada, and in particular British Columbia.

2.1 Aggregates Resources

A variety of definitions of mineral aggregate exist. The geologic definition of aggregate describes the resource as particles of rock produced from naturally occurring deposits of sand, gravel and bedrock formations (Smith, 1993 [b]). Definitions that stress the utility of aggregate are used by both federal and provincial agencies. Energy, Mines and Resources Canada (EMRC) defines mineral aggregate by its source and processing methods, which consist of sand, gravel and crushed stone (Vagt, 1992). The Ontario Ministry of Natural Resources (OMNR) has a two part definition as follows:

> *"(mineral aggregate is)...all consolidated and unconsolidated materials such as gravel, sand, clay, earth, stone, limestone, dolostone, sandstone, marble, granite and rock other than metallic ores...(and an aggregate resource is)...identified mineral aggregates that are considered to have sufficient quantity and quality to be potentially economically viable for extraction" (1989, p. 2).*

Ontario distinguishes between mineral aggregate and aggregate resources. Common to the above definitions is that sand, gravel and rock can be said to comprise natural aggregate. The British Columbia Ministry of Energy Mines and Petroleum Resources (MEMPR) further clarifies the definition in the Sand and Gravel Study (1980) for The Lower Mainland:

> *"Sand and/or gravel...refers to the natural deposits or unprocessed materials..(whereas) aggregate refers to the product processed for industrial use, for instance crushed, screened and washed" (p. 8).*

In Quaternary Resources in Canada, W.A.D. Edwards (1984) defines aggregate as

> *"...hard, inert construction material used with Portland or bituminous cements to form concrete, motar and asphalt. It is also uses without cement as railroad ballast, in road construction, and in general building construction...(it) includes mineral aggregate such as sand and gravel or crushed stone and synthetic...aggregates such as recycled concrete or asphalt, burned shale or clay and slag"(p. 684).*

For the purpose of the thesis I shall define mineral aggregates as sand, gravel and/or bedrock deposits of extractive and/or processing potential for use as construction materials.

2.2 The Distribution and Occurrence of Aggregate Resources

The principal sources of aggregate are the unconsolidated surficial deposits that have accumulated in the northern hemisphere since the onset of the Pleistocene Ice Age (Flint, 1971). In many cases, the materials contained in these deposits are preferable to aggregate generated directly from the crushed parent rock because glaciation and weathering effect favourable changes in rock particles. As the materials are transported or weathered, the weaker materials that comprise the aggregate are, for the most part, worn away. The result is a stronger, more useful, aggregate from that of the parent material. Further mechanical treatments such as screening or washing can increase the utilization potential of the product.

Therefore, knowledge of the glacial history of an area is extremely important in identifying areas of potential aggregate resources. Glaciation, together with melt and deposition of materials through fluvial activity, produce specific landform characteristics that are indicative of potentially high quality aggregate deposits.

2.2.1 Glaciation and Glacial Deposits

According to geologic timelines (Figure 2.0) the earth is presently in the Holocene epoch of the Cenozoic era. Thus, when we refer to aggregate resources of this era, they are described from the latest period associated with mass deposition. The aggregate resources developed in Canada today are of the Quaternary period as defined by the limits of ice advance during the last Ice Age of the Pleistocene epoch. In British Columbia, the majority of aggregate resources are associated with episodes of the Fraser glaciation (Hora, 1988). There are three deposit typologies that may be described as a result of glaciation, each of which has a variety of associated landforms: glaciofluvial, glaciolacustrine and marine-glaciomarine. In the Central Interior of British Columbia, glaciofluvial and glaciolacustrine deposits are predominant (Tipper, 1971).

The two varieties of glaciofluvial deposits are outwash and ice contact deposits. Outwash deposits are transported via the meltwaters expunged from a retreating glacier. Ice contact deposits are associated with meltwaters carrying sediment where deposition takes place within or along the glacier itself. Deposition occurs in channels or caverns cut into, and within the glacier by meltwaters. Landforms associated with this type of deposition include outwash plains, till plains, eskers, kames, moraines and drumlins (Flint, 1971).

Glaciolacustrine deposits are associated with former lakes that formed when glaciers blocked or dammed natural drainage. The resultant landform features are of a beach or deltaic variety forming a lacustrine basin in the area of deposition. The most useful aggregate deposits associated with this type of deposition are found in

Figure 2.0 Geologic Sucession

Geological Age				
Age: millions or years	**Epoch**	**Period**	**Era**	**Eon**
0.01-...	Holocene	Quarternary	Cenozoic (recent life)	Phanerozoic (evident life)
1.6-0.01	Pleistocene			
5.2-1.6	Pliocene	Tertiary		
23-5.2	Miocene			
35-23	Oligocene			
56-35	Eocene			
65-56	Palaeocene			
146-65		Cretaceous	Mesozoic (middle life)	
208-146		Jurassic		
245-208		Triassic		
290-245		Permian	Paleozoic (acient life)	
363-290		Carboniferous		
409-363		Devonian		
439-409		Silurian		
510-439		Ordovician		
570-510		Cambrian		
4600-570		Precambrian	Poterozoic (early life)	
			Archaean <Origin of the earth	

(from Harland et al. 1990)

the old beach or shoreline areas of the glacial lake as they tend to be sorted into ranges of discrete size due to sediment size and mass. The Prince George area was part of a lacustrine basin which formed during deglaciation and has produced some suitable granular materials along the old shore line of the proglacial lake (Tipper, 1971).

2.2.2 Fluvial Deposits

Some of the best aggregate deposits are those subject to fluvial activity after glacial deposition. Fluvial deposition is a further refinement of the material as a form of natural processing by running water. Fluvial deposits contain a more consistent particle size distribution and thickness and a lower proportion of silts and clays due to the washing effect of running water (Smith, 1993 [b]). In general, fluvial deposits are sorted better than most glacial deposits and as a result, can reduce the amount of processing required to generate a suitable aggregate product. Fluvial deposits are associated with river channels, river terraces, and alluvial fans. River channel and terrace deposits are most common to the Prince George area along the Fraser and Nechako Rivers (Tipper, 1971).

River channel deposits consist of sand and gravel which comes to rest in a stream channel. Such deposits have the potential to be replenished in rivers large enough to transport vast quantities of sediment, or in mountainous regions that generate high velocities of runoff and stream flow. In the past, the dredging of river beds has been a common practice in the mining of aggregates. For example, River Junction Aggregates in Prince George dredged sand and gravel at the confluence of the Nechako and Fraser Rivers in 1979 (City of Prince George [a], 1993). The impacts associated with this activity such as the lowering of the water table, habitat degradation and downstream erosion have reduced the acceptability of this form of extraction. In New Zealand, however, this practice continues due to the high sedimentation of rivers.

River terrace deposits are the remains of former flood-plain areas of a river. As the river valley progressively erodes, the actual flow of water moves to the lowest level of the valley. Stepped terraces remain on the bedrock benches on both sides of the valley. Terrace and floodplain deposits coarsen upwards and are usually capped by clay or silt material (Flint, 1971). In addition, the quality of a deposit is often unpredictable due to discontinuities in the river channel after flooding and meandering over a period of time. This type of deposit is the most dominant source of mineral aggregate in British Columbia.

2.3 Mining Mineral Aggregate Resources: Access, Production and Use

The production of mineral aggregates is a form of surface, or open pit mining. Although, typically occurring at much smaller scales from that of other types of mining such as coal or bauxite surface mines, the overall magnitude of aggregate extraction is far greater. In 1982, the total land area disturbed, utilized and alienated by all mining activities in Canada was 284,237 hectares. This is roughly equivalent to half the size of Prince Edward Island (Marshall, 1982). Aggregate extraction accounted for an estimated 138,025 hectares, or 49 percent of this total. Projections for the year 2000 indicate an additional 107,616 hectares of land area disturbed by aggregate extraction for a total of 245,641 hectares of additional land (Proctor and Redfern, 1974). Since 1982, no additional nation-wide survey of this nature has been undertaken. Aggregate extraction is a significant disruptive activity which primarily takes place within the fringes of urban areas. The methods of accessing and processing the resource are becoming increasingly scrutinized across the country as communities continue to grow close to, and around existing operations.

2.3.1 Mineral Aggregate Access and Extraction

The access and extraction of mineral aggregates involves a number of issues ranging from overburden removal, blasting, design, transportation and environmental protection. Regardless of the source from which aggregate is to be removed or the type of operation (hard rock quarry or sand and gravel pit) four basic operations should take place in the extractive phase of operations: 1) overburden removal and face preparation; 2) excavation (digging and loading); 3) conveying and hauling to the processing plant; and 4) reclamation (Ontario Department of Mines, 1970; Smith, 1993; B.C. Ministry of Transportation and Highways, 1995).

The initial stripping of a site can involve the handling of up to four materials prior to accessing the resource. The first step requires the clearing of trees, shrubs and any other vegetation from the site. This is followed by the removal of topsoil, subsoil and overburden. The depth of topsoils and subsoils is generally negligible compared to that of the overburden. Overburden material generally consist of soils unsuitable for aggregate production. Over fluviatile deposits it is expected to be relatively thin and regular in depth, whereas glacial deposits possess deeper degrees of overburden which can vary over the same deposit. Ideally, these materials are stripped and stored on site separately for future use in reclamation (Ministry of Energy, Mines and Petroleum Resources, 1994).

Once clearing and stripping have been completed, face excavation follows. The excavation technique is dependent upon the nature of the deposit, topography, proposed restoration and the scale of operations. Excavation is generally carried out with equipment such as back-hoes, hydraulic shovel excavators or dragline excavators or dredgers for extraction below water levels on site. The vertical face of the deposit is cut away and loaded onto trucks or conveyor belts for transport to the processing plants or stockpiles. In quarries, the rock face is blasted and/or drilled to produce fractured rock for transport or crushing.

Materials are transported to the processing plant by loader, dump truck, or conveyor belt. Trucks are typically able to transport from 15 tonnes to 75 tonnes;

however, some extremely large open pit mines employ dampers capable of hauling 100 to 150 tonnes. Conveyor capacities are in the range of up to 1,000 tonnes per hour with the ability to transport material over a number of in-pit kilometers (Smith, 1993 [b]). Once transported for processing, the aggregate can either be stockpiled for future processing, processed immediately, or transported off-site for processing elsewhere.

The removal of material from the land greatly alters the pre-mining conditions of the landscape. The progressive development and reclamation of pit and quarry operation is recognized by many regulators and operators as the most economically efficient, and environmentally sensitive method of site restoration. McLellan (1983) identifies two reason for this: "progressive rehabilitation is less costly...since the necessary equipment is readily available and most of the soil is handled only once" (p. 205). Topsoil and overburden materials are transported directly from a new extraction area to an adjacent mined-out area. In this manner soil nutrients are preserved, and the land area disturbed at any one time is minimized. Once backfilled to the original topographic plain or deliberately contoured to another, the site has the potential to be used for a variety of landuses such as recreation, industrial, residential, natural habitat, open space, agriculture or forestry (Green et al., 1992).

2.3.2 Mineral Aggregate Processing

The processing of aggregate resources can take place on the mine site or at a remote location depending upon the planning requirements of the producer and/or the governing regulations, such as sufficient zoning. The purpose of processing is to prepare the rock or mineral to a form suitable for its prescribed use. An aggregate is described in terms of its required specifications. These specifications are usually derived from an industry standard and are based on stress criteria for the strength of an aggregate. Processing primarily involves crushing (comminution), sizing

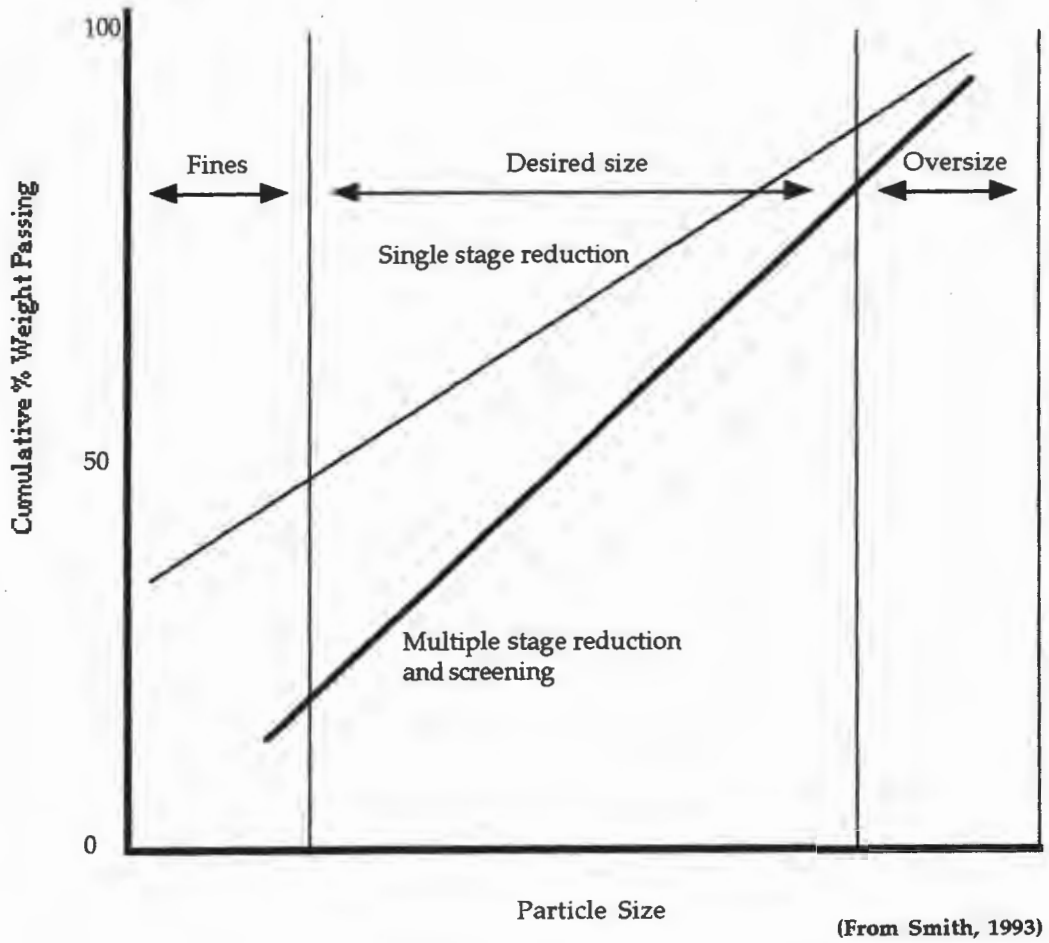
(screening), and beneficiation (washing/sorting) of materials for use or sale by the operator. Processing plants may be either fixed or mobile. Permanent plants favor large mines with life spans of 30 years for hard rock or 10 years for sand and gravel. Smaller sites lend themselves to the use of a mobile or temporary plant that can be used on another site at a later time.

Crushing is the particle size reduction process. Whereas, the goal for most mineral ores is the achievement of maximum size reduction, aggregate crushing aims to separate a series of particle size fractions from the resource (Smith [b], 1993). This produces a range of products marketable to many sectors of the local economy such as construction stone, backfill, cement and asphalt. Figure 2.1 illustrates how multiple stage reduction and screening generates more aggregate within desired sized fractions of the product. Line 'B' illustrates how more material is produced in the desired size range through multiple stage reduction, while fines and oversized materials are reduced. A greater portion of the line falls within the desired size range of material through multiple stage reduction. Crushing is done by a variety of machines such as jaw crushers, impactors and cone crushers.

Sizing is accomplished through processes of screening (sieving) and classification of aggregate. It is possible to sieve a dry aggregate to a size of 0.05mm; however, in the field, aggregate is not dry and it is economically impractical to undertake drying on site. Moisture in the aggregate causes a cohesiveness of material and increases the difficulty of screening to smaller sizes. As a result, the material tends to limit screening to 3-6 mm at the processing plant. An alternative to this problem is the addition of water to the material to separate and suspend the smaller particles in a 'slurry' like form. This techniques improves screening options down to a size of 0.5mm.

Screening, or sieving, utilizes a series of apertures (gaps) that are square, rectangular or round in shape. Aggregate particles are processed for a specified duration which maximizes the probability that all fractions required will pass

Figure 2.1 Single and Multiple Stage Crushing Comparison



(From Smith, 1993)

through the desired aperture. The most common types of screens employed in this activity are vibrating screen (inclined, horizontal or both) and grizzly screens. Vibrating screens utilize a gyrating motion to sort the appropriate particles through the screen while grizzly screens are used primarily for separating out oversized materials. The grizzly screen consists of steel bars or rails that prevent oversized materials from passing through for further processing.

Beneficiation improves the quality of the aggregate through separation processes such as washing. This can divide materials based upon their physical and chemical properties such as colour and surface chemistry. For example, sand and gravel are often washed and/or scrubbed to remove silt and clay contents that may occupy the surface of the aggregate particles. Other beneficiation methods can involve elaborate techniques of magnetic separation of irons from aggregate to simple hand sorting of material to reject visibly deleterious material.

2.3.2 Petrographic Analysis and Classification

Aggregate resource use varies greatly from the laying of a simple sidewalk to the more complex development of an airport runway. Safety and efficiency, require understanding of the capabilities of the aggregate product. The suitability of an aggregate is determined through engineering specifications which consist of a classification and a variety of tests. The process of petrographic analysis groups aggregates by their characteristics relevant to their intended use. First however, the materials are organized by their igneous, sedimentary and metamorphic qualities. Igneous rock is that which originated below the earth's surface, while sedimentary rocks are those formed through sediment layering over long periods of time. Metamorphic rocks are igneous and sedimentary rocks that have been altered through heat and pressure deep in the earth's crust.

Smith (1993 [b]) recommends a descriptive scheme that includes a description of the aggregate type, a description of the physical characteristics, and a petrological

classification. Physical characteristics for classifying aggregates include:

a) nominal size;
b) particle shape;
c) surface texture;
d) colour;
e) cleanliness: free of dust silt and clay; and
f) presence of surface coatings.

Petrographic classification also uses characteristics that can be compared to national specifications regarding their use in specific projects. Analysis includes mechanical, durability, and chemical testing of materials to assess performance under standardized situations. These tests allow the appropriate use of aggregate resources and lengthen the life of developments in which the resource is used. A summary of these tests is provided in Table 2.0 for illustrative purposes. A more detailed description of the contents of this table is found in Appendix 'A'.

2.3.4 Mineral Aggregate Production and Use in Canada

Canada has the highest per-capita production of aggregate resources in the world (Beeby, 1995). It occurs in all ten provinces as well as portions of the Territories. In the United States, aggregate production ranks second among all non-fuel minerals and is the only mineral commodity produced in every state (Doolittle and Hossner, 1985). With respect to land area disturbed, it also follows that aggregates represent the largest amount of production of all non-fuel minerals in Canada. In 1993, the total production tonnage of all non-fuel minerals in Canada totaled 408.7 million tonnes. Aggregates accounted for a total production of 327.5 million tonnes (80 percent) of this total (Statistics Canada, 1994). The production value of aggregates used for structural materials is high, exceeding that of valuable metals such as gold, copper, and silver in 1993 (Statistics Canada, 1994). Table 2.1 provides a summary of the production values for these materials. Aggregate production has been greatest in the highly populated provinces such as Ontario, Quebec, and British Columbia.

Table 2.0 Petrographic Analysis and Testing of Aggregates (Smith, 1993)

Mechanical Tests	Purpose	Method(s)
a) aggregate impact value	test of strength/pulverization	blows from piston/screened and weighed
b) aggregate crushing value	test of strength/compaction	compressed piston/screened and weighed
c) 10% Fines Value	identify load required to produce 10% fines	load plunged through screens, the force required recorded
Durability Tests		
a) aggregate abrasion value	estimation of surface wear	load stuck to resin board and rotated against rotation lap /loss in weight recorded
b) aggregate attrition test	estimate wear of samples on another	load rotated in cylinder/% of material removed is measured
c) Los Angeles abrasion test	estimate wear due to attrition and impact	load rotated in cylinder with 6 to 12 steel balls/weight loss recorded
d) polished stone value	determine susceptibility of stone to polishing	simulated tires run on sample/polish of specimen measured
e) soundness	observe resistance to change in physical environment	refrigeration/freezing and thawing of sample
Chemical Tests		
a) organic content test	detect retardants that could inhibit hydration of cement	immersion in solution sodium hydroxide/colour noted
b) chloride content test	prevent corrosion to imbedded metals/ increase resistance	nitrate solution added to sample
c) sulphate content test	removal prevents crack and expansion of concrete	sulphate ions extracted though water solution
d) alkali reactivity test	test for potential concrete expansion	sodium hydroxide treatment applied

Table 2.1 Mineral Production Values, 1993 (Statistics Canada, 1994)

Material	Value ($'000)
Structural Materials	2,349,403
Gold	2,284,991
Copper	1,796,963
Silver	156,793

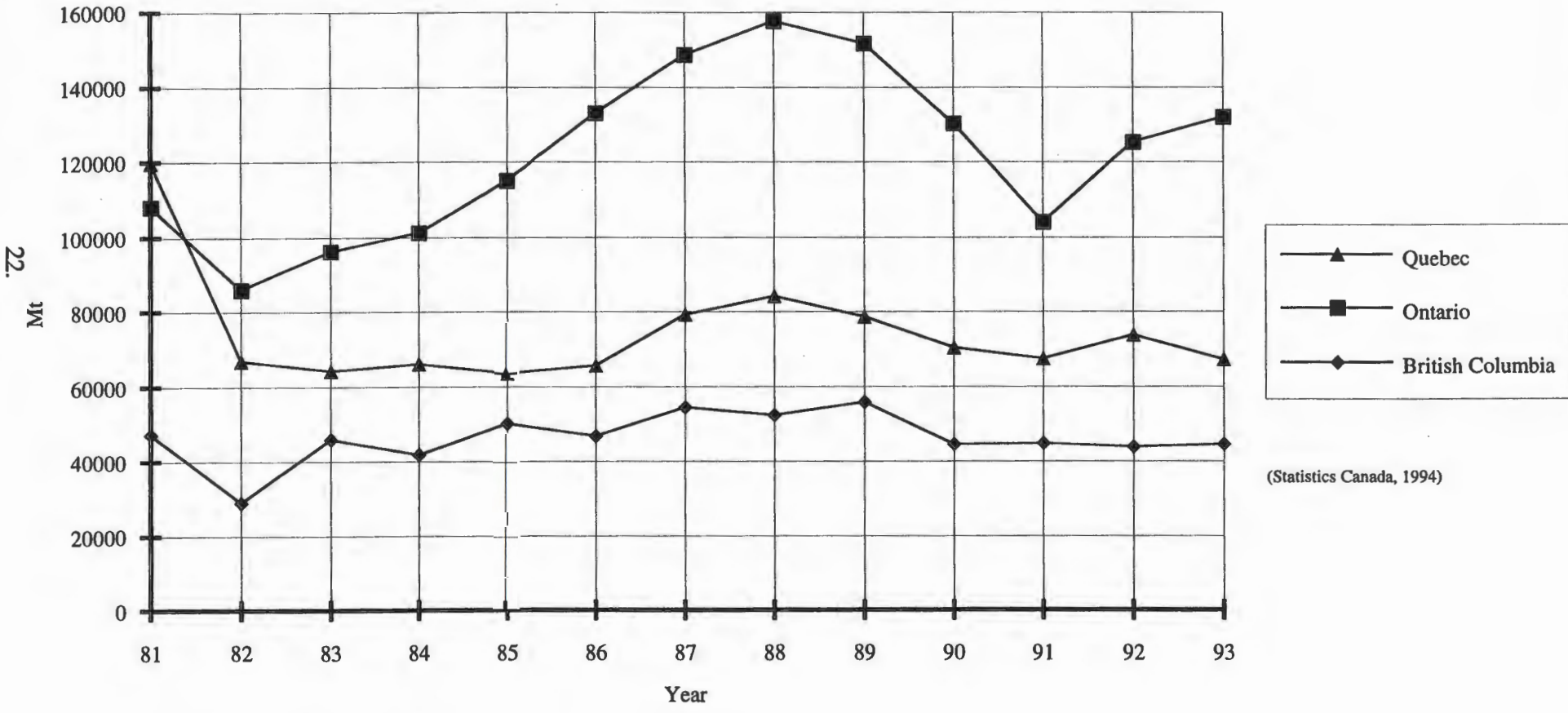
From 1981 to 1993 production generally increased, although rates of production dropped somewhat during times of recession. There was a leveling out of production in the 1990's. Figure 2.2 compares the production rates of Ontario, Quebec and British Columbia for this time period.

Trends in Figure 2.2 indicate that production levels peaked in the mid-1980's and dropped significantly at the end of the decade. All three provinces have begun to level-out somewhat in the 1990's. National comparisons of housing starts with aggregate production may indicate a trend. As illustrated in Figure 2.3, when houses are being constructed, aggregate production follows.

Use of aggregates varies with the type of material produced and consumption patterns on a national and provincial scale. For stone, Statistics Canada (1994) indicates that limestone provides the greatest production tonnage and value on a national scale followed by granite. Ontario, Quebec and British Columbia are the top three producers of these products. The main uses have been crushed stone for road construction and chemically processed stone for domestic cement production. Of the total 80.5 million tonnes of limestone produced 35 percent is utilized as road surfacing, 14 percent domestic cement, and 11 percent as concrete aggregate. In Canada, granite is primarily used as a crushed stone product for road surfacing (4 million tonnes) and asphalt aggregate (3.3 million tonnes) (Statistics Canada, 1994).

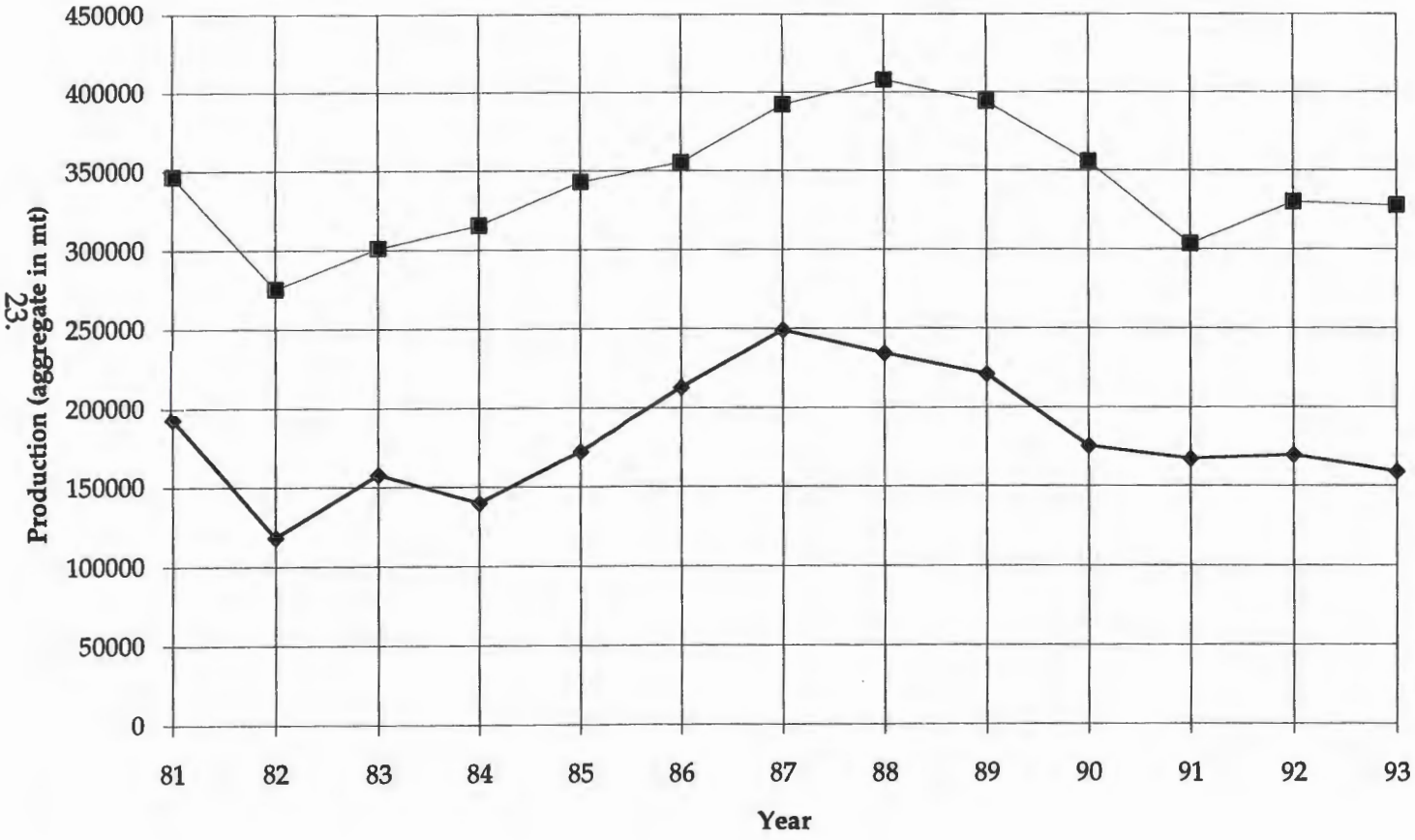
The primary uses of sand and gravel in Canada is also roadbed and surfacing material, concrete, and then asphalt aggregate. Similar use patterns apply in Ontario, Quebec and British Columbia. Nationally in 1993, 60 percent of all sand and gravel produced was used for roadbed construction and road surfacing. Concrete aggregate utilized 12 percent of this material while asphalt production consumed 8 percent. Figure 2.4 illustrates the use of sand and gravel in Canada in 1993. Provincially, Ontario is the largest consumer followed by Quebec and British Columbia (Statistics Canada, 1994).

Figure 2.2: Aggregate Production in Ontario, Quebec and British Columbia: 1981-1993



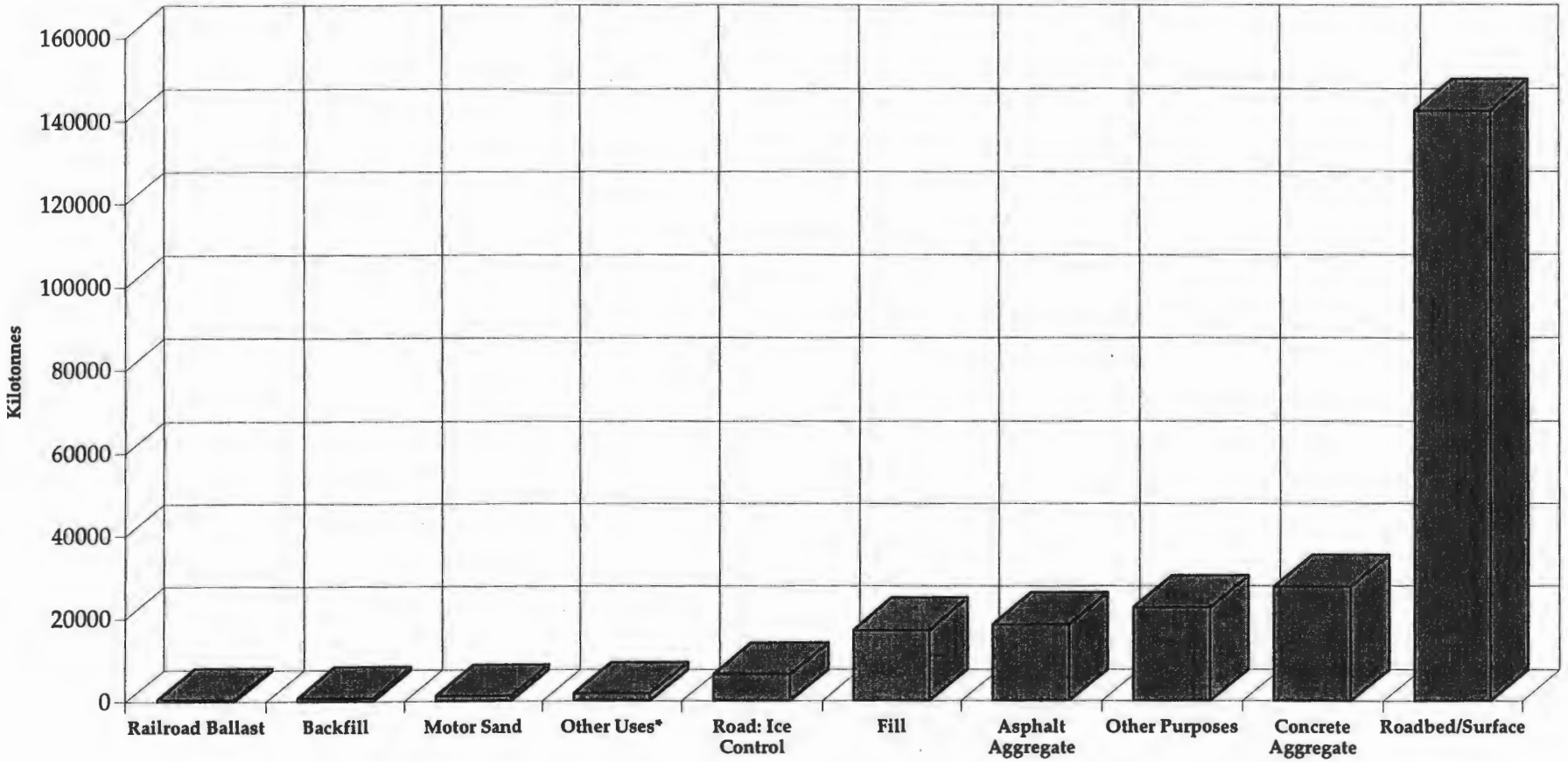
(Statistics Canada, 1994)

Figure 2.3 Housing Starts versus Aggregate Production in Canada, 1981-1993



(Statistics Canada, 1994)

Figure 2.4: 1993 Utilization of Sand and Gravel in Canada



(Statistics Canada, 1994)

Clearly, mineral aggregate resources are a significant resource in the Canadian landscape. Use of this natural resource also shapes the Canadian cultural landscape because its uses include architectural design and contribute overall to community development. Management of mineral aggregate resources must take such values into consideration.

2.4 The Management Regime for Mineral Aggregate Resources

There are distinctly different roles for federal, provincial and municipal agencies with respect to the management of aggregate resources. The following review of the management regimes affecting British Columbia aggregate harvesting, describes federal and provincial roles and relationships to municipal jurisdictions.

2.4.1 Federal Involvement in Aggregate Management

The federal government's role in aggregate management could be described as regulatory. The departments directly involved in the management of mineral aggregates are 1) Energy, Mines and Resources Canada (EMRC); 2) Environment Canada; 3) Department of Fisheries and Oceans (DFO) and, 4) the Department of Indian and Northern Affairs. Energy Mines and Resources is essentially a monitoring agency with respect to aggregates. This agency publishes yearly updates on aggregate production and consumption, and identifies yearly trends and forecasts on a national scale (Vagt, 1993).

The Department of Fisheries and Oceans on the other hand, is more directly involved in aggregate management. The Department of Fisheries and Oceans' comments are required on applications that may potentially impact rivers or other water bodies in each offices jurisdiction across the country. The *Fisheries Act (1985)* requires a 'Gravel Removal Order' as part of the approval of operations that involve dredging from rivers and any other water body. DFO's Land Development Guidelines identify their regulatory role over mineral aggregates as"...[the protection

of] fish populations and their habitat from the potential damaging effects of land development activities" (DFO, 1993, p. 10). Indian and Northern Affairs supervises and regulates aggregate production on indian reserves across the country. Beyond these federal roles, aggregate management is negligible at this level of government.

2.4.2 Provincial Responsibilities in Aggregate Management: British Columbia

Provincial governments have primary responsibility for aggregate resource management in Canada. A variety of government agencies and provincial statutes in each province delineate a regulatory framework within which aggregate resource harvesting is to occur. In British Columbia, this framework is established primarily by three Provincial statutes: the *Mineral Tenure Act (1988)*, the Mines *Act (1989)*, and the *Municipal Act (1979)* .

Mineral Tenure Act (1988)

The *Mineral Tenure Act* establishes what constitutes a mineral in British Columbia. This distinction is extremely important in that it has ramifications with respect to resource development rights. Minerals are considered to be the property of the government despite who may hold the surface rights to a property (Pearse, 1988). As interpreted in the Mineral Tenure Act, aggregate resources are not considered to be a mineral. In British Columbia a mineral is considered under Section 1 of this Act as:

> *"...ore of metal and every natural composition that can be mined ...but does not include:*
> *(c) coal, petroleum, natural gas, earth, soil, peat, marl, sand and gravel, and*
> *(d) rock, riprap and stone products that are used in the construction or maintenance of a road, building or framework..."*

This definition has important resource management implications. The right to access sand and gravel is issued along with the surface rights to a land owner. As

such, the importance of local regulatory control over aggregate management is significant. Although geologically aggregate is a mineral (of mineral composition), sand and gravel are not recognized as such by the province of British Columbia. The accessing and processing of aggregate resources is addressed in the *Mines Act.*

Mines Act (1989)

Sand, gravel, and quarry operations are considered to be mining operations as defined under the *Mines Act.* The primary requirement for an aggregate source to be developed consists of the issuance of a permit under Section 10 1-8 of the Act. In general, the *Mines Act* regulates the many technical aspects associated with the development, operation and closure of a mine site. With respect to aggregate extraction, the degree of detail to which permit applications are scrutinized is often left to the discretion of the mining inspector. As a result, review requirements vary depending upon what the Ministry feels is required within the bounds permitted by the *Mines Act,* and the nature of the permit application, such as site location, size, geology, material quantity and operational safety.

The Ministry of Energy Mines and Petroleum Resources (MEMPR) is adept at regulating many of the technical aspects associated with mining activity under the auspices of the *Mine Act;* however, it does not address social and local environmental concerns associated with municipal land management. The ability to regulate aggregate extraction at the local level is defined in the *Municipal Act* and administered by the Ministry of Municipal Affairs.

Municipal Act (1979)

The *Municipal Act* provides municipalities with the ability to plan, and control land use within their jurisdiction. This is primarily achieved through the implementation of Official Community Plans (OCPs) as per Section 944 of the *Act* and zoning by-laws designed to implement the Plan, as per Section 963 of the *Act.*

The *Municipal Act* permits the OCP to contain statements and map designations respecting "the approximate location and area of sand and gravel deposits that are suitable for future sand and gravel extraction" (Section 944 5(c)).

Although the designation of deposits in the OCP is permitted, the extraction of sand and gravel is not considered a land use, but rather a use of land. This means that, the act, or activity, of extraction is the management focus rather than what features (structures etc.) are placed on the land. Thus, extraction is not controlled or implemented through land use designation and zoning alone. Instead, Section 930.1 provides each municipality with the ability to implement soil removal by-laws. Within this section:

> *(2) The council may, by bylaw, regulate or prohibit*
> *(a) the removal of soil from. and*
> *(b) the deposit of soil or other material on any land in the municipality or in any area of the municipality, and different regulations and prohibitions may be made for different areas.*
>
> *(3) A provision in a bylaw under subsection (2) that prohibits the removal of soil has no effect until the provision is approved by the minister with the concurrence of the Minister of Energy, Mines and Petroleum Resources.*

Municipalities have the ability to implement soil removal by-laws unilaterally, but only to the point where the by-law restricts soil removal. Subsection (3) stipulates that the Minister of Energy, Mines and Petroleum Resources must approve those by-laws that attempt to prohibit soil removal. The implications of Subsection (3) are such that soil removal by-law approval power is possessed by two ministries. All soil removal by-laws are reviewed by the Minister of Energy Mines and Petroleum Resources and approved or denied concurrently with the Minister of Municipal Affairs. Upon ministerial approval, the local jurisdiction then has authority to implement the by-law at the local level. The Ministry of Municipal

Affairs then, through the *Municipal Act*, defines the scope of management within which municipalities can manage mineral aggregate resources.

The Ministry of Environment, Land and Parks (MELP) also has the potential to participate significantly in aggregate management. The recent *Environmental Assessment Act* (Bill 29) requires that any new pits and quarries be subject to environmental assessment if production exceeds 500,000 tonnes per year or 1,000,000 tonnes over four years for gravel pits, and more than 100,000 tonnes produced per year for quarries.

Other provincial agencies with an interest in aggregate management include the Ministries of Forests, Finance, Transportation and Highways, Agriculture, and the Workers Compensation Board (MEMPR, 1980).

2.4.3 Municipal Management of Mineral Aggregate Resources

As mentioned above, provincial statutes provide municipalities with three primary tools for the management of aggregate resources. These are Official Community Plans (OCPs), Zoning By-laws and Soil Removal By-laws.

Official Community Plans allow for the identification of soil removal areas on a separate schedule to that of land use in the OCP. Thus, extraction could potentially take place on lands designated as residential in a municipality as long as it is designated such on a soil removal schedule. Zoning is utilized by municipalities to control the processing of materials. In order to process materials (crush, screen or wash) on site the appropriate industrial zoning is required. Zoning enables the municipality to regulate elements such as setbacks, landscaping and access as they pertain to processing plants. Given the regulatory approach of OCPs and zoning by-laws, it is not uncommon to have extraction taking place at one point in a municipality and processing of the extracted materials at another.

The primary tool through which municipalities manage and regulate aggregates is with Soil Removal By-laws (SRBLs). Not all municipal jurisdiction posses SRBLs

and the content of these documents, where they do exist, vary. The differences are often indicative of the types of issues that initiated the original by-law development. For example, resource deficient municipalities may develop regulations that are particularly protectionist in terms of preserving areas for aggregate development in the future, while others may stress strict control over operational aspects due to proximity to residential and commercial areas. Others may contain a combination of many regulatory elements.

Municipal by-laws are provincial legislation derived from the *Municipal Act*. As such, by-law documents are comprised of a standardized framework in terms of the basic elements that make these documents legal and enforceable.

In general, all SRBLs provide procedural details for the permitting of aggregate operations, the processing of applications, municipal remuneration, and monitoring and enforcement by-law provisions. They commonly include land use control clauses that detail the methods through which aggregate operations are to be recognized in each municipality, such as in the OCP, and the discretionary elements that are provided for in permitting extractive uses of the land (conditions of approval). Operational elements are also included to regulate and control how mining is to occur. This could include site planning of the area, dust control, noise abatement, and haul route designation. Finally, SRBLs also contain biophysical/social components that allow for the evaluation of environmental and social concerns associated with aggregate operations in particular areas of the municipality.

Municipal management of aggregate extraction tends to focus on controlling some of the technical aspects of resource harvesting in order to reduce the impact of this activity on the community, with less attention to long range management of the resource. The case study analysis of the City of Prince George will be further elaborated on in Chapter Four of the thesis. The localized nature of the consumption of aggregate resources clearly requires provincial-level management

and direction for municipalities. Directives for management by municipalities have primarily been derived from the courts. Recent decisions have assisted in clarifying municipal control over aggregate resources and their ability to regulate the industry as a land use.

Municipalities can regulate extractive operations and utilize official community plans to manage and control aggregate resources. In the case of Pitt River Quarries Ltd. versus Dewdney-Alouette Regional District (Mascarin, 1995), Judge Clancy determined whether extractive operations involve the use of land, or the use of buildings and structures. While the *Municipal Act (1979)* excludes mines from the definition of land, the *Assessment Act (1979)* includes quarries and, sand and gravel as land, but excludes coal or other minerals. Judge Clancy refers to one of his previous decisions in Maple Ridge versus Thornhill Aggregates Ltd. (1993) where he concluded:

> *"Inclusion for one purpose need not inferentially require exclusion for all other purposes. I accept..the Assessment Act definition of land was intended to ensure harmony between the provisions of the Assessment Act and the Municipal Act" (Municipal and Planning Law Reports, 1995, p. 266).*

With respect to local regulation of mines Judge Clancy then found:

> *"...the quarry operation is a mine, it is not excluded from the definition of land found in the Municipal Act. The land on which the petitioner carries on its operations is within the jurisdiction of the District...mines and minerals are not excluded from the definition of land. Whether or not the operation is said to be a mine, the land use is subject to regulation by the District"(p. 267).*

Therefore, it is evident that a municipality may regulate within a zone the use of land, buildings and structures associated with extraction. This includes the power to prohibit any use or uses in a zone as per Section 963 of the *Municipal Act*. Extractive operations may be controlled as a land use.

Judge Clancy further defines the exercise of jurisdiction in reference to the relationship between the *Municipal Act* and the *Mines Act*. While a permit to

operate a mine is required under the *Mines Act*, it does not grant the permit holder the use of the land for such purposes anywhere in a municipality. Permit applications are made to MEMPR pursuant to the Health, Safety, and Reclamation Code (1992). As Judge Clancy states:

> *"...the permit provisions of the [Mines] Act and the Code...are concerned with safety and health in the operation of mines, and in the proper reclamation of lands affected by mining. The legislation does not purport to say where mining activities may be carried out. If a municipality chooses to prohibit or restrict mining operations within its boundaries, legislation enacted for that purpose is not in conflict with the provincial statutory theme. ...the municipality is concerned with the impact of processing on neighboring properties, the viability of transportation networks, and the protection of the environment generally" (p. 269).*

In summary, Judge Clancy clarifies the relationship between the two acts and the ministerial powers granted therein. He found that the *Mines Act* and the *Municipal Act* have different purposes, territorial scope, are administered by different authorities, and subject to different procedural requirements. As such, the powers of the minister under the *Mines Act* are within the act only, and do not extend to sanctioning other activities without regard for other enactments. Therefore, municipalities may utilize their powers under the *Municipal Act* to manage and regulate aggregate resources within their jurisdiction in conjunction with other planned land uses.

While the province has not provided an expressed direction to municipalities with respect to aggregate resources management, the courts have. This recent legal challenge by Pitt River Quarries Ltd. indicates that municipalities can control extractive operations through zoning, and address land use issues such as impacts and conflict through the powers delegated to them under the *Municipal Act*. The British Columbia Courts have defined the institutional arrangements regarding

aggregate resources management at the municipal level. What is needed is an appropriate process by which local municipalities can manage this resource.

2.6 Summary

Mineral aggregate resources represent a significant component of the mining industry in Canada. The value to local economies are significant, but so is the potential for disturbance and conflicts associated with its exploitation. The challenge of mineral aggregate resource management is to ensure access and development of a non-renewable resource, while mitigating impacts and compensating communities who must endure the intrusion of this industry. Local municipalities need new approaches that are long range in foresight yet immediate in securing compatibility in local land use.

Chapter Three

Environmental Resource Management at the Local Level: A Theoretical Framework

3.0 Introduction

A good quality of life and economic development cannot be sustained in a ecologically deteriorating environment (Crombie, 1991). A healthy and vibrant natural environment is a key component of a healthy community. It is necessary to develop approaches to land management that take into account environmental impacts generated through actions designed to maintain or develop a good quality of life as well as maintaining economic growth within our communities. Human patterns of natural resource production, consumption, management have ramifications with respect to the health of both our natural and human environment. Planning tries to create images of a possible community environment; it is "concerned with the attainment of preferred conditions in the physical environment, and that the community's preferences are the prime consideration" (Hodge, 1986). As planning aims to specify and maintain land uses consistent with public goals and objectives, it also needs to limit uses incompatible with the ecological processes of the land (Westman, 1985). This balanced approach to planning, or environmental planning, is instrumental in determining how our local land resources will be used. It has a large role to play in integrating resource use with community sustainability.

Environmental planning is an attempt to integrate ecosystems enhancement in land development planning. Environmental planning possesses elements of impact assessment and integrated resource management and can be described as an impact oriented method of planning that transcends the scope of standard practice (data collection/analysis, goal development, alternative consideration, and plan preparation). In addition, environmental planning attempts to achieve

compatibility, not just in land use determination, but also in achieving a harmonic relationship between land uses and the surrounding natural and human environment (Lang and Armour, 1980). The past decade has seen increasing emphasis on better and more consistent incorporation of community values into the decision making and implementation processes of resource management and community development plans. In essence, a socialization of the process now allows technical and purely scientific data to be integrated with social and community inputs as a means to direct decision making and plan development (Lang, 1990). Community input and community value assessment have become important aspects of environmental planning. Consequently, innovative impact assessment and integrated resource management approaches aim to permit community inclusion in resource management at the local level.

This chapter develops a theoretical framework that will contribute to local resource management practices based upon a synthesis of environmental planning principles and the recent approaches in impact assessment and integrated resource management.

3.1 Environmental Planning

Planning consists of many things; in a pragmatic sense it may involve economic or fiscal planning, urban design, or social planning. However, theorists generally agree that planning is a process that transports knowledge to stimulate positive action. Friedman (1987) points out that planning is an attempt to solve the theoretical problem of "making technical knowledge in planning effective in informing public action"(p. 36). This is a particularly relevant statement with respect to environmental planning. The need to manage the environment with the public interest in mind requires the collection, understanding and application of a wide spectrum of information. How this information is assembled and implemented is

vital to the desired outcomes of environmental planning. The definition and perceptions of environmental planning have changed over the past decade.

Lang and Armour (1980) provide one of the early contexts for environmental planning in Canada by outlining its meaning, the type of information involved, the procedural characteristics, and the planning principles upon which environmental planning is based. Lang and Armour (1980) propose that to environmentally plan means to:

> *"[prepare] for purposeful action directed towards specific environments or environmental resources for the overall purpose of optimal enhancement of environmental capacity and quality " (p. 21).*

This definition identifies the subject base of this activity (environments/resources) as well as the goals (enhance capacity and quality) of the 'action' undertaken upon the subjects. Watt (1973) sees environment as varying degrees of ideals from a watershed or animal habitat to a neighbourhood or recreation area, whereas a resource refers to anything needed by an organism, population or ecosystem which by increasing availability allows for an increasing rate of energy conversion.

While Watt proposes an objective definition of a resource based upon the science of energy transfer or conversion, Zimmermann (1964) offers a functionally subjective, human based definition of this term. He stresses that resources are materials available to humans through our knowledge of such materials and our ability to acquire and put these materials to use through technology. In Zimmermann's words "resources are not, they become; they are not static but expand and contract in response to human wants and actions" (p., 21). These definitions stress that the subject matter of environmental planning is extremely dynamic. Both environments and resources can be variable in shape, size, and relative importance to other variables depending on the human views of the subject at the time.

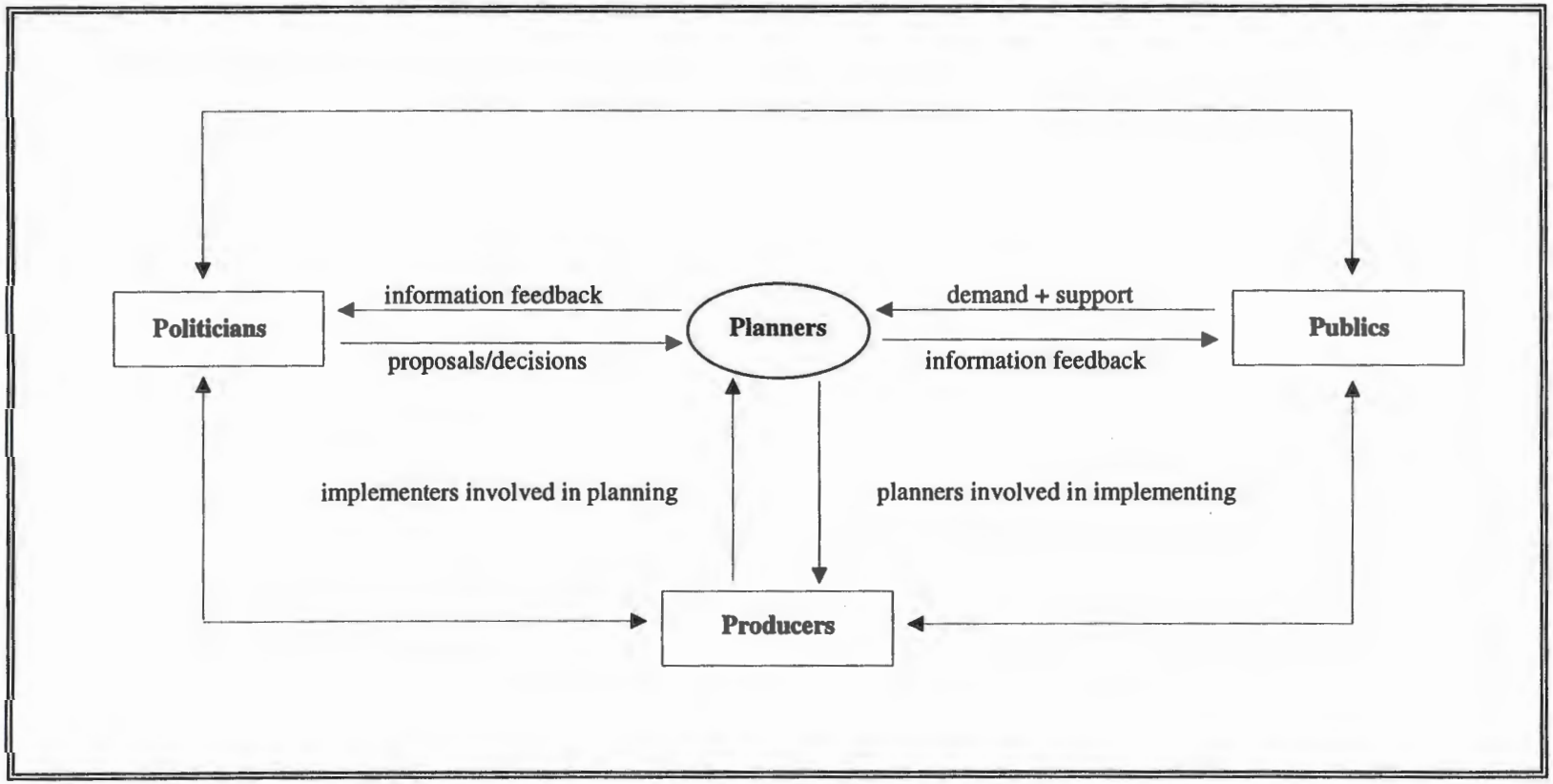
Environmental planning attempts to direct uses of environments and environmental resources so that their utility is maintained as well as their capacity to meet people's needs in the future. Dorney (1978) has established a set of principles upon which environmental planning should be based (Table 3.0). The principles consist of the three categories: *Planning, Natural Sciences* and *Social Sciences*, implying an integration of varying types of knowledge across different disciplines. Where the natural sciences tend to be extremely technical in nature (stability, resilience, productivity), the social sciences are entirely humanistic in approach (community values, perception). The planning emphasis here, according to Lang and Armour (1980), is weighted heavily towards co-ordination and understanding of incoming information as well as institutional frameworks. In addition, the planner is responsible for integration of information from the natural and social science fields for use in decision frameworks.

The process upon which environmental planning is based (the method through which knowledge becomes action) does not necessarily support the goals of planning environmentally, in that it does not always inform public action. That is, that while the issues considered in the environmental planning model are more holistic in nature, the enacting mechanism is substantially the same. Ideally, environmental planning attempts to improve the relationships between politicians, planners and the public so that decision making reflects mutual goals for environments and human use of resources. However, in many circumstances there remains a top-down model that is strictly rational in approach. Benveniste's (1977) model (Figure 3.0) is illustrative of this point. While feedback is a dominant element in this model, the implementers (producers) of plans and policies direct public action through implementation with the planners. The public is in no way directly involved in formulation nor plan implementation. Their role is potentially

Table 3.0: Environmental Planning Principles (Dorney, 1978)

Planning	Natural Science	Social Science
•Develop site specific environmental goals and objectives	•Inventory existing resources for quality and quantities	•Identify community and institutional values, concerns and perceptions. Include natural features of symbolic importance.
•Favour low risk designs and encourage flexibility in land use, infrastructure and resource use.	•Understand historical ecosystem propertires and trends (capacity, thresholds and linkages).	•Understand cultural linkages between land uses, productivity and resource recycling or re-use.
•Understand compatibility and incompatibility between adjacent land uses.	•Determine ecosystem stability, resiliency-diversity relationships.	•Map recreational capability.
•Undertake environmental protection planning (mitigation, risk assessment, contingency plans and monitoring).	•Understand population dynamics of organisms and indicator species in the area.	•Evaluate local/regional economic strategies within the context of environmental concerns.
•Identify and create/enhance amenity landscape resources.	•Determine carrying and assimilative capacity limits.	•Develop strategies to alter human values and perceptions where feasible.
•Incorporate environmental policies and protection measures into official plans.	•Identify relationships between land capabilities and biotic resources.	•Develop educational approaches at all levels.
•Assess environmental impacts.	•Identify constraints, protected areas, enhancement opportunities, sequential use of land, unique geological land units.	
•Evaluate new technology from resource, cultural and economic perspectives	•Identify health and nuisance related landscape problems	
•Identify institutional structures and their capabilities.	•Control externalities.	
	•Plan for conservation and sustained yield of resources.	
	•Regulate or reduce entropy (degradation) in ecosystems.	
	•Design low maintenance landscape systems	
	•Design and promote monitoring of ecosystems.	

Figure 3.0: Benveniste's Model of Environmental Planning



(From Lang & Armour, 1980)

limited to reacting to derived plans and policies. Friedman (1987) points out that reform generally tends to be directed to the rulers of society and that reform is an activity generated from the top, and part of an 'orderly' way to change society. In turn, one may conclude, the main value of the early endeavors of environmental planning has been to inform politicians and implementing agencies about environments and environmental resources and our need to maintain and support them for our own well being. Institutional elements have begun to realize that long term human interests are dependent upon a harmonious relationship with the rest of nature (Norton, 1988).

Environmental planning has evolved considerably into the 1990s. Associated concepts include sustainable development, environmental impact assessment and integrated resources (environmental) management. One of the key trends in its evolution is a 'socialization' of the process by which social values and preferences are viewed only as information resource for plan development. People have become direct participants in issues identification, data analysis and alternatives selection in environmental decision making (Armour, 1990). In essence the process through which public action is directed has the potential to become directed by the public itself in conjunction with planners and politicians. This approach invokes 'social-learning' in planning limiting the traditional approaches of the 'rational-comprehensive' or 'social-reform'.

Social learning is a form of planning that begins and ends with public action. Knowledge is acquired through action and interaction with others in order to reach and implement decisions. It is related to human activity and stresses social processes from the standpoint of actual practice (Friedman, 1987). Thus, social learning in practice brings stakeholders into the decision making process. An examination of recent initiatives in environmental impact assessment and integrated resource management illustrates how social learning has become a large component of

environmental planning and that local resource management practices can benefit in the application of such an approach.

3.2 Environmental Impact Assessment

Impact assessment has been criticized for its narrow scope and inability to move beyond the technocratic in information acquisition (Westman, 1985; Smith, 1993[a]; Burdge et al., 1995; Webler et al., 1995; Meredith, 1995). Subsequently, the true potential of impact assessment may have not yet be realized in resource management and environmental planning. Moreover, Smith (1993 [a]) identifies the focus of impact statements as the main cause of this process' deficiencies. Project specific impact statements alone provide a "narrow focus, [inhibiting] the ability of impact assessment to address such issues as risk, uncertainty and cumulative effects" (p. 95). There is a need to redefine impact assessment such that it is "a process of environmental planning that provides a basis for resource management to achieve the goal of sustainability" (p. 95). Meredith (1995) , supports the concept that impact assessment is a culturally specific activity and that rather than simply dealing with ecosystems, impact assessment must address socioecosystems to encompass social and ecological perspectives of our environment. Impacts generated on the environment must address the culture in which these impacts occur. Clearly, impact assessment is undergoing a transformation or socialization process that complements the technical science of impact assessment with the process of social legitimization. This transformation enhances its utility in local resource management initiatives.

3.2.1 Background

Environmental impact assessment (EIA) began in the United States with the passing of the National Environmental Policy Act (NEPA) in 1969. The NEPA established environmental impact statements as the principal vehicle of impact assessment. The purpose of impact statements was to incorporate scientific data describing the potentially impacted environment for review, analysis, and public disclosure in the decision making process. It was initially an information generating activity designed to inform decision makers. In Canada, impact assessment followed the U.S. example after the establishment of a task force which established guidelines for impact assessment at the Federal level. In 1973 the Environmental Assessment Review Process was established under the regulatory authority of the Federal Environmental Assessment Review Office (FEARO). Today, the Canadian Environmental Assessment Act (CEAA) and CEAA Agency oversee assessment in Canada on projects where the federal government is the proponent, federal lands are to be used, and/or where federal funds are involved. Provincial acts also exist in Canada to provide assessment of industry projects as well as those undertaken by the Provinces (Robertson, 1990).

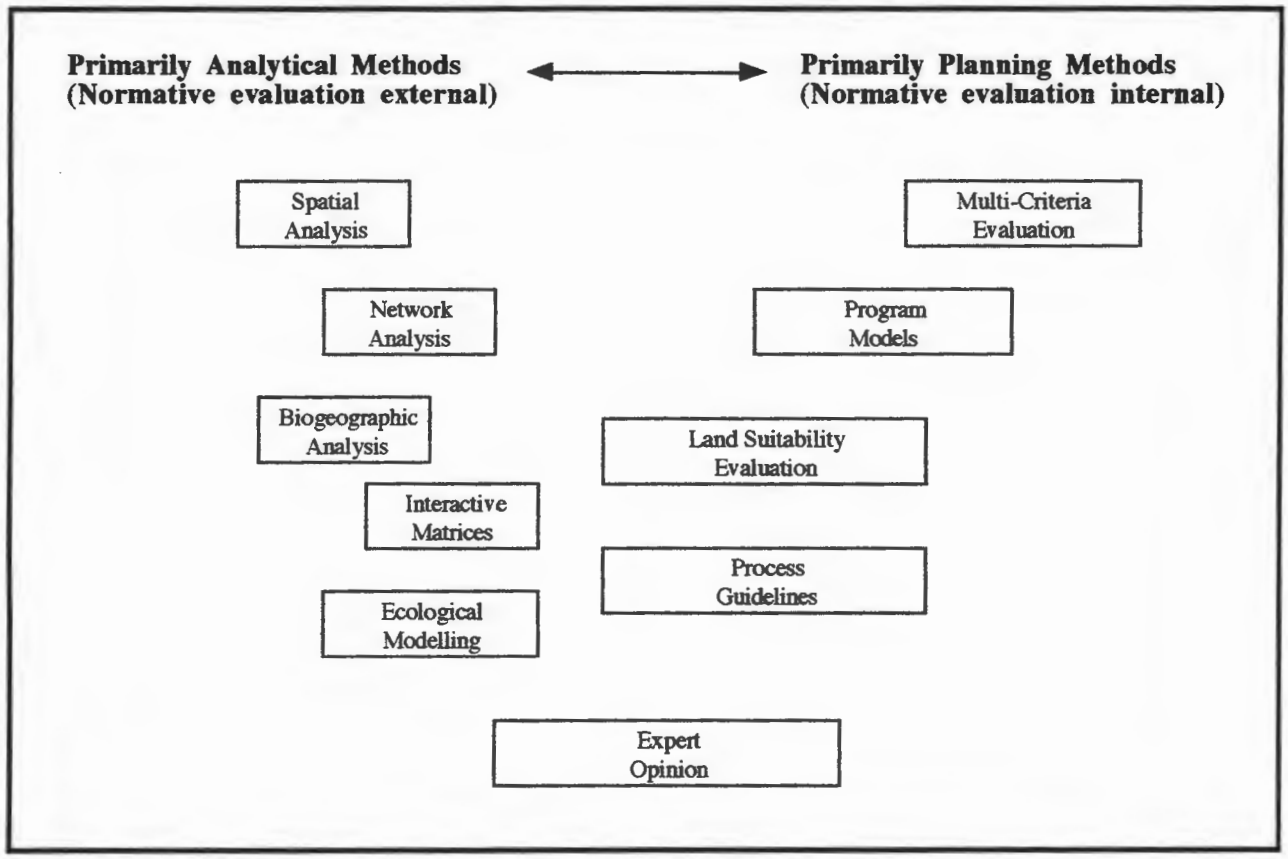
Originally impact assessment was directed to large resource development projects and the need to ensure proper environmental design. This design would be evaluated through the production of an environmental impact statement (EIS) containing scientific data, analysis and technical reporting on potential impacts upon the environment. One of the main deficiencies of EIA has been its emphasis on biophysical data. Sadler (1990) identifies the need to integrate social systems into assessments in order to "...accommodate the competing ranges of interests and values and adjust them to different environmental capacities at local and regional scales" (p. 99). If impact assessment is to play a role in environmental planning, it seems clear that social values, and natural sciences must both be incorporated into the decision processes of this activity.

New approaches to EIA have developed as the deficiencies of the process became apparent. The assessment process has been refined to address social impact, community impact, risk assessment, and human stress. EIA attempts to address "... the consequences of public or private actions that alter the ways in which people live, work, play...and generally cope as members of society" (Burdge et al., 1995, p. 11). One common trend in the application of new techniques has been that, no matter how rigorous the science in information assembly and analysis, the process through which it has been implemented can constrain the usefulness of this knowledge. Accordingly, Smith (1993 [a]) is advocating a new role for impact assessment. Rather than impact assessment strictly as an information generator, it should become a bridge that integrates the science(s) of the environment under study to the politics through which resource management is implemented. The method through which this is to be realized is through integrating planning and impact assessment.

3.2.2 Approaches to Planning and Impact Assessment.

Successfully linking information to political processes for meaningful resource management may require the integration of impact assessment methods and planning processes. Efforts to achieve this integration must recognize that impact assessment consist of two distinct, yet inherently related, methods. Figure 3.1 illustrates the distinction between the two methods as proposed by Spaling and Smit (1995). The first is comprised of analytical techniques which stress information generation and scientific analysis, while the second focuses on planning principles stressing preferences among choices. The distinction between the two methods derives from their tools of analysis. While analytical techniques rely strictly on data interpretation and "what is", planning methods utilize preference, values and social perceptions of problems to interpret "what ought to be", and is thus forward looking in perspective. In this sense planning methods rely upon normative evaluation

Figure 3.1: Two Methods Towards Environmental Impact Assessment



(Spaling and Smit, 1995)

whereas analytical methods exclude normative evaluation from the decision rule process. While Spaling and Smit (1995) distinguish between approaches, they do not link the two together in a procedural sense. Therefore, under this classification, while a problem may be the same at the top of the figure, the expert opinion and directional decision at the bottom may be quite different and possibly in conflict with one another.

Smith (1993 [a]) proposes that the analytical and normative approaches to impact assessment can function concurrently and are the key to linking environmental information to application in resource management. Smith relies heavily on the works of Beanlands and Duinker, and Whitney and Maclaren to make this connection and refers to it as the 'scientific approach'. The scientific approach is best characterized through the works of Beanlands and Duinker (1983) who propagated the standardization in method as a means of improving impact assessment.

Beanlands and Duinker (1983) identified a lack of scientific quality in impact assessment in Canada, primarily due to a laissez-faire approach in the application of the scientific method. They also identified a lack of continuity in that assessments usually end with an impact statement, leaving information transfer and communication to become disjointed throughout the remainder of the process. Beanlands and Duinker suggest approaching impact assessment as a scientific experiment based upon the science of ecology. Such an approach is one "that makes use of ecological principles and concepts in the design and conduct of assessment studies and in the prediction of impacts" (p. 18). Their approach proposed six guiding steps to impacts assessment:

- the identification of valued environmental components;
- the definition of a context for impact significance;
- the establishment of boundaries;
- the development and implementation of a study strategy;
- the specification of the nature of predictions; and
- the implementation of monitoring.

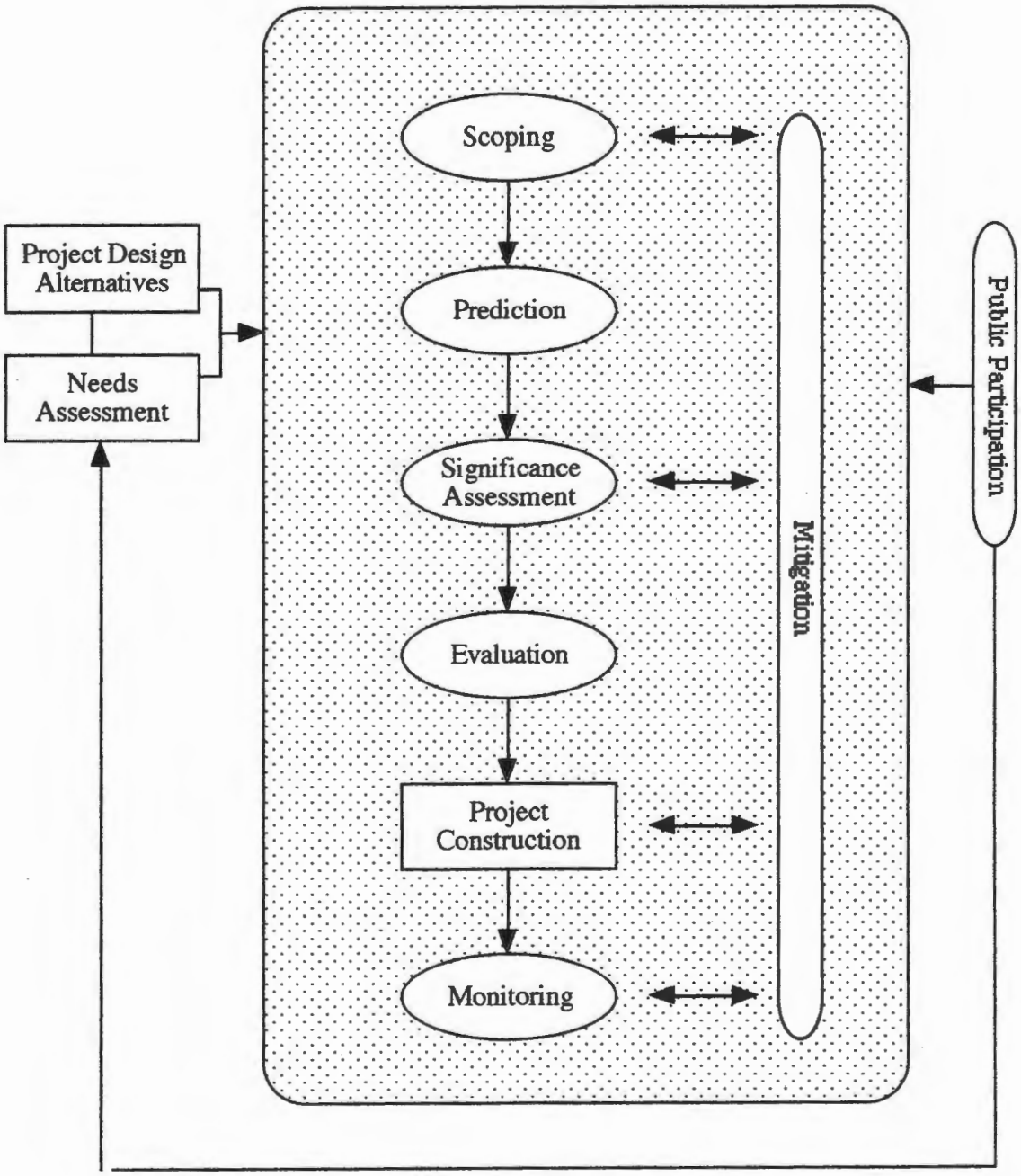
Key to this approach is the identification of valued environmental components (VECs: elements of the environment for which there is public or private concern). This exercise establishes the direction or scope an environmental assessment should take. Evident in this structure is a heavy reliance on the scientific approach to impact assessment; however the inclusion of VECs is significant in that it implies preferences and value sets as in the normative methods proposed by Spaling and Smit.

Building upon Beanlands and Duinker's work, Whitney and Maclaren (1985) incorporate a social context into impact assessment. While supporting the approach of a scientific experiment, they suggest the inclusion of social and ecological sciences as a means to an integrated approach to impact assessment that brings together the normative and evaluative approaches. Figure 3.2 depicts the approach suggested by Whitney and Maclaren. Important features include public participation at all stages of the process as well as needs justification and alternatives in project design. This process promotes a flexibility or adaptiveness to socio/political environments prior to undergoing impact assessment, and can therefore, identify immediate shortfalls in project design or community needs. Overall, this can make the assessment process more meaningful by strengthening its focus. In general, the steps in this process include:

- Scoping: preliminary scrutiny of the proposal;
- Prediction: the future condition of valued components;
- Significance assessment: the magnitude of change upon components;
- Evaluation: consideration of positive/negative changes on components;
- Project construction; and
- Monitoring: of actual effects/match with predicted impacts.

Table 3.2 elaborates on the procedure/goals for each stage.

Figure 3.2: Scientific Approach to the Integration of Impact Assessment into Planning



Whitney and Maclaren (1985)

Table 3.1: Elements of the Scientific Approach to Impact Assessment

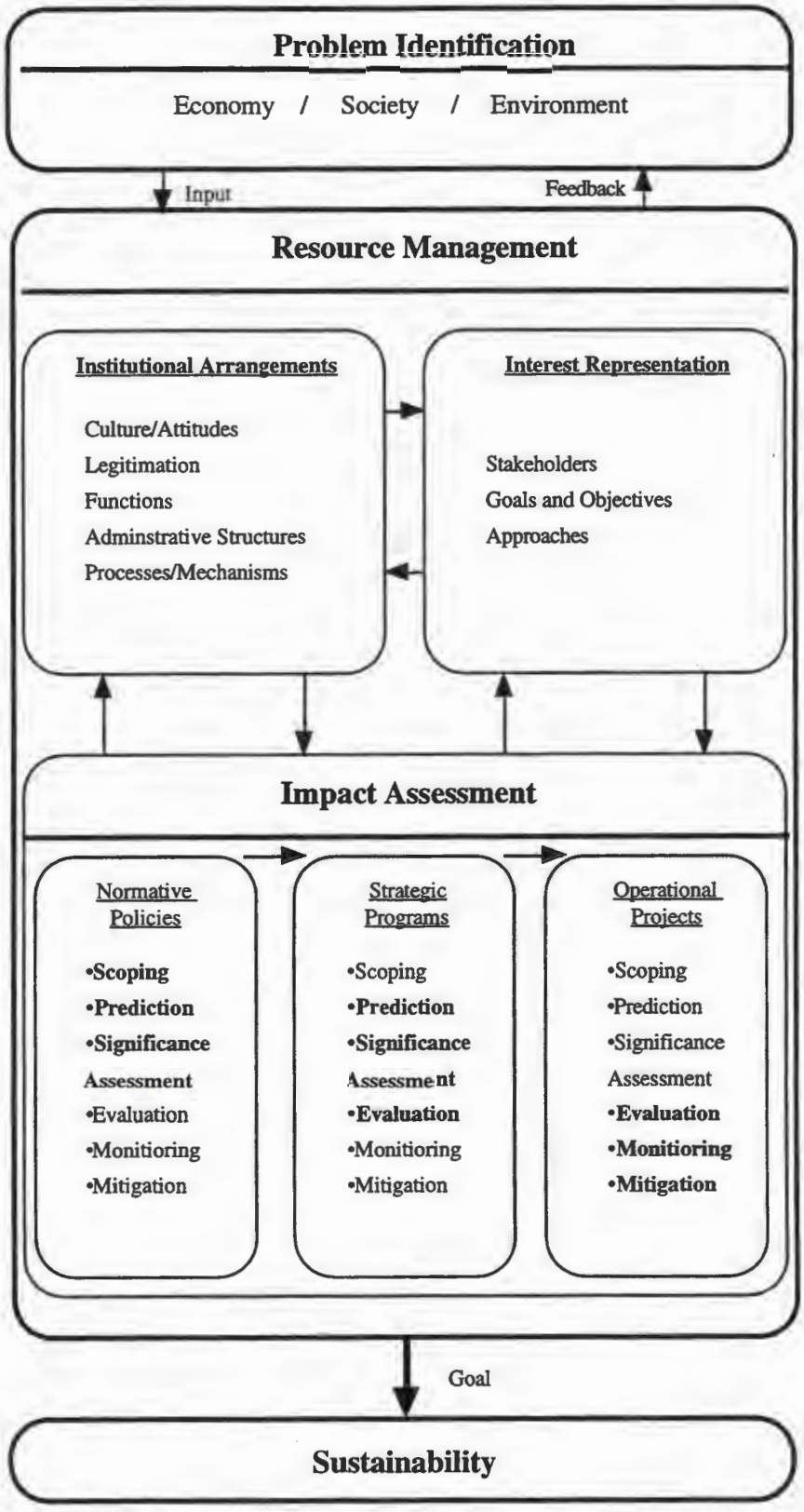
Scoping →	Prediction →	Significance Assessment →	Evaluation →	Monitoring
•identify relevant groups to be involved	•Account for systems interaction	•Conduct without project comparisons	•Establish aggregation versus disaggregation of impacts	•Compliance or surveillance monitoring to ascertain compliance with mitigation
•Identify the environmental and social components that are publicly and/or scientifically relevant	•Account for dynamic change in environments	•Assess cumulative effects	•Define the level of measurements to be employed	•Effects monitoring to compare actual with expected impacts to validate predictions
•Establish a hypothesis regarding impacts on values environmental components as basis for impact assessment	•Account for the probablistic nature of future events	•Determine impact duration	•Determine weighting procedures	•Public concerns monitoring to identify and track views of the effected public
•Identify the spatial and temporal boundaries for the study	•Account for the uncertainty of future events	•Determine risk	•Determine the use of common measurment units	
	•Account for the variability of phenomena	•Define the stability and resilience of environmental components	•Ensure an ease of understanding to the evaluation process and	
		•Determine the relative magnitude of impacts	•Utilize public involvement	
		•Establish quality standards		

Such an approach to impact assessment is a viable method of resource management when incorporated into the planning process. Figure 3.3 depicts Smith's (1993 [a]) integrated framework to resource management. Such an approach "is essential to the achievement of sustainability in resource use and community well being" (p. 95). Environmental impact assessment becomes the central process in planning policies, programs and project development within the realm of resource management. As such it becomes a problem solving mechanism or tool that is utilized by a variety of interests alongside existing institutional structures. The goal of such an approach, according to Smith, is sustainability. Thus, in incorporating the scientific and social contexts of EIA into the resource management planning process, Smith has been able to illustrate what may be referred to as a modernized formed of environmental planning incorporating natural and social science principles with those of planning.

According to this framework various interests may initiate and/or partake in problem solving initiatives to work out mutually acceptable solutions. This is clearly a move away from traditional planning models where interest representation is reactionary and hierarchically lower in the procedural flow of information. Smith seems to support an approach to environmental planning that encourages a social learning approach supportive in recent planning literature in the form of public participation where " (participation)...is viewed not simply as yet another form by which people are co-opted into the existing structures of domination, but rather as an autonomous political practice" (Friedman, 1987, p. 222).

Work by Webler et al. (1995) supports social learning as a key to the success of impact assessment for four reasons. First, meaningful public participation in the process enhances the competence of the final decision through the use of local knowledge and the public examination of expert knowledge. Second, legitimacy is established in a process where affected parties can state their case and have equal

Figure 3.3: Smith's Integrative Framework for Sustainable Resources Managment



(Smith, 1993)

opportunities to influence the outcome. Third, social learning in the form of public participation is connected with democratic processes in decision making. Finally, involvement in a learning experience can foster stewardship ideals for the community in which people participate. In this sense the benefit of environmentally sound practice goes beyond the results of the impact assessment alone and extends to day-to-day activities in the community as a whole.

Given the structure and theoretical approach of Smith's framework, it would appear to lend itself quite well to the local management of natural resources, where community sensitivity is particularly high, and where the local planning of natural resources is subject to public scrutiny. However, in this context the model does not specify a direct decision path nor scale of policy, program or project that may be subject to evaluation. In addition, a historical context of resource management in an area may be a key factor in assembling participating groups. Prior experiences affect people's willingness to come to the table to co-operate (Webler et al., 1995). Incorporation of integrated resource management principles can help alleviate these problems.

3.3 Integrated resource management at the Local Planning Level

The product of methodological frameworks in environmental resource planning must reflect the way people think and feel about the land and its values (Kessler et al., 1992). If this is not the case, then an 'us-against-them' attitude will persist in environmental management and impede the rate of progress towards sustainability. The approach must be sensitive to the historical context into which resource management plans are being developed. While in some instances a plan, policy or project may be reviewed as new to the community and progressive, and generate an eagerness among participating parties, others may be react negatively to a problem that has persisted in the community for some time. In such an instance, it is likely

that a certain degree of ideological polarity already exists between the participating parties.

Walther (1987) indicates "the success of integrated resource management is a function of the historical context into which a plan or program [or project] is placed, and secondary of its professional design" (p. 445). Such an effect could be compounded further when groups come together and begin to gather more information on the issue at hand if historical contexts of resource conflict are not considered prior to the implementation of an integrated management framework. Without incorporation of historical contexts in problem solving, Walther believes that the result is an 'idealistic' approach to resource management. This may result in conflict throughout the process, hindering decision making. This has the potential to drive participants further apart, impede plan development and compromise decision frameworks.

Born and Sonzongi (1995) have devised four principal dimensions of integrated resource management that are capable of addressing historical contexts. These characteristics can complement Smith's integrated resource management framework:

- comprehensive/inclusive;
- interconnective;
- strategic/reductive; and
- interactive/coordinate defines the 'how'.

Comprehensive in the context of integrated resource management refers to the scope and extent of the management activity. All relevant factors must be incorporated into the management process including biophysical data, chemical and human components, and the stakes private and public entities may have in the process. Historical conflicts or relationships between entities need to be incorporated.

The interconnective dimension includes the linkages and interrelationships that were identified in the first dimension. This reveals the conflicts and communities of interest associated with resource management activity and assists in developing a decision structure to facilitate or reduce polarities among groups or issues.

The strategic/reductionist dimension is used to determine which elements of the identified issues will be considered in the resource management process. The purpose of this step is to eliminate those issues or relationships that cannot feasibly be addressed in the planning and management framework, and to establish the parameters and scale of discussion and debate in the process. Participating groups become aware of what is, or is not, open to discussion; they can develop their participatory roles accordingly. Essentially, this step clarifies the nature of the problem and the relationship of the parties who will address the problem. It removes uncertainty and provides focus to the process. Borne and Sonzogni refer to it as:

> *.." a filtering process...[which] aims to make integrated environmental planning and management adaptive, anticipatory and more attuned to the realities of the political decision arena" (1995, 171).*

The final dimension, interactive/coordinative, addresses how resource management should take place. This step focuses on the sharing of ideas and information transfer in the problem solving process. The goal of this step is to achieve consensus among participating parties based on the information derived from the process. Interactive/coordinative steps aim for shared decision making and the development of a stewardship philosophy for the resource issues under investigation.

Borne and Sonzogni's four dimensional approach to integrated resource management could be useful in eliminating a degree of situational 'idealism' if incorporated into Smith's management model. The first three dimensions (comprehensive/inclusive, interconnective, and strategic/reductionist) can be

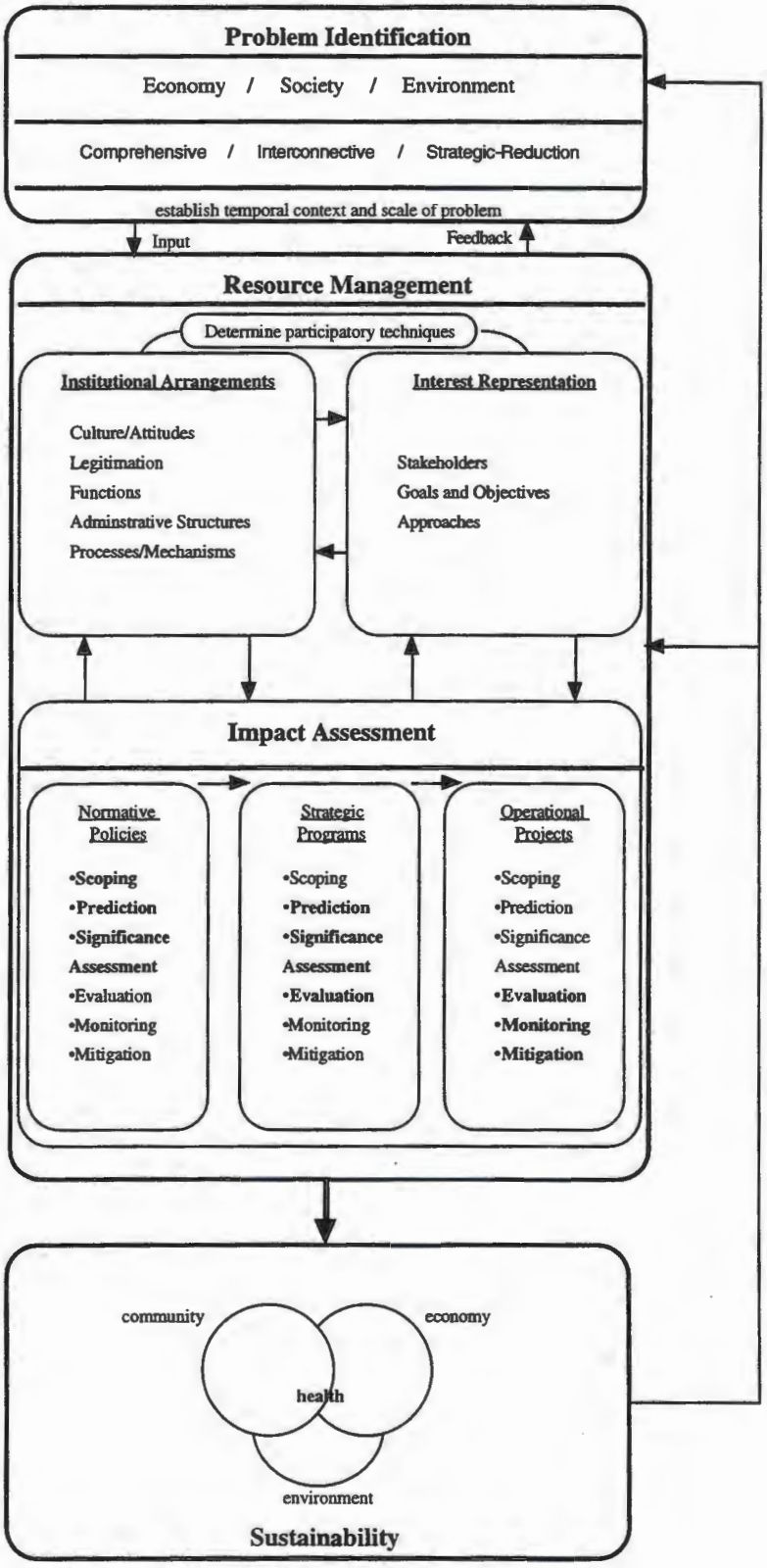
incorporated into the problem identification stage of Smith's framework. The historical context of the resource issue and participating parties can be established, defined and accounted for prior to attempting resource management practices. In turn, this can also establish the parameters around which debate and discussion will be directed. The nesting of smaller problems between groups of interest can be revealed within the scope of the larger problem identification stage of the framework. Thus, the nature of all problems (nested and compounded) can be searched out at this stage and 'filtered' through to be addressed (if appropriate) at the resource management stage.

In essence, the management approach establishes a scale as to what issues will be addressed. The final dimension (interactive/coordinative) correlates with Smith's resource management approach and functions in the transfer and comprehension of information between and among participants in the resource management process. Thus, by incorporating integrated resource management principles into Smith's management framework, some of its shortcomings are alleviated and its use in local resource management becomes more feasible.

3.4 A Framework for Local Resource Management Initiatives

Figure 3.4 illustrates a synthesized framework of Smith's and, Borne and Sonzogni's proposed for integrated resource management. The ability for such a framework to solve all resource management problems is unrealistic. Such a process may not be functional in all situations and may offer only partial solutions in general. However, it does offer a comprehensive method of approaching some resource management problems that exist in local municipalities. It incorporates a social learning process and an impact assessment approach derived from both natural and social sciences and provides a contextual setting within which problem solving can be undertaken. In general, the framework possesses the elements that theoretically can lead to environmental health through establishing a 'structurally

Figure 3.4: Synthesized Framework for Sustainable Resources Managment



sound' bridge between problems identification and sustainability where "impact assessment is seen as the process for environmental planning providing the basis for resource management to achieve the goal of sustainability" (Smith [a], 1993, p. 101).

The synthesized framework can be described by each of the three main sections: Problem Identification, Resource Management and Sustainability. Problem Identification reflects the identification of issues, conflicts, opportunities, and problems in a community. The identification of these factors triggers the need or desire to develop resource management plans, policies or projects. At this stage it is important to assess the factors that are bringing the issues to light, their interrelationships and significance to the remainder of the resource management process.

The three components of resource management are identified as: institutional arrangements, interest representation and impact assessment. Institutional arrangements, are vital in the process; they may deal with how interests will be represented and should open the door to innovative techniques in participatory problem solving activities. The institutions involved must stress the integration of interests; otherwise, community values and perceptions of resource issues will be lost among proponents and administrators.

Once appropriate institutional arrangements are established, interest representation techniques need to be applied. While Smith's original model would have dictated these techniques through institution determination alone, the addition of historical context in problem identification can assist in determining what type of participatory techniques may be appropriate. Issues that have a number of groups possessing highly contrary ideas towards the resource problem may require intensive techniques such as stakeholder roundtables, workshops and site visits. Issues of less conflict may utilize more passive techniques such as interviews, questionnaires, and public meetings.

EIA is the final element of resource management. Smith perceives impact assessment as a process of environmental planning. As discussed earlier, this approach to impact assessment integrates social and natural science approaches to impact assessment. It consists of six activities that represent an iterative approach to policy development, program implementation and operation of approved projects (Table 3.1). Central to this approach are prediction, significance assessment, and evaluation. Prediction provides for the assessment of future situations expected from specific planning initiatives. Thus, this approach is forward looking rather than simply a data generating activity. Significance assessment allows prediction of the magnitude of impacts on the environment once futures have been determined, while evaluation permits the participants to rank alternatives and select a course of action. Since this approach addresses not only project related impacts, but also those generated by policies and programs, it can be uniquely geared to local resource management problems and the development of community stewardship in the local area.

Finally, the last element of Smith's framework may be altered to reflect a concept of sustainability as express by Crombie (1991) that focuses on the related health of environment, community and economy. The inclusion of this concept at the end of Smith's integrated framework is indicative of the unpredictability of the environment and of the potential for error to develop in the resource management process. The integration of this concept supports an incremental approach to resource management and indicates that 'we may have to go back and try it again' if health is not achieved the first (or second, or third...) time. In this sense, the process is iterative. The idea is that, over time as a stronger knowledge and understanding of the community in which we live develops, the likelihood of attaining overall community health will increase.

3.5 Summary

I have attempted to develop an integrated approach to resources planning that draws from the foundations of environmental planning and from the progress of impact assessment and integrated resource management over the last decade. Impact assessment incorporates an increasing social interest in its methodology. A logical progression in resource management is the integration of this process with planning. The use of this approach in aggregate resource management presents an opportunity to apply this model at the local level.

Prince George: A Case Study-Methodology

4.0 Introduction

The City of Prince George is located in the Central Interior of British Columbia at the confluence of the Nechako and Fraser Rivers. The lands originally were inhabited by a Carrier community until the Northwest Company of Fur Traders (NWC), led by Sir Alexander Mackenzie, expanded into the area (Lamb, 1970). In 1806, Simon Fraser established Fort George just south of the river junction as a trading post and transportation depot from which goods could be sent south via the Fraser River (Lamb, 1960). The area remained primarily as a trading post and reservation for the Carriers until 1911, when the Department of Indian Affairs purchased the Carrier reservation to facilitate the construction of the Grand Trunk Pacific Railway (Runnells, 1946). In 1915 Prince George was incorporated into a city of approximately 442 hectares. Since that time, the City has amalgamated adjacent areas to increase the area of Prince George to 32,400 hectares (City of Prince George [a], 1993). Johnson (1991) has described the unique geographical character of Prince George. The city is isolated from nearby competing centres and as a result must supply its own service and supply functions. This includes all the structural materials required to facilitate the growth of the city. Prince George is essentially a "gateway" city through which people and products move to and from north-central and north-eastern British Columbia.

Following migration patterns of people from the prairies in the 1950s, the City of Prince George experienced rapid population growth in the 60s and 70s. This growth was spurred by the establishment of successful pulp, paper, and timber supply industries. The population increased from 15,000 people in 1961 to 69,653 residents in 1991. The latest growth rate data for the City indicate an average of 0.6 percent per year. The development of the University of Northern British Columbia is

anticipated to increase the annual growth rate through the latter half of the decade to between 1 percent and 1.5 percent. Also, as the regional centre of northern British Columbia, it is estimated that by 2006 the population will increase to approximately 83,000 residents, with an average household size of 2.7 people. This translates into the need for an additional 4,943 housing units (City of Prince George [b], 1993).

4.1 Glacial Geomorphology: Sand and Gravel Occurrence and Distribution

The glacial history of the Central Interior Plateau (CIP) is well documented (Tipper, 1971; Holland, 1976). During the Pleistocene period, at least 10,000 years ago, the central interior of British Columbia was covered by a sheet of ice approximately 1520-1830 meters thick. This glacial blanket began to slowly melt about 11,500 years ago, resulting in the re-advancement of ice lobes. Melting or deglaciation continued until the temperature was suitable for modern vegetation, roughly, 9-10,000 years ago. It was during the re-advancement of these lobes that massive sections of ice, up to 914m thick, drifted down the Coast and Cariboo Mountains onto the CIP. Tipper suggests that all of the Fraser River from Prince George to Mission may have been buried under ice at this time. During the deglaciation process the CIP landscape became a lacustrine basin that held three glacial lakes. Of these lakes, the two largest were in the Prince George and Vanderhoof basins. Proglacial Lake Prince George drained north and was located where the entire study area currently is. The lake level was gauged to be no more that 72 meters until further melting occurred in the Fraser River Valley, allowing additional drainage to take place. The period of time that these proglacial lakes existed is unknown.

The most northern subsection of the CIP is the Nechako Plateau. Donahue (1973) describes the Nechako Plateau as being moderately undissected, to deeply cut along the Fraser River and its tributaries. The Nechako Plateau is bordered on the north by the Skeena and Omineca Mountains, the south by West Road River, the east by the Fraser Basin, and on the west by the Hazelton Mountains. Holland (1976)

indicates that "The Plateau was occupied by ice, which, in moving across it, marked the surface with thousand of grooves and drumlin like ridges which are paralleled to the ice flow" (p. 68). The geomorphology of the Plateau is comprised of bedrock that originated Mesozoic and Paleozoic sedimentary and volcanic rock. Over time, erosion has worn the landscape and led to the common appearance of gently rounded surfaces. Likewise, most of the mountains are remnants of centuries of erosional processes at work. These mountains include the Quanchus, Fawnie and Nechako ranges (Tipper, 1971).

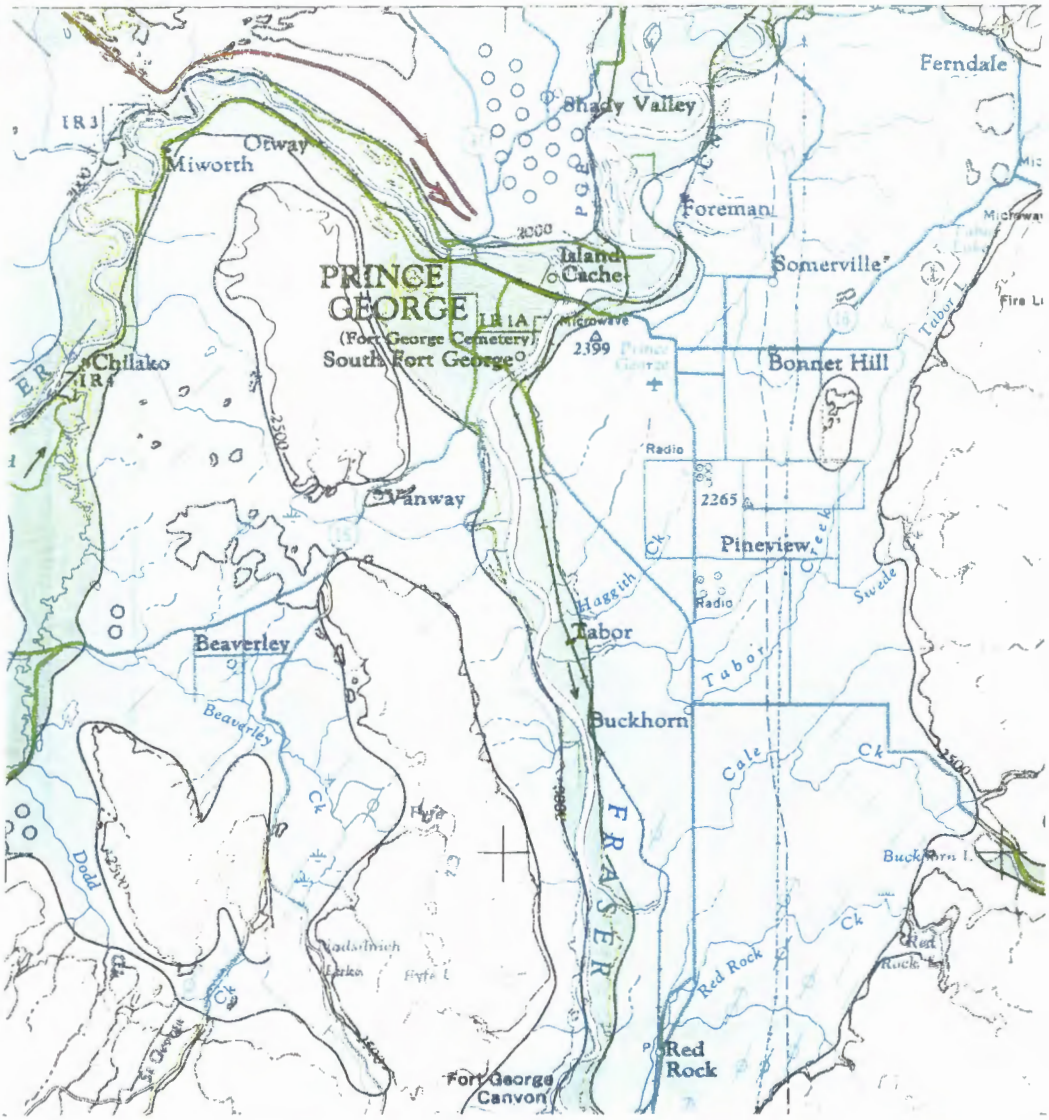
The results of this glacial activity include the presence of outwash present along previous routes of drainage from the proglacial Lake Prince George (the Fraser, Nechako and Crooked Rivers). In addition, three large esker complexes are located west, northwest and north of Prince George, the result of earlier stages of glaciation. These are know as the MacKinnon, Stuart River, and Bednesti compound eskers and are identifiable as formed ridges, kettles and meltwater channels (Tipper, 1971). Figure 4.0 provides an illustration of deglaciation patterns in the Central Interior Plateau.

4.2 A Basis for the Case Study Approach

In terms of the management of aggregate resources in Prince George, there is a need to coordinate the social preferences of the local community and the purely resource based perspectives of the provincial administrating agencies, and producers. There is an evident void in the joint management of local land resources in Prince George and the regulation of the extraction of sand and gravel by the City and the Ministry of Energy Mines and Petroleum Resources (MEMPR).

The local management of mineral aggregate resources as an environmental planning issue has created persistent conflict between community residents, pit/quarry operators and the local government of Prince George. Past inadequacies in planning and management of this resource activity have led to disruption of

Figure 4.0: Deglaciation Patterns of the Central Interior



(adapted from Tipper, 1971)

community neighbourhoods and environmental degradation. Such disruptions can lead to a net loss of potentially productive local land resources (Marshall, 1982). The need for this activity to locate near markets (and therefore residents) and the natural deposition of mineral aggregate in sometimes environmentally sensitive areas (river terraces, headwater moraines) provides an opportunity to test how an integrated approach incorporating harvesting and community values may facilitate the management of aggregate resources in Prince George.

The City of Prince George now has about fifty designated soil removal areas (City of Prince George [a], 1993). The local management approach presently relies primarily upon permit processing. There is no strategic resource management plan for aggregate resources in Prince George. In addition, the existing Soil Removal By-law, enacted in 1979, is out of date and not consistent with more recent provincial legislation (City of Prince George [c], 1993). The city is in the initial stages of addressing how soil removal can be better managed within municipal boundaries.

One of the greatest problems the city has is consistent conflict and opposition from residents generated towards new applications for sand and gravel extraction in the area. In addition, there has been very little provincial direction for the municipality to follow with respect to the management of this resource. At the present time, no formal resource management policy exists for long term mineral aggregate extraction in British Columbia for municipalities to follow. From a provincial perspective, sand and gravel operations are evaluated strictly upon their technical merit alone. Assessment criteria include the quantity and quality of the deposit, staging and phasing extraction and the processing of the extracted material. Consideration is not given to the social impacts generated by pit operations near or within, existing communities. Additional ecological criteria may be considered by the Ministry of Environment, Lands and Parks or Fisheries and Oceans Canada. The result is an adversarial relationship between the City and the Ministry of Energy Mines and Petroleum Resources; although managing the same resource, the two

agencies have very different management interests. Thus, there is an absence of systemic relationships, both natural and institutional, in the management of this resource.

The city is under increasing pressure from residents to reduce the impacts associated with extractive activity. The new Official Community Plan (OCP) has identified community displeasure regarding the nuisance of sand and gravel extraction in Prince George, particularly along the Otway Bench and North Nechako Road area. The OCP (1993) calls upon the city to attend to this problem. The application of a local environmental planning approach could aid in addressing this issue by providing a framework which encompasses the scientific and technological needs of the aggregate extraction industry and social needs of the Prince George community.

This case study proposes to analyze the problems associated with the existing management of aggregate resources in Prince George and determine the key social and technical aspects that need to be addressed in strategic management of mineral aggregates. The case study will highlight the shortcomings of the existing management framework, the impacts of extractive operations in the city, and elements of the community for which there is professional and public concern. I will use this information to develop an integrated management approach to aggregate resources based upon the resource management framework presented in Chapter Three.

4.3 Prince George: A Case Study Approach

The purpose of my research is to develop a strategic resource management framework for sand and gravel extraction in the City of Prince George. My method is twofold. First, case study methods were used to assemble primary and secondary data on the status of sand and gravel management in Prince George. Second, I develop a strategic resource management plan for the City based upon recent

theoretical approaches involving the integration of environmental impact assessment strategies and local planning processes. The goal of this exercise is to integrate the harvesting values of aggregate resources with those values of the community.

My approach is based upon Descriptive Case Study Theory as proposed by Yin (1993). Yin distinguishes six categories of case studies depending on whether they are single or multiple, and either exploratory, descriptive, or explanatory (Table 4.0).

Table 4.0: Yin's 2x3 Case Study Typologies

Single	Multiple
exploratory/questions	exploratory/questions
descriptive/phenomena	descriptive/phenomena
explanatory/data relationships	explanatory/data relationships

Yin defines these objectives as follows:

> *"An exploratory case study is aimed at defining the questions and hypotheses of a subsequent study...A descriptive case study presents a complete description of a phenomenon within its context. An explanatory case study presents data bearing on cause-effect relationships-explaining which causes produced which effects" (p. 5).*

A single descriptive case study approach is applied in this research where the City of Prince George is selected to describe the phenomenon of sand and gravel management at the local level. The Prince George case study includes the following objectives:

- To identify how and where sand and gravel resources have been, and presently are being managed in Prince George;
- To identify the strengths and weaknesses and/or problems associated with the present practice of sand and gravel extraction in Prince George with attention directed towards the permitting and approval process, the perceptions of impacts generated from extractive operations and opportunities for mitigation of impacts of areas disturbed by this activity; and

- To determine what elements of the community landscape are most important in terms of integrated management of gravel resources as well as the protection of the landscape elements from negative impacts associated with extraction in Prince George.

Yin has suggested case study research to be most applicable when the desire is to "(1) define topics broadly, not narrowly; (2) cover contextual conditions and not just the phenomenon of study; and (3) to rely on multiple, not singular sources of evidence" (p. 11). The first two elements have been defined in the theoretical parameters above. The next task is to select methods for collecting the information required to satisfy the objectives of the case study inquiry. Yin suggests such methods should include the use of surveys, experiments, the analysis of archival records, and histography. May (1993) supports such a multi-faceted approach in what he refers to as "triangulated inquiry" which allows for a comparison of data from interviews, observations, documents and surveys (p. 126). In my research, this method enables comparisons among interviews with stakeholders, observations of relevant meetings and committees in the city, City documentation, and the use of questionnaire data. The Prince George Case Study employs a multitude of methods in an effort to meet the three objectives above.

4.3.1 Document Review and Retrospective Analysis

The purposes of document review and retrospective analysis techniques in my study were twofold. First, I sought to establish the context in which aggregate extraction takes place in Prince George, with reference primarily to the institutional arrangements that facilitate the management of the resource at the municipal level. These arrangements include the legislation, plan and policy documents, and the local by-laws that affect the management of aggregate resources. Second, I conduct an analysis of City files to assess the past and present activity with respect to aggregate removal within the city limits.

May (1991) points out that a document "represents a reflection of reality" (p. 139). I reviewed the following documents to determine how aggregate extraction is being managed in Prince George and where it has been occurring over a seventeen year period (1979-1995):

- The Official Community Plan: regulating land use designations and providing a growth management plan for Prince George;
- The Supplement to the Official Community Plan: presenting data on the city's resources and identifying past trends, the current situation, relevant issues, community values and priorities, and projection for growth;
- Soil Removal By-law #3000: regulating aggregate extraction in Prince George since 1979;
- Soil Removal By-law #1996: a new by-law designed to improve upon the permitting and regulation of aggregate operations in the city (awaiting approval in 1996);
- Soil Removal Permit Files: files documenting the processing of permits for the removal of aggregate resources throughout the city since 1979; and
- Council minutes/planning reports/meeting minutes: detailing the processing of an application for soil removal designation and permit.

The Official Community Plan documents and Zoning By-law were reviewed to identify how the city plans for and manages aggregate resources. The Soil Removal By-laws were compared and contrasted to identify how the approach to the permitting and regulation of aggregate operations has changed since 1979. The Soil Removal Permit files were reviewed to determine where and how extractive activity has occurred in Prince George and to assess the magnitude of land disturbance incurred over this time period. The chronology of a recent application before council was reviewed to establish the current issues before the city with respect to extraction, the rationale behind decisions made by council and how the Development Services department is presently managing land use conflict related to this issue.

As an unobtrusive form of social research the document review and retrospective analysis utilizes both quantitative and qualitative procedures in assembling the results for interpretation (Babbie, 1989). Quantitative methods

included a compartmentalization of the contents of the soil removal files to provide information on the specific elements of the permitting process such as impact mitigation, size of operations and reclamation proposed. The remaining documents were analyzed in a qualitative sense. May (1993) indicates that reliance on quantitative methods alone provides insight only into "what has been produced" and not the decisions that "informed its production." In this light then, the document review complements the file review in detailing how aggregate extraction decisions are made in Prince George. Collectively, this information describes how and where extractive activity occurs in Prince George.

4.3.2 Participant Observation

Jorgensan (1989) encourages the use of participant observation particularly in descriptive case studies, while Yin (1993) elaborates on the method indicating that observation and participation in the realities of the subject matter enable the researcher to study the phenomenon in a "real world" context. Participation in the Prince George Case Study included my attendance at Council meetings and public hearings addressing issues related to aggregate extraction, as well as participation on the Soil Removal By-law Committee and the Aggregate Inventory Advisory Group.

By attending Council meetings, public hearings and Development Services meetings, I established the primary issues surrounding aggregate extraction in Prince George and discussed how Council and Development Services address those issues. By attending arbitration sessions of conflicting groups, I gained insight into how the various stakeholders broached the issues of aggregate extraction one-on-one. By participating on the Soil Removal By-law Committee and the Aggregate Inventory Advisory Group, I gained a great deal of information on stakeholder interactions, the perceived impacts of extractive activities, and the strengths and weaknesses of the existing management of the resource.

I recorded my observations by notes which were later confirmed by comparison with the prepared minutes of each meeting. The notes and minutes were reviewed to identify trends and establish relationships between the variety of groups participating in the process of aggregate management in Prince George.

4.3.3 Interviews

I conducted interviews with the various stakeholder groups in Prince George throughout the fall of 1995. My research goals for the interview method were to identify regulatory strengths and weaknesses of aggregate extraction in Prince George, identify the major impacts of this activity in the city, assess the importance of rehabilitation on impacted areas, and to define valued environmental components in Prince George. The following stakeholder groups were interviewed:

- The North Nechako Bench Residents Association;
- Federal, Provincial and local regulators/managers of aggregate resources; and
- Commercial operators in Prince George.

Thirteen interviews were conducted. For each group, a unique set of questions was prepared in order to obtain the appropriate details from the individuals interviewed. For example, questions directed to the residents association were focused on the nature of the organization, its mandate, and the type of relationship the group has with the city and operators in Prince George. Questions directed to the regulators focused on more technical issues such as management frameworks and agency relationships as they pertain to aggregate extraction. Operators were asked to provide information on how they obtained approval for their operations and their perspective on how such operations affect the surrounding community. In addition, all interview subjects were asked a common set of questions pertaining to aggregate management, community impacts, reclamation, and elements of the community for which they had concern. Appendix 'B' contains copies of the questions that were asked of each stakeholder group.

Fowler et al. (1990) indicates that case study interviews may require a less standardized approach to interviewing techniques when the research goal is to describe a set of individuals or organization. In other words the goal is not to describe a population, but rather a particular circumstances. He states that:

> *"A typical approach for such studies is to enlist respondents as collaborators in the research, explaining to them what is wanted and asking them to provide the needed information. The specific areas to be covered are specified, but follow-up questions are used freely to obtain further explanation on topics about which the interviewer wants more information" (p. 19).*

This was the approach undertaken in the Prince George Case Study. Interview subjects were asked to participate and did so on a voluntary basis. Interviews were conducted in the offices or homes (residents association) of the respondents and lasted between forty-five to ninety minutes. The context of the interview was explained prior to the interview appointment and repeated at the beginning of each interview. I explained the purpose of the interview, and sought to establish a relationship with the respondent. I explained how the information provided from the interview would be utilized (Fowler, 1990).

The interviews were recorded on audio tape as well as on note paper. They included follow-up questions to probe deeper into issues that were not contained in the questionnaire or to acquire further elaboration on a particular question or response. The interview results were not coded, but rather were analyzed by question and respondent to identify commonalties in response, areas of particular interest by respondent, and individual highlights from a respondent such as a Federal perspective versus a local perspective regarding management priorities for aggregate resources. Collectively, the interviews provided insight on how aggregate resources are and should be harvested in Prince George and identified the most important community issues surrounding aggregate extraction.

4.3.4 Questionnaires

A mail out survey questionnaire was distributed to the general public throughout the summer of 1995 and winter of 1996. The purpose of the questionnaire was to obtain viewpoints from residents of the community who are not directly associated with any of the stakeholder groups and thus were not represented in the interviews. The questionnaire sought information pertaining to the regulation of aggregate operations, the impacts perceived by the community, and reclamation opportunities in Prince George. The questionnaire also sought to gauge interest on the issue of aggregate extraction in the city. This would clarify the extent to which aggregate extraction is an issue beyond those directly impacted, or involved in, its management (Feitelson, 1991).

My approach for the questionnaire component of the research was based upon the Total Design Method (TDM) of Dillman (1983). This approach consist of two parts: (a) identifying and designing each aspect of the survey process that may affect response rate in a way that maximizes response rates; and (b) organizing the survey effort in a way that assures that the design intentions are carried out in complete detail" (p. 360). Given the constraints of time and money, I incorporated in my questionnaire as much of the TDM as was possible. Response rates upwards of 80% have been obtained with this method. The methods applied in the Prince George Case Study to implement the questionnaire can be described in four stages: Questionnaire Design, Deployment, Response and Analysis.

Questionnaire Design: The questionnaire was typed on regular sized white paper (8.5 x 11 in.) and then reduced to produce a 5.5 x 8.5 inch ,ten page booklet The cover page was entitled "Sand and Gravel Extraction in Your Community" and included a photograph of sand and gravel operation behind a wetland. Appendix 'C' contains a copy of the questionnaire mailed to residents. There are no questions on the first page of the booklet; however the last page is used to

invite additional comments and expresses appreciation to the respondent for participating in the research. The questions are ordered in four groupings throughout the questionnaire:

- Planning for Extraction: questions addressing where extraction should take place and the role of public agencies in managing aggregate resources;
- Sand and Gravel Operations: questions probing the observable impacts generated by operations in the city;
- Reclaiming Sand and Gravel Pits: questions dealing with the state of reclamation in Prince George and land use desirability; and
- Sand and Gravel In Your Neigbourhood: questions addressing whether the respondent has utilized the resource and to what degree sand and gravel operations have had a positive or negative social, economic and environmental impact on their community.

The final section of the booklet requests personal information from the respondent regarding sex, age, duration of residency in Prince George, education and income. Questions are structured so that the respondent can answer in the easiest way possible with entries made along a straight vertical line of moving back and forth across each page (Dillman, 1983; Gaskell et al., 1994).

Questionnaire Deployment: A random sample of three hundred households was selected from the Prince George telephone directory. The limitations of such directories are well documented and generally fall into the two following categories: (1) people without telephones will not be included in the sample, and (2) people with telephones may not be included in the directory upon request (unlisted numbers) (Dillman, 1983, Babbie, 1989). In general, the ability for mail-out questionnaires to obtain a representative sample of the population is difficult and significant when compared to face-to-face interviews. That is why I included both interviews and questionnaires in my case study research.

A one page cover letter was included, typewritten on University of Northern British Columbia letterhead. It describes the purpose of the research, who is conducting the research, how to complete and return the questionnaire and

emphasizes the voluntary nature and confidentially of the questionnaire. In addition, the backside of the cover letter included a letter of support for the research from the Director of Development Services with the City of Prince George encouraging potential respondents to participate in the questionnaire. Also included with the questionnaire package was a pre-stamped self-addressed envelope. Each return envelope was coded to identify which of the five pre-established zones of the city the response came from. The zones are number one to five and comprise the four quadrants of the city and the bowl area.

Dillman recommends three more additional contacts with those who have not responded after the first week of the mail-out. Supplementary mail-out post cards are delivered one week after the initial mail out followed by a second questionnaire package two weeks later and a third seven weeks after the initial mail out. Due to limited resources it was possible only to deliver a portion of a second mail out. After eight weeks, potential respondents were telephoned to inquire if they had received the first questionnaire and whether they would like another opportunity to respond. An additional one hundred and fifty questionnaires were delivered in the supplementary mail-out.

Questionnaire Response: Thirty two questionnaires were returned as a result of this effort. This accounts for a response rate of 10.6%. I believe three factors are responsible for this low rate of response. First, in the week following the initial mail-out, postage prices were raised. As a result, the return envelopes had insufficient postage to be returned. The raising of the rates was not made known to me at the time postage was purchased. Conversations with the post-office upon the realization of the rate increased indicated that early responses (one to two weeks) would 'likely' get through. The impact on overall response rates is difficult to determine but it is believed that it may have been significant due to the time of mailing. The initial mail out was in August of 1995, a popular

vacation month and therefore, it is possible that the time of potential response would have been delayed beyond the one to two week delivery window provided by the post office.

The second element affecting the response rate was the return of questionnaire packages in instances where individuals had moved. To avoid this in the second mail-out, the name of the selected household and "occupant" was included on the envelope. The third factor that may account for the response rate is a lack of interest and/or knowledge in the subject matter. Aggregate resource are generally not well understood by the general public unless their residence is directly impacted by extractive activity (McLellan, 1982; McNaughton, 1991).

Contingency tables were prepared and Chi-square tests conducted on demographic data to determine if there was a relationship between the sample return and general population characteristics. The tests indicate that the sample of respondents is not related to the population. These results are presented with the questionnaire analysis in Chapter Six.

Questionnaire Analysis: The questionnaires were statistically analyzed utilizing the Statistical Package for the Social Sciences (SPSS) as supported by Babbie (1989). A code book was constructed assigning numerical codes to each of the potential responses for each question. Each questionnaire was then coded according to the code book and entered into the SPSS data base for analysis. The results of the analysis are presented in Chapter Six.

4.3.5 Site Observations

I visited selected extractive operations in Prince George to obtain visual perspective of ongoing activities in the city. Selected sites included three private operators, two city owned operations, and pits managed by the Ministry of Transportation and Highways. The purpose of this exercise was to relate actual

activity with some of the identified impacts and shortfalls of the approval process in Prince George. The results of the Site Observations are included in Chapter Five.

Aggregate Resource Management in the City of Prince George

5.0 Introduction

This chapter determines the state of aggregate resource management in the City of Prince George. I identify how the City is utilizing planning instruments such as the Official Community Plan and By-law approval power will be examined. The state of the aggregate industry in Prince George is a reflection of these management and regulation initiatives. As such, the land use characteristics of the industry are also examined to determine the magnitude of activity in the city, the spatial distribution of operations, impact mitigation techniques, and areas of land use conflict. This analysis will highlight which aspects of local management lack an environmental planning perspective. These elements will then be incorporated into the proposed management directive at the conclusion of the thesis.

Methods employed in satisfying these objectives include retrospective analysis of City documents and files, observation techniques of relevant Council and departmental planning meetings, and site visits to aggregate operations in the city.

5.1 Official Community Plans

Hodge (1986) associates a community plan with many tasks or objectives. A community plan provides a guide in long-range decision making, and is a commitment on the part of the community to the physical growth of their local environment. It is "a long-range, comprehensive, general policy guide for future physical development"(p. 206). Perhaps most of all, a community plan can be perceived as an instrument of education, communication and coordination. As a planning tool, the community plan needs to address elements such as the future

goals and objectives of a locality as well as the immediate needs of the same area. It needs to plan ahead as well as control the present.

Traditionally, community plans have focused on assurance in communities with respect to public interests such as health and safety, efficiency, and equity as they relate to land development and the future prosperity of a municipality. Today however, community planning also incorporates a broader view of land use which includes environmental protection and enhancement. It is recognized that the impacts associated with the human use of land must be considered in the planning and control of the community landscape as a whole. Leung (1989) supports this approach in that land use planning must now take into consideration environmental protection issues ranging from air quality to habitat protection in our communities. Such initiatives are particularly important in areas where there is a mixture of urban and rural land uses and where resource harvesting is taking place. Thus, community plans must also plan for and control the use of natural resources at the local level.

5.1.2 The Prince George Official Community Plan and Supplement.

Section 944 of the *Municipal Act* permits local governments in British Columbia to develop and adopt community plans. Community plans are defined in the *Municipal Act* under Section 945 as a "general statement of the broad objectives and policies of the local government respecting the form and character of existing and proposed land use and servicing requirements"(501, 1993). With respect to sand and gravel extraction, the *Municipal Act* requires that local governments include statements and map designations detailing the approximate location and area of sand and gravel deposits that are suitable for future sand and gravel extraction (501, 1993).

The current Official Community Plan (OCP) for Prince George, adopted in April of 1993, repealed the previous OCP adopted in 1979. The update to the OCP was the

result of an ongoing plan review which began in 1983 in response to increased rates of growth (City of Prince George [b], 1993). Accompanying the OCP is an Official Community Plan Supplement containing the baseline information upon which the policies of the OCP are based.

Collectively, both the OCP and the OCP Supplement contain information pertaining to aggregate resources in Prince George. In both documents, aggregate extraction is referred to as soil removal. The OCP Supplement describes the soil removal permit system in Prince George and identifies community values and priorities with respect to industrial uses in the city. The OCP meanwhile serves three general purposes: 1) to establish the parameters of the implementing soil removal by-law; 2) to identify where soil removal is taking (or has taken) place, and 3) to state future undertakings in order to accomplish management objectives in aggregate resources harvesting.

The OCP supplement briefly describes the procedural requirements in establishing a soil removal operation. First, the land must possess a 'soil removal area' designation. This is applied for through the City and, if approved, is incorporated onto a separate schedule in the OCP. Secondly, once a designation has been obtained, the City is then obligated to issue a 'soil removal permit' provided the proposal conforms to the soil removal by-law. If processing of materials is a component of the proposal, an industrial zoning is also required and regulated through a separate zoning by-law. Thus, extraction and processing are entirely separate activities under the existing regulatory framework. The OCP Supplement states:

> *"The Zoning By-law is separate from the soil removal by-law. It has no bearing on where soil can be removed; only where it can be processed. And in reverse, the soil removal by-law has no bearing on processing; only where soil can be extracted" (City of Prince George [b]. 1993,p. 43).*

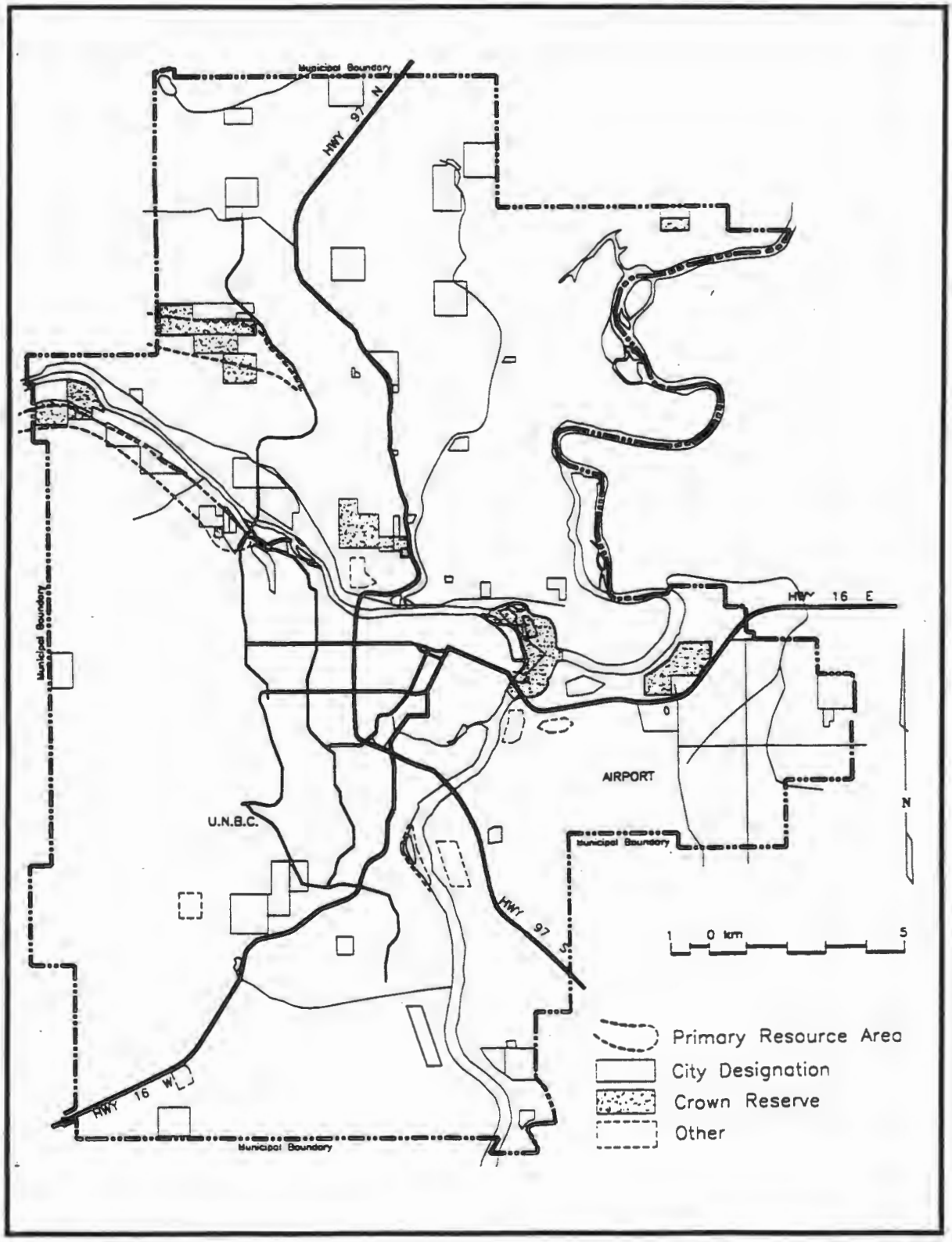
As part of the preparation of the new OCP, the City held open houses for residents to voice their opinions and concerns with respect to the new plan. The OCP Supplement identifies the issues raised at these meetings. One of the most vocal groups present were residents of the North Nechako Road area; they objected to the abundance of soil removal activity in their area, and raised concerns of excessive noise, smell and visual disturbances. These concerns were directly related to removal activity on the escarpment along the south side of the Nechako River and along Foothills Boulevard.

The OCP soil removal policies provide guidelines addressing the 'permitting' of removal operations. The permit is required to control operations and establish conditions of approval related to impact mitigation and rehabilitation. In addition, the City is to maintain accurate records of areas designated for soil removal that are available to the public. A final guideline of the City is to protect undeveloped areas with potential for soil removal from residential encroachment.

The designation of areas where soil removal is, or has occurred, is incorporated into the OCP as Schedule 'D'. Figure 5.0 depicts these designations. The Otway Bench area is identified in the OCP as the prime source of soil removal in the city. It is also the area for which residents to the north have raised the most concerns regarding disturbances experienced in their neighbourhood. The OCP designates the land use for this area as 'future' (F) in order that soil removal be completed here first and a land use determined at a later date (City of Prince e George (a),1993). The plan expresses a likelihood of residential development in this area upon completion of soil removal and reclamation.

Finally, the OCP indicates that the City will conduct an inventory of soil resources in the area in conjunction with other government agencies and the help of the private sector.

Figure 5.0: City of Prince George Soil Removal Designations



(adapted Prince George OCP, 1993)

5.1.3 Analysis

Presently, the OCP and Supplement are primarily descriptive documents establishing guidelines to control aggregate extraction in the City. The OCP describes 'what is' taking place and lacks long term policies that will guide 'what could be' with respect to aggregate resources management in the city. An inventory of aggregate resources in the area is one of the first steps in generating a long term management plan. The City indicates commitment to this undertaking in the near future.

The operational control of aggregate extraction is expressed entirely through the soil removal by-law. From a land use control perspective, the OCP has deficiencies. First, the activity of aggregate extraction (soil removal) was not considered to be a land use at the time of plan development. Rather, it was considered a use of the land, or a temporary activity permitted within specified land use designations. Soil removal areas are not identified on the OCP land use schedule, and thus there are 'residential' and 'future' land use designations on which extraction is taking place. Removal areas are contained on a separate schedule and within the industrial policies of the OCP. Users of the Plan may have difficulty in making the connection between the land use schedule and the soil removal schedule of the OCP.

Second, the majority of aggregate extraction takes place in the Future ('F') land use designation. This designation "identifies lands for which a specific use could not be identified at the adoption of the Plan and in the public interest, future land use options be retained" (p. 11). While such a designation is appropriate for general use, this designation may be misleading in the case of mineral extraction because of the potential intrusiveness of operations. It does not provide land use confidence in the community and can be misinterpreted by potential home buyers or investors. In summary, the existing OCP, lacks the necessary components as defined by Hodge (1986) and Leung (1989) in planning for aggregate resources. While the OCP stipulates the controlling mechanism for application processing (the soil removal by-law), it is deficient in many other important ways. It lacks a long-range decision

making component, it does not provide a commitment to the community as to how aggregate resource will be managed, and is more misleading than it is educational. For example, only existing sites are identified in the city. Potential development areas are not known, and a phased development strategy for aggregates is not available to users of this document.

5.2 Implementing By-laws

Implementing by-laws are designed to guide and coordinate the use of land under the policy objectives established in the community plan. These planning tools establish the necessary conditions to achieve the goals of a plan, and as stated by Hodge (1986): "act as the interface between the polices of the plan and the aims of those who make decisions that transform the physical environment" (p. 218).

The OCP policies establish the parameters of impact mitigation, reclamation and encroachment as the primary concerns for the soil removal by-law. However, other polices that must also be incorporated are those inherently related to the activity of aggregate extraction. Specifically, the City has environmental stewardship policies which aim to make Prince George "an environmentally healthy and sustainable community" (p. 75). These policies address issues such as natural areas conservation, ecosystem enhancement, air and water quality, and the minimization of resource use through efficient processing and recycling. All of these policies are relevant to the removal of aggregate resources from the community landscape and should be reflected in an implementing by-law.

5.2.1 Prince George Soil Removal By-law #3000 (1979)

The City of Prince George presently regulates aggregate extraction under Soil Removal By-law #3000. However, in the Spring of 1995 the City began work on the development of a new by-law (By-law #1996) to address changes in provincial

legislation and increasing community concerns over extractive activity. It is expected that this by-law will be in effect by the Summer or Fall of 1996.

Soil Removal By-law #3000 is examined by four general components common to municipal by-laws regulating the use of land: 1) procedural requirements; 2) information requirements; 3) conditions of approval; and, 4) remuneration.

Procedural Requirements: Soil Removal By-law #3000 was initially administered by the Engineering Department, but control was recently transferred to Development Services. Once a soil removal area designation has been approved, the proponent must apply for a permit. Soil removal designations are incorporated into By-law Schedule 'A' as well as OCP Schedule 'D'. Designation in the By-law requires Council approval and a public hearing, notice of which is issued in the local newspaper. If the proposal conforms to the operating conditions of the By-law, the City is then obligated to issue a permit. Permits are issued for one year and must be renewed on a yearly basis. Permits fees are based on volume as determined by an aerial survey conducted in the City, or by declaration of the operator.

Information Requirements: At the permit application stage, the applicant is required to submit the application and provide the following information:

- the purpose for which the soil is to be removed;
- a plan depicting the excavation areas on the property; and
- a plan depicting final contours and volume of removed materials.

The applicant is also asked to include information pertaining to slopes, erosion control, drainage control, access to the property, fencing, stages of excavation, stockpiles, machinery and building locations. In addition, haul routes, dust control and end land use information are to be submitted as necessary.

Conditions of Approval: The conditions of permit approval aim to alleviate the potential adverse affects of soil removal in the city. Some of the most relevant conditions include: positive gravity drainage must be assured; operations must not encroach on adjacent land uses; appropriate slopes must be established upon completion of operations; soils must be returned to exposed areas; and appropriate rooted ground cover must established.

Remuneration : Securities are collected by the City to ensure that the conditions of permit approval are upheld and that the general operation of the site conform to the approved plans. Securities in By-law #3000 are assessed by area; sites less of than two hectares pay a sum of $5,000. Sites greater than two hectares pay an additional $2,500 per hectare. Thirteen months upon completion of operations the permit holder may have the security deposit returned at the satisfaction of the City engineer that the terms and conditions of the permit have been met.

5.2.2 Analysis

OCP policies addressed within Soil Removal By-law #3000 include impact mitigation methods, reclamation and encroachment. However, the by-law has shortcomings. First, it is reactionary in nature. Applicants are asked to incorporate into their application the efforts they intend to take to minimize impacts such as dust, noise, erosion and drainage. There are no minimum standards for the applicant or the regulators to follow. Until complaints are registered by residents in the area, the City does not have any assurances that impact mitigation is taking place. The City essentially assumes a reactive position to impacts as they occur or are reported.

Second, the bulk of the information requirements are submitted at the permit stage of the approval process rather than the designation stage. The result is inadequate information transfer at the public hearing and designation stages of the

process. This arouses suspicion of the applicant among residents, and impedes the planning process when Council finds it necessary to direct the applicant and city officials to 'bring them more information'.

Third, the administering of the By-law by the Engineering department for many years has led to a focus on the technical merit of applications rather than the social and environmental effects that aggregate operations may have in the city. Similar to MEMPR, Engineering is concerned primarily with the technical merits of applications, and secondly with associated land use issues. Development Services now administers the By-law and consults with Engineering. This is more appropriate as Development Services also administers the OCP and can readily relate By-law applications to the context of the OCP.

Fourth, the use of aerial surveys to monitor extraction ceased in the eighties due to cost. Operations are now regulated by the operators themselves. The City has found it difficult to provide the necessary by-law enforcement officers to monitor operations over the years and has essentially had to rely either on the 'word of the mouth' of operators or complaints from residents. In addition, it is difficult for some officers to interpret or understand the technical details surrounding a soil removal operation and to determine whether or not a site is in compliance with the By-law.

Finally, one of the greatest shortcomings of By-law #3000 is its approach to reclamation. By-law #3000 does not require progressive rehabilitation of the mine site, it simply requires that slopes are contoured to the approved plan and that a rooted growth is established. This aspect of the By-law conflicts with the environmental stewardship policies of the OCP. Progressive rehabilitation is recognized as one of the primary means to minimize operational impacts (dust, erosion and disturbance) and one of the most cost effective means to achieve reclamation of the site (McLellan, 1983).

Compounding this factor is the fact that no processing is permitted on site without appropriate zoning. As well, there is an absence of requirements pertaining to the preservation of topsoil removed during operations. Thus more material must be transported further and there are greater losses of organic material needed to establish growth on disturbed areas. Impacts include increased truck traffic, pollution, safety hazards, dust and noise, and greater cost to import organics on site to establish growth. This is an inefficient use of resources both financially and environmentally.

It is evident that By-law #3000 has an intent to coordinate aggregate extraction within the parameters established in the OCP. However, given the weaknesses contained in the by-law itself and the difficulty in implementing and interpreting it, the by-law fails to provide an effective process through which these policies may be realized. It is reactionary in nature, environmentally dated and fails to provide an adequate interface between decision makers and the policies of the OCP.

Collectively, the OCP and Soil Removal By-law #3000 are the two planning tools utilized by the City to manage aggregate resources since 1979. A review of soil removal permit files provides a description of aggregate extraction activity in Prince George over the years and insights into the effectiveness of the existing management approach adopted by the City.

5.3 Soil Removal File Review

The soil removal file review reveals both qualitative and quantitative information regarding the history of aggregate extraction in Prince George. File contents indicate of how the City has managed aggregate resources over the years, including interactions with stakeholders. The contents of each file also provide valuable technical information about each operation in the city including its size, status and other relevant details relevant to approval or denial of an application.

I reviewed Sixty-one soil removal by-law files dating from 1979 to the present. Information obtained from each file was summarized (see Appendix 'D' for a sample). Target information from the City files included: 1) land disturbance and the state of extractive activity in the city, 2) applied impact mitigation efforts, and 3) surrounding land uses.

5.3.1 The state of aggregate extraction in Prince George

I used an application status sheet prepared by Development Services and the Soil Removal Designation Schedule (Schedule 'A') to approximate the magnitude of land disturbance and the state of extractive activity in Prince George.

The land area disturbed by sand and gravel mining in Prince George is estimated at five hundred and seventy hectares. Active mining accounts for approximately three hundred and twelve (54%) of this total. Unreclaimed areas is estimated at one hundred and fifty hectares (26%) to which can be added abandoned and temporary mine site disturbances of fifty eight hectares. Approximately two hundred and eight hectares (36%) of unreclaimed lands remain in the city. The land area reclaimed from mining in the city is approximately fifty one hectares, or nine percent of the total area disturbed. A summary of data obtained from the files is presented in Appendix 'E'

Based upon the tonnage approved, the greatest area mining disturbance is the North Nechako Foothills Blvd. and Otway Road area. This area accounts for approximately seventy four percent of approved tonnage in Prince George. Prince George East, College Heights and areas along the Hart Highway possess the balance of fourteen, seven and three percent of extractable tonnage, respectively, in Prince George.

In summary, the present state of aggregate mining in Prince George reveals that while disturbance of the landscape continues, reclamation efforts have failed. There is a need to ensure that concurrent to the mining of aggregate, land areas disturbed

or alienated by this activity are returned to a productive state. In this manner, local land resources may be used to the benefit of the entire community.

5.3.2 Applied Mitigation Efforts

The majority of files reviewed did not indicate that mitigation efforts were being consistently applied at operations throughout the city. Most operators aim to prepare slopes of 2:1, or a fifty foot decrease in vertical slope for every one hundred foot horizontal distance from the edge of the pit. A slope of 2:1 or less meets acceptable safety standards (MEMPR and MoTH, 1994). One file reported to be reclaiming to a slope of 1.5:1. Site specific circumstances may have necessitated this and made it an acceptable slope to City standards.

Erosion control following mine closure was predominantly reported to be achieved through seeding, terracing, landscaping or through the re-rerouting of drainage on site. Many applicants indicated a combination of these efforts depending upon the topography of the completed mine site.

Drainage control during operations was reported to be attained through positive gravity with the use of sloping and ditch digging, pooling ponds for sediment or through the natural percolation of the mine floor.

Finally, dust control is achieved on site primarily through the use of water, calcium chloride and oil, and in some instances by paving portions of the site access and haul route.

Typically operations were open for eleven hours per day anywhere between six a.m. and nine p.m.. Very few of the files contained any details as to how operators proposed to mitigate the effects of their particular operations.

5.3.3 Surrounding Land Uses

Pits are primarily located in areas surrounded by Natural, Future, Residential and Park designations. This is particularly the case in the Nechako, Foothills and Otway Roads area. Other sites are in areas of Industrial and Public land uses. In two instances, a School or Institutional designation is immediately adjacent to a soil removal or processing facility. Examples include the Heritage Pit, located east of Foothills Blvd. and south of the Nechako River (owned by the City of Prince George); and the Ocean Cement processing facility along the north side of the Nechako Road at Highway #97.

5.3.4 Analysis

The status of City permit files is a good indicator of the difficulties associated with implementing Soil Removal By-law #3000. From an administrative standpoint, consistent application of the by-law should result in a standard set of files composed of similar documentation. This however is not the case. Information in the files was extremely variable. Some files, primarily those relating to larger pits in the city, contained significant amounts of information. Plans, reports, correspondence and the approved permit were standard as well consultant reports submitted on behalf of the applicant. Extreme inconsistency characterizes many of the smaller applications, possibly because of jurisdictional confusion between the City and the Ministry of Energy, Mines and Petroleum Resources (MEMPR).

Prior to 1979, sand and gravel pits were approved on an application-by-application basis when individual proponents approached the City with a request to establish a soil removal operation. In 1979, By-law #3000 was adopted by the City of Prince George in an attempt to standardize the approval process to establish soil removal operations within the city. At this time, joint approval was not required of soil removal by-laws by the MMA and MEMPR. In the mid-eighties, joint approval became a requirement and the legality of By-law #3000 was questioned by MEMPR and the City. The issue has not been resolved despite the decisions of legal

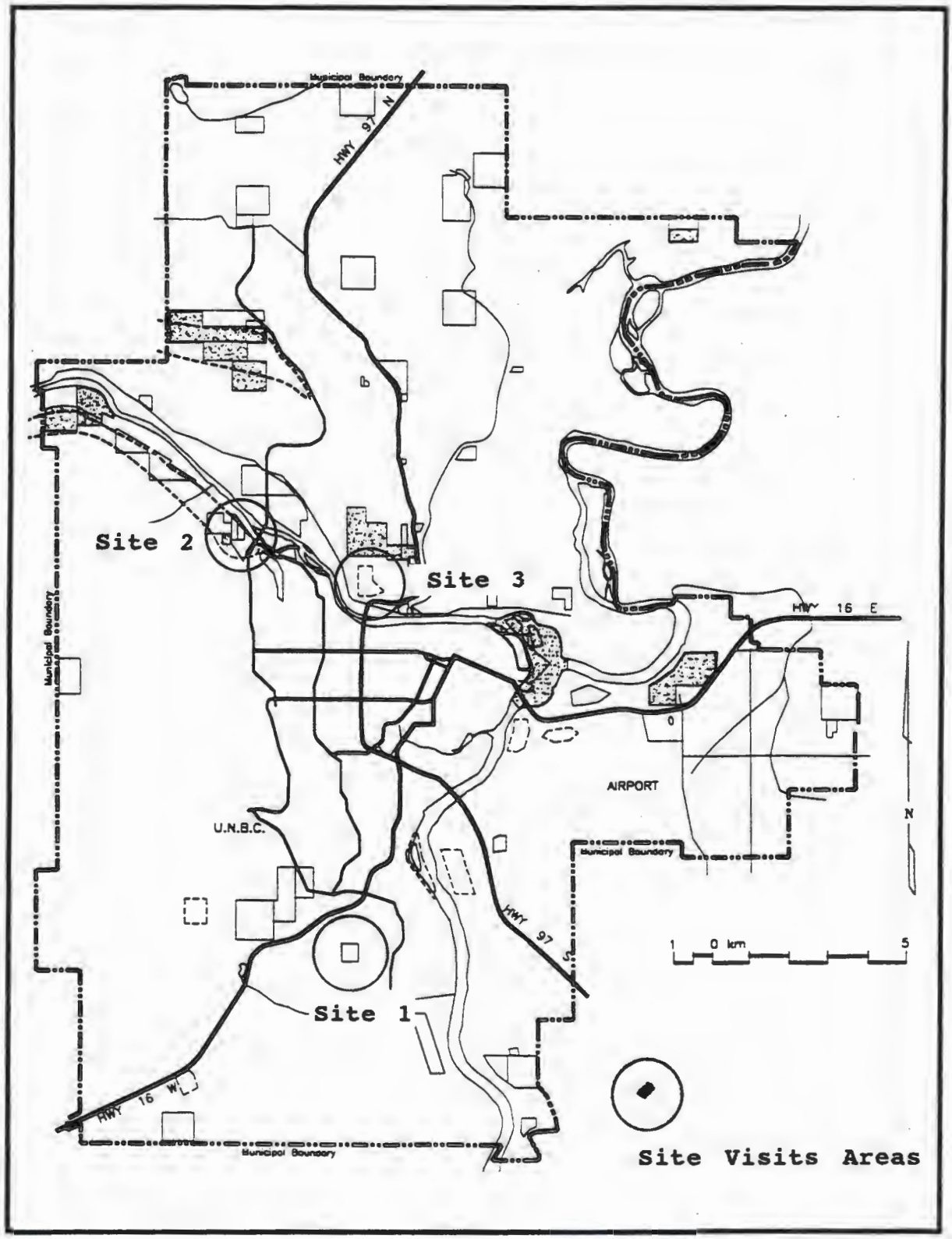
challenges on the issue in other areas of the province. This is one of the primary reasons the City has undertaken the task of preparing a new soil removal by-law.

Finally, the files revealed the persistence of many problems associated with soil removal operations in the city. Reclamation has not kept up with the pace of land disturbance; this is compounded by the fact that some sites have been abandoned entirely. In addition, impact mitigation has not been regularly practiced by operators. Areas of land use conflict persist in the city where operations occur near schools and residential areas.

5.4 Site Visits/Photographic Review

I visited sites to observe how approaches to aggregate resource management affect the local landscape (Figure 5.1). The following series of photographs illustrate some problems and some solutions such as encroachment, environmental degradation, dust, landscape disturbance and safety.

Figure 5.1: Location of Reported Site Visits



(adapted Prince George OCP, 1993)

5.4.1 Site No. 1: Encroachment and Mitigation

Kode Construction owns one of the largest privately owned pits in the city. Kode has approval to extract 1,300,000 cubic meters and to conduct limited on-site processing. This pit is one of the deepest in the City and the depth of the pit and surrounding topography of the area will provide a challenge for reclamation (Figure 5.2).

Figure 5.2: The site of Kode Construction. The scale of land disturbance is significant while the site is neighboured on three sides by residential development.

The new development is encroaching upon the Kode pit from the east. This pit has provided gravel for much of the construction of College Heights and UNBC. Originally, the site of the pit was relatively remote from other active land uses, but College Heights residential development has encroached upon the pit (Figure 5.3).

Figure 5.3: A view from the pit top of bank, east towards the Fraser River and down upon College Heights. The new residential development in the mid-ground of the photograph represents potential conflict between these two land uses. The open face of the pit is directly exposed to the residential development and river valley to the east.

The use of a simple berm can be effective in limiting sound as well as viewscapes into a mine (Figure 5.4). However, the upland character of some sites may preclude the use of berms. Residents in the high ground have no relief from the operations (Figure 5.5).

Figure 5.4: A view directly along the property line of the Kode pit and adjacent land uses looking north. The photograph was taken from the top of a berm designed by the operator to limit viewscapes into the operation.

Figure 5.5: Residents in the midground are directly adjacent to the limits of extraction. The topography of the landscape makes it difficult to reduce viewscapes into the operations. The use of screening with trees or shrubs could mitigate this problem.

5.4.2 Site No. 2: Environmental Degradation, Dust , Aspect and Cumulative Effects

Rolling Mix Concrete (RMC) is the owner of another large private operation in Prince George. RMC operates a thirty eight hectare site located at the junction of Foothills Boulevard and Otway Road along the Nechako River, for which 1,200,000 cubic meters of gravel has been approved for extraction and processing (Figure 5.6).

Figure 5.6: The disturbance of the north face of Cranbrook Hill is evident. This cut is highly visible from the north side of the Nechako River and upon approach to the Bowl Area along Foothills Blvd. heading south. Here, a highly visible and appreciated natural feature of the city is experiencing extreme disturbance.

Visually degraded landscape, aspect and dust are three of the most common concerns of residents along the north side of the Nechako River (Figure 5.7). This area of the city possess the greatest amount of extractive activity. Cumulative impacts are apparent in the area where many operations are located in close proximity to one another along Otway Road and at the junction of Foothills Blvd. and the Nechako River (Figure 5.8).

Figure 5.7: The processing plant of RMC where material is sorted and/or crushed on site. To the right is a large stockpile of processed sand for use in the production of materials such as concrete. Of particular note is the height of the cut into Cranbrook Hill and the haze of dust beyond the conveyor in the mid-ground.

Figure 5.8: A site immediately adjacent to RMC west along Otway Road. Space crowding of operations along Otway road at the base of Cranbrook Hill has generated extensive land disturbance along the Nechako River.

5.4.3 Site No. 3: Land Use Conflict and Pedestrian Safety

The location of some operations in the city present serious land use conflicts. Active pedestrian uses neighboring a dangerous industrial activity is one example. It is possible to remedy such conflict with the use of adequate fencing or greater buffers between uses (Figures 5.9, 5.10 & 5.11).

Figure 5.9: A view into the Ocean Construction extraction and processing facility located at the intersection of Highway #97 and North Nechako Road. The sign reads "Private Property - No unauthorized persons allowed - DANGER - Sheer cliffs and water quarries." The fence upon which the sign is posted is the property boundary between Ocean Construction and a school.

Figure 5.10: The playground at the back of the school in the foreground, the fence divider in the mid-ground, and the pit in the background.

Figure 5.11: A hole in the fencing perimeter adjacent to the school. While fencing is in place, it is far from sufficient in separating the two activities. Relief is not provided from the danger of the neighboring land use.

The photographs depict a sample of the conflicts aggregate extraction operations have with neighboring land uses in Prince George. They also illustrate the magnitude of disturbance that takes place on the landscape in areas of intense activity. Better management control in the OCP and new soil removal by-law supporting progressive reclamation, minimum distance separation, increased safety and environmental protection guidelines could alleviate some of these problems in the future.

5.5 Summary

The OCP and Soil Removal By-law are not being used adequately in managing aggregate resources in the city and the results are readily visible throughout Prince George.

Sand and Gravel removal is currently managed through a permit system on an 'application-by-application' basis, and is dependent upon the initiative of private landowner speculation on resource potential and project development. The OCP serves to identify areas for which a permit has been issued. The OCP lacks strategic planning and direction as to long term resource development in the city, environmental protection and impact mitigation of continuing and future operations. Records of the administration of the SRBL ranged in content and detail and lack adherence to standards.

Mining in the city has consumed five hundred and seventy hectares of land with very little reclamation taking place in exhausted pits as well as continuing operations. The focus of removal activity is located at the Foothills Boulevard and Nechako and Otway Road areas. Problems have manifested themselves throughout the city because of the existing management approach, namely: encroachment, land disturbance, unsightliness, dust and safety issues. These issues have contributed to conflict among stakeholders in aggregate resources management in Prince George and produced a negative image of the industry.

Stakeholder Perceptions of Aggregate Resources management in Prince George

6.0 Introduction

Chapter six assesses stakeholder perceptions of aggregate resources management in Prince George, and identifies the strengths and weaknesses of this management approach. Stakeholder groups surveyed include regulators (federal, provincial and local), community groups, operators and the general public. Information was obtained from the participants through a variety of methods consisting of: open ended interviews, a mail out questionnaire, observation of Council meetings and Development Services meetings, and participation on the Soil Removal By-law Committee. I focus on the planned management of aggregate resources, permitting procedures, operational impacts, perspectives on reclamation, and the identification of valued environmental components in Prince George.

6.1 Interviews

I interviewed a variety of people from federal, provincial and local agencies with an interest in aggregate management. A geologist and land surveyor were interviewed because of both their experience in the field and their involvement with permit applications in the city. Pit operators and members of the North Nechako Bench Residents Association were also interviewed. Operators provided an industry perspective of aggregate resources, and the residents identified the concerns of affected residents. All interviews were structured around four general topic areas: the planned management and permitting process, operational impacts of aggregate extraction, reclamation and the identification of community elements for which there is professional and/or public concern. I also examined the state of the relationship among stakeholder groups, because the nature of these relationships,

either cordial or hostile, has ramifications for resource management at the local level.

6.1.1 Planned Management and Permitting Procedures

The following personnel participated in the open ended interviews:

- The Department of Fisheries and Oceans (DFO);
- The Ministry of Energy Mines and Petroleum Resources (MEMPR);
- The Ministry of Environment, Lands and Parks (MELP);
- The Ministry of Transportation and Highways (MOTH);
- City of Prince George Development Services (planners and engineers);
- A B.C. Land Surveyor and Member of the Rivers Committee;
- A professional geologist and consultant;
- A spokesperson of the North Nechako Residents Bench Association; and
- Two representatives of the aggregate industry in Prince George.

Regulators included ministry officials, the City of Prince George and a professional geological consultant (with expertise in resource management and use in Prince George). The regulators all expressed the importance of aggregate resources as it relates to any type of community growth and infrastructure maintenance in the area. All participants agreed that resources closest to the demand centre should be exploited first with attention paid to minimizing impacts on riparian habitats. It was also emphasized by the personnel representing the City, that the OCP should speed aggregate resource development ahead of other land uses in priority areas in order to reduce encroachment upon pit sites and reduce future land use conflict.

Table 6.0: Aggregate Management by Provincial and Local Agencies. The table summarizes the management functions assumed by the agencies that are directly involved in aggregate management in Prince George.

Agencies	Functions
Department of Fisheries and Oceans.	Addresses concerns with respect to sediment loading in rivers, streams and tributaries. Would prefer to see more upland pits than those situated along the river's edge.
Ministry of Transportation and Highways.	Focuses on long term planning horizons of 25 to 50 years. Establishes demand requirements based upon growth and then targets areas where resources deposits need to be acquired or saved. Assisted by Gravel Managers Handbook which sets policy goals and objectives.
Ministry of Energy Mines and Petroleum Resources	Mandate is to maximize the benefit from the resources while minimizing conflict. The emphasis is on "how" extraction takes place, not on long term management of the resource.
City of Prince George	Goal is to ensure availability and supply for future use. The City has indicated that presently this is not clearly expressed in plans and policy and that there is a need to better utilize the OCP and municipal by-laws to meet this objective.

When asked about the effectiveness of the existing management structure of the aggregate resource on a province wide scale, the majority of respondents indicated that it works well until you get involved with local jurisdiction. They said that at this level there is some confusion concerning the responsibilities of the involved agencies and which agency is the lead manager. This confusion is particularly evident between MEMPR and the City of Prince George where work permits have been issued by the Province within City limits without consultation with the City itself. The way the Mines Act and Municipal Act work together enabling

municipalities to control extraction, and the strength of municipal community plans and soil removal by-laws to plan for and regulate aggregate resources is unclear. The City said that "the Municipal Act needs to clarify 'extraction' as a land use activity (as) the Mines Act is entirely unsympathetic to public input and land use concerns such as access, noise and hours of operation." The confusion and lack of communication has resulted in negative feelings between some of the administrating agencies as well as increasing community opposition to operations proposed throughout the city. A solution suggested by the City is to implement a "joint-permit" approved concurrently by Mines and the City once the appropriate plans and by-laws are in place that would permit such a process.

Many of the participants are in support of a comprehensive provincial policy for aggregate management that could simplify the framework of approvals and clarify who the key agencies to be contacted are. In addition, the City feels that guidelines could be produced that provide direction to municipalities concerning policies and by-laws that manage aggregate resources at the local level. Contrarily, Mines indicated that they are content with existing policies and generally not in favor of more municipal control through by-law implementation.

Respondents felt that the local jurisdiction is the appropriate authority to take the lead in aggregate management. With the incorporation of management policies within the OCP and an approved SRBL, participants indicated that municipalities can take a more active approach to aggregate management than the province can at a local scale. One concern revealed by operators about local management was that decision makers can change frequently and can be swayed too easily by public opinion, resulting in the loss of potentially valuable deposits because of inadequate knowledge of the technical merits proposals.

Although no aggregate resource inventory has been completed in Prince George, respondents feel that there is an adequate quantity and quality of aggregate available to meet the future growth and maintenance needs of the city. However, it was also

stressed that an inventory is required to identify potential development reserves to direct extraction concurrently with development.

Community members interviewed included a member of the Rivers Committee (a professional land surveyor) and a spokesperson of the North Nechako Bench Residents Association. Community members express a great deal of frustration with the planning and permitting of operations in the city. These feeling are associated with a lack of communication between residents groups and the city, and the feeling that despite the public expression of concerns about extraction, the City has it's "own agenda" to develop most of the deposits in the area. Community members felt that council can be swayed too easily by its own departments and by aggregate producers. In addition, community participants indicate that there is a need to meet earlier on in the approval process that includes "public forums on applications and published decisions inviting comments to provide more certainty among stakeholders." Community respondents indicated that the relationship between community groups and/or individual residents is nonexistent in most cases and sometimes "hostile", stating that "in general producers do not interact with residents."

Comments from the community interviews focused primarily on local jurisdiction over the resource. Indeed, it was indicated that the North Nechako Bench Residents Association has never contacted provincial agencies over the course of it's seventeen year dispute over extraction in Prince George. The greatest shortfalls community members identified are as follows:

- The lack of an overall plan that addresses the phasing of resource development;
- The disjointedness of existing operations devoid of reclamation schemes and linkages to surrounding land uses;
- The separation of land use and soil removal maps in the OCP. This is felt to be misleading and confusing to those whom the OCP is designed for;
- The absence of time-lines being made available to the public with respect to the duration of operations in specific areas of the city; and

- In general, community respondents feel a lack of confidence and assurance in the existing OCP and SRBL in managing aggregate resources in Prince George at this time.

Community participants support development of resources close to the demand centre first, but under the appropriate controls and a long term management plan. They said recent efforts by the City are an improvement from the past and that increased contact and communication with concerned residents has taken place in the past few years. Participants were generally not in favor of protecting identified deposits for removal. One group felt that if "reserves exist elsewhere (they should be developed there first), there is a mistrust with people on how it has been regulated in the past, no one knows when it will end."

The operators that were interviewed indicated that the approval process is currently a lengthy one and that the existing SRBL in Prince George is extremely poor and not enforceable. In general, operators feel that regulations do not meet the reality of operations and usually increase costs to the operator. In addition, at the community level there can be a "heart versus head" approach with respect to council decisions impeding the viability of the industry within the community.

When asked about community contact in the approval of their operations, the producers indicated that no contact was made, but that they are more than willing to discuss with people the nature of their business and how they intend to run their operation. The operators did indicate that community contact can assist in clearing up misconceptions associated with extraction, but that operators generally take a "no news is good news" approach to public relations and only interact with residents when requested or provoked to do so. One of the producers' main concerns with the regulation of aggregate extraction is that without a standardized management framework, the "playing field" for different sized operations is uneven. Thus, "it seems to be the larger producers who are hammered, enabling smaller ones to operate at lower cost. The requirements should be the same for all operations placing us all under the same rules."

Regarding jurisdiction, one operator indicated that once an inventory is completed that working with the local jurisdiction is not a problem as long as the province establishes standard criteria for the municipality to manage the resource. In addition it is important that producers have a recourse to the province if municipalities become too restrictive. Another producer supports distant provincial involvement stating that: "it doesn't really matter how much the local government gets involved..the city has no process."

When asked whether they would support an increase in government control over the development rights to aggregate resources, all of the interview participants indicated that they were against it. The main reasons cited were that too much intervention will slow down the approval process and that to remove a property right from a land owner is: "unfair and compromises values of the individual."

6.1.2 Impacts of Aggregate Extraction

All participants in the interviews were asked what the most pronounced impacts associated with sand and gravel extraction are in Prince George, and how these are manifested on the landscape and in the community (Table 6.1).

Table 6.1: Impacts Associated with Aggregate Extraction in Prince George

Interview Group	Impact	Manifestation
Regulators	• noise • visual disturbance • dust/particulate • tree removal • safety • decreased property values • sediment loading • scarred landscape • cheap building material	• poor stewardship • health issues • food chain affects • affordability/lower taxes
Community	• visual disturbance • wasted land/abandonment • dust • noise •cheap building material • loss of natural features • loss of wildlife	• affects civic pride • lower quality of life
Operators	• noise • increased runoff	

In addition to the immediate impacts of extraction regulators and operators were informed of the 'shadow effect' of those impacts associated with mining activity that occur off site. Participants were asked if they could associate any shadow effect of aggregate operations in Prince George. The regulators identified six impacts that are part of the shadow effect from aggregate operations: noise, dust, property values, safety, road damage, and stream water quality. On the other hand, operators stated that there were no shadow effects cast by their particular operation.

6.2.3 Reclamation

The most significant issue among those interviewed in the Regulators and Community groups is that of reclamation. There has been very little reclamation of exhausted sand and gravel pits and that progressive reclamation of current operations is not a standard practice in Prince George. The lack of reclamation is one of the most important factors to residents and the City. Community members said that without reclamation, impacts such as noise and unsightliness become persistent impacts in an area of potential opportunity and benefit to the community. Both groups identify the solution to the problem in two parts. The first is: "to identify end land uses possibilities at the beginning of the process" with the assistance of the OCP, while the second method requires staging/phasing of operation to reduce the magnitude of continuing effects. The Community participants feel that residents have a role to play in "saying how they want the land left" and that this could be achieved through cooperation among affected parties. The regulators also acknowledge the community role in ensuring the land is not wasted throughout the city, however, this role should be limited to participation in land use designation and not the granting of permits.

Operators were asked to describe their reclamation efforts. One operator is working towards a recreation plan prepared at the time of application in 1979, while the other operator is not working with any reclamation plan in place, preferring to "design as you go." Reclamation efforts by both producers involve leveling and contouring of the site to obtain acceptable elevations and slope. In general, both producers are in favor of reclamation, one indicating that it can go a long way to removing the "black eye" from the industry.

6.2.4 Valued Environmental Components

The final interview question determined elements of the environment for which there is professional and/or public concern. The question was asked of all participants and stated as "The environment of Prince George is comprised of

numerous social, cultural, economic and natural elements. For each, or any one element, what are the most important issues or concerns at this time in the Prince George area?" In addition, a follow-up question inquired about characteristics of the Prince George area that the respondent valued, or what was it that they particularly preferred about the area. The purpose for this was that original responses to the question were all negative and it was felt necessary also to explore elements of the environment of Prince George that people appreciated (Table 6.2).

Table 6.2: Identified Valued Environmental Components (VECs)

Respondent	V.E.C.: Concern	V.E.C.: Appreciation
Regulators	• air quality is poor • downtown revitalization • a better theater (size) • regional hospital facility • limited shopping opportunities • poor river access • more bike trail/lanes needed • environmental protection • river valley protection • a lack of civic pride • physical appearance of city	• recreational opportunities • employment available • business opportunities • university available • city is self contained • transportation network good • minimal traffic congestion • wilderness access available • small town warmth • friendly people • affordable • good place to raise children • the 'cut banks' of the Nechako
Community	• downtown revitalization • aesthetic improvement of city • poor urban planning • more parks required	•plenty to offer youth • open space linkage • economic initiatives
Operators	• loss of steady jobs • inefficient government • narrow vision for the area • fiscal responsibility needed • poor theater (size) • city requires more exposure	• affordable • it is a vibrant city • recreational opportunities • winter activities • culturally expanding • infrastructure upgrades

The identification of the VECs serves to highlight some of the areas aggregate resource management needs to address in the of long term planning and approval

of operations. In particular, elements such as air quality, access, linkages, river valley protection, and the physical appearance of the city are issues that better aggregate management could improve in Prince George.

6.2.5 Summary

Aggregate resources are recognized as a necessary commodity. However, the municipal management of the resources does not coordinate management of the resource with other agencies, in particular MEMPR. There is an identified conflict between the Municipal Act and the Mines Act. Once a municipality has the appropriate planning controls in place (policy and by-law control) neither jurisdiction is clear as to whom then assumes the management lead. That is, when MEMPR issues an approval, does the land owner have the right to establish operations, despite the OCP and soil removal by-law of the municipality? There is need for the province to provide direction to municipalities. From a residents' perspective, the uncoordinated management of aggregate resources has built frustration in the community. Residents desire a long term management plan for the resource. Operators see the municipal process as ancillary to that of the province because standard enforcement of the soil removal by-law has not taken place. The operators' main concern is that of equity in the application of any process imposed upon them. A process that is the same for all operators despite the size and duration of operations is desirable.

The lack of reclamation in the city is one of the primary deficiencies in the management of local land resources from which aggregates have been extracted. A revised approach to reclamation is needed that originates at the beginning of the approval process, involves residents and is progressively completed throughout the life of an operation. Current reclamation efforts are minimal at best and lack a clear direction for the development of a productive community landscape. The identified valued environmental components serve to direct new management efforts.

6.2 The Survey Questionnaire

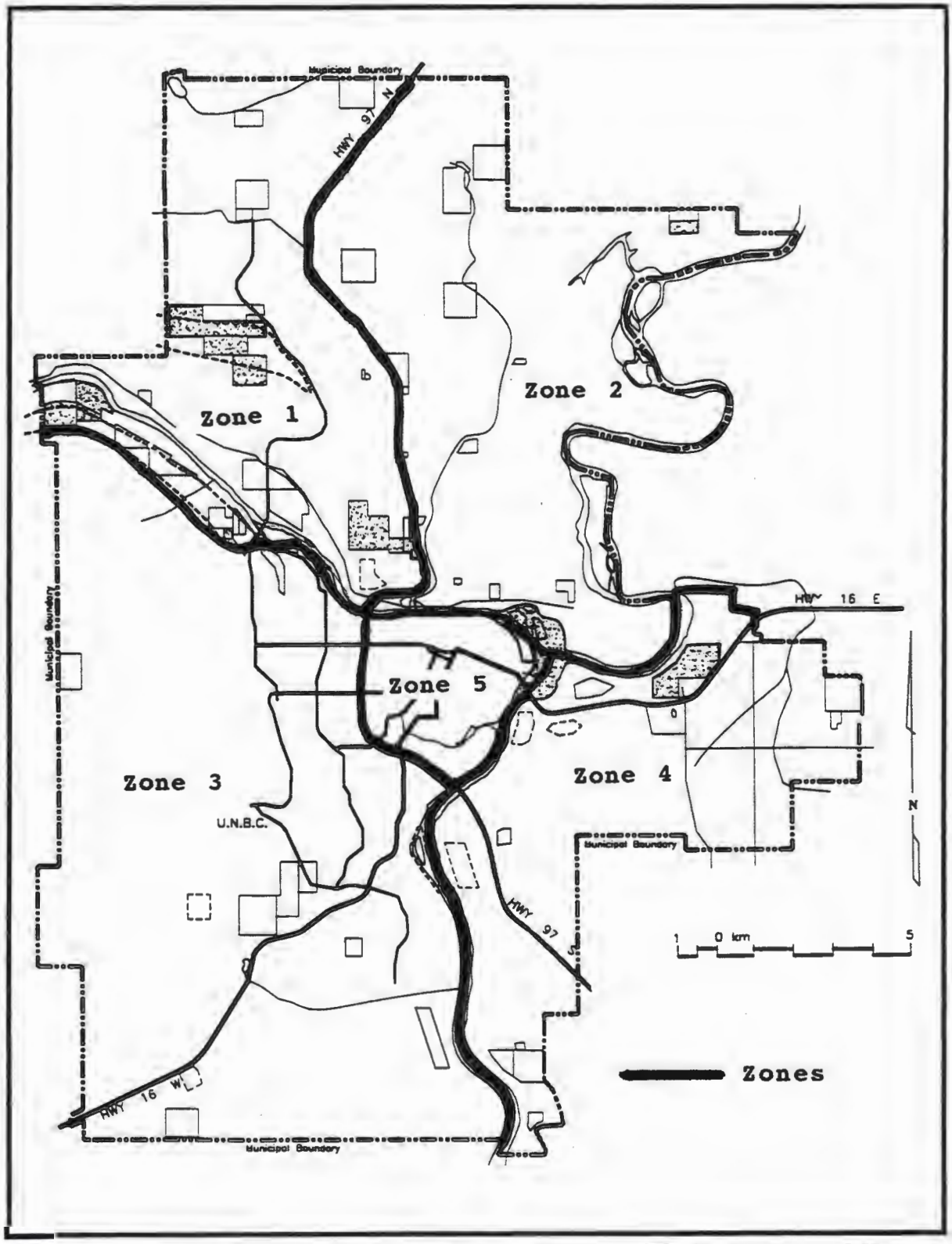
A survey questionnaire was distributed to obtain input from the general public about the management of aggregate resources. Similar to the interviews, the questionnaire was structured to obtain information on planning and permitting, operational impacts reclamation and the use of sand and gravel in Prince George.

6.2.1 Demographic Data and Sampling

Chi-square tests was performed on the demographic data of sex and education returned with the questionnaire to determine the degree to which respondents observed were related to the sample population (Appendix 'F'). The test results indicate that the sample respondents are not related to population surveyed (sex; 4.5, $p = .05$, $df = 1$; education; 23.95, $p = .05$, $df = 3$). The relationship is significant at the .95 level where there is a 5 percent chance that this observed relationship is attributable to sampling error only (Clark and Hosking, 1986; Babbie, 1989; and Zohlman, 1993). The returned sample was overly represented by males and respondents with college or technical school education. This discrepancy may be related to the low response rate of 10.6 percent and the sample size of three hundred. Factors affecting the response rate were discussed in Chapter Four. As such, responses do not necessarily represent those views of the population surveyed. However, the findings of the questionnaire provide an adequate supplement to the other research methods employed in this study.

The majority of those who responded came from the Northwest quadrant comprising 37.5 percent of the return, followed by the Southwest quadrant

Figure 6.0: Questionnaire Response Zones



(adapted Prince George OCP, 1993)

returning 24.4 percent. The bowl area is third with 15.6 percent with the Northeast and Southeast quadrants both had response rates of 6.3 percent (Figure 6.1).

6.2.2 The Planning and Permitting Process

The first section of the questionnaire determined residents awareness and concern for aggregate extraction within the city and to highlighted elements of the planning process residents felt were most important (Table 6.3).

Table 6.3: Planning For Extraction: Response Summary

Satisfaction with planning process.	• Indifferent = 47% • Satisfied = 34% • Not Satisfied =19%
Should extraction take place in Prince George?	• Yes =78% • No =19% • n.a =3%
Planning Process Elements Ranked by Importance	1a.) Information available to public. 1b.) Review by government agencies. 1c.) Land use conflict considerations. 2) Information required from applicant. 3) Public input into process. 4) Government agency cooperation.

Most of the respondents were indifferent about the planning process permitting aggregate extraction in the city. However, some respondents suggested methods by which the process could be improved and included incorporating more public consultation into the process (10 percent of respondents) and more detailed planning in the city (10 percent of respondents). A large majority of those surveyed agree with extraction taking place within city limits (Table 6.3), while those who do not indicated that it should take place outside of the city (6 percent) or be placed under strict controls (6 percent). Other respondents indicated that the location of such operations should be dependent upon an inventory of the resource (6 percent).

The majority of respondents identified information availability, government review of applications and land use conflict issues addressed as the most important elements of the planning process. Responses of 87.5 percent ranked these elements as either 'very important' or 'extremely important'. Following closely behind these aspects, 81.3 percent of respondents felt that the information required from the applicant is important.

6.2.3 Sand and Gravel Operations

Residents were asked to provide input regarding the impacts of extractive operations in the city. A list of potential impacts/issues was provided and respondents were asked to rank each in terms of importance. Table 6.4 lists, in order of importance, the potential impacts respondents are most concerned with. Scores were assigned to each class of response as follows:

- Not Important = -2
- Somewhat Important = -1
- Very Important = 1
- Extremely Important = 2

These combine to produce a rank score range -64 to 64 and are derived by multiplying the frequency of response by the appropriate score of the response class.

Table 6.4: Ranking of Impacts and Issues Associated with Extraction

Impact/Issues		Ranking/Score
1a)	Reclamation	40
1b)	Pedestrian safety	40
2)	Dust	38
3a)	Noise	36
3b)	Erosion	36
4)	The environment	35
5)	Property values	34
6)	Watercourse sedimentation	33
7)	Unsightliness	32
8a)	Hours of operation	29
8b)	Fencing	29
9)	Buffers between uses	28
10)	Health risk	25
11)	Road damage	24
12)	Home resale problems	22
13)	Lower water levels	21
14a)	Appropriate signage	18
14b)	Truck traffic	18
14c)	Duration of operations	18
15)	Smell	16
16)	Lifestyle degradation	15
17)	Access points to pit	13
18a)	Loss of wildlife	11
18b)	Size of operations	11
19)	Tree removal	5

Reclamation and pedestrian safety are the two priority issues of the respondents, followed by dust, noise and erosion. It is interesting to note that tree removal is the issue of least concern to the respondents. In general, scores indicate that there is a concern for all of the items presented in the questionnaire. The listing above indicates a broad range of importance among these issues and assists in identifying those perceived by the respondents to be most important. This provides a priority of issues that could be applied in a management plan.

When asked whether their individual residence has been impacted by extraction, the majority of respondents (87.5 percent) indicated that it had not. Those that did identify impacts (12.5 percent) listed things such as unsightly aspects from their

residence, loss of attractive community landscapes and trees, and increased traffic outside of their homes.

Methods by which impacts from operations could be reduced were suggested by some respondents. A total of ten suggestions were made by nine individual respondents (28 percent):

- Remove gravel faster from the site;
- Limit the size of operations;
- Reduce removal opportunities;
- Increase buffers between uses;
- Impose better reclamation;
- Reduce the hours of operation;
- Limit operations to outside of city boundary; and
- Increase communication among affected parties.

The questionnaire also probed resident perceptions of how individual operators were performing in the city. Most respondents (46.9 percent) indicated that they did not know how aggregate operations were performing in Prince George. However, 28.1 percent of responses indicated that operators were performing 'good', while one respondent (3.1 percent) feels that operators are doing an 'excellent' job. 'Inadequate' and 'poor' performance were recorded by 12.5 percent of respondents. When asked to provide additional comments about the performance of aggregate operations in the city a variety of responses were recorded which indicated that some respondents feel:

- Encroachment of residences onto pits is the real problem;
- The media is unfair to operations in the city;
- It is a necessary disturbance;
- Better reclamation could improve things; and
- Operators are out to make a quick buck.

After I had inquired about the impacts and issues surrounding aggregate operations in Prince George, survey participants were asked whether or not they could live near a sand and gravel operation. Almost half (46.9 percent) of the respondents indicated that they could live near a operating pit, while the remaining

25 and 28.1 percent of respondents respectively felt that they could not live near a pit or were uncertain about whether or not they could do so.

I compared mean responses focusing upon the issues of the highest concern in zones where the majority of aggregate extraction is taking place in Prince George. The Northwest quadrant (Zone 1) contains the highest intensity of removal activity, while the Southwest quadrant contains one of the largest and deepest operations in the city (Kode Construction). Responses were coded from '0 - 4', where '0' indicates that the issue is 'not important' and a response of '4' indicates the issue is 'extremely important'. A comparison of mean responses identifies the issues in this area that residents are most concerned with (Table 6.5).

Table 6.5: Issues of Highest Concern by Zone

Northwest Quadrant (Zone 1)		Southwest Quadrant (Zone 3)	
Issue	Mean Response	Issue	Mean Response
• Reclamation	3.8	• Pedestrian safety	3.7
• Appropriate buffers.	3.7	• Reclamation	3.3
• Dust	3.7	• Property values	3.2
• The environment	3.7	• Resale difficulties	3.2
• Sediment	3.7	• Health	3.2

Responses from the Northwest Quadrant are different from those of the Southwest. Residents in the Northwest have responded to issues, or impacts, that may be related to the magnitude of activity taking place in this area. In the Southwest residents responses may reflect the nature of the most prominent operation in the area. Kode Construction (Figure 5.2) is a large and extremely deep operation relative to others found throughout Prince George. In addition, this area of the city contains much of the new residential development. As such, it may be more of a concern at this time to residents and new home owners what the financial impacts and safety hazards an extractive operation will have upon their home.

6.2.4 Reclaiming Sand and Gravel Pits

Residents were queried on their perception of reclamation efforts throughout the city. This section of the questionnaire began with an explanation of what is meant by reclamation and stated "The landscape from which sand and gravel is removed is generally entirely disrupted by operations. Reclamation returns the disturbed landscape to a productive state" (see Appendix C). A combined 34.4 percent of respondents indicated that reclamation efforts in Prince George are either unacceptable (15.6 percent) or poor (18.8 percent), while an additional 34.4 percent do not know the state of reclamation efforts in the city. A smaller portion of respondents (25.1 percent) indicated that reclamation efforts are 'good' (18.8 percent) or 'excellent' (6.3 percent).

Respondents were then presented with a list of activities associated with reclamation and asked to identify the importance of each (Table 6.6).

Table 6.6 Ranking of Impacts and Issues Associated with Reclamation

Impact/Issues	Ranking/Score
1) Seeding/fertilizing	42
2) Tree planting	40
3) Defining an end land use	33
4) Screened buffers	31
5) Post operation maintenance	29
6) Ongoing reclamation	26
7) Wildlife enhancement	21
8) Reducing steep slopes	19

In terms of end land uses, respondents were asked to identify the types of land uses they find most desirable for the city as a whole and in particular, their neighbourhood (Table 6.7).

Table 6.7: Desirable Land Uses

City Land Uses Desired	Rank/Score	Neighbourhood Land Uses Desired	Rank/Score
1) Recreational uses	19	1) Residential uses	23
2) Residential uses	11	2) Recreational uses	19
3) Wildlife habitat	9	3) Wildlife habitat	6
4) Fish/water fowl habitat	8	4) Fish/waterfowl habitat	1
5) Urban uses	1	5) Urban uses	-9
6) Commercial uses	0	6) Forestry uses	-22
7) Forestry uses	-2	7) Commercial uses	-23
8) Agricultural uses	-16	8) Agricultural uses	-37
9) Industrial uses	-23	9) Industrial uses	-41

Recreation and residential land uses are the most desirable to the respondents of the survey. On a city-wide scale respondents were more tolerant of other land use opportunities such as natural areas for wildlife as well as urban and commercial uses. Within the neighbourhood however, respondents are less tolerant unless the land use is a natural area for wildlife or fish and waterfowl habitat such as a pond or lake. The remaining land uses are not preferred in any of the respondents neighbourhoods.

6.2.5 Sand and Gravel Use

The remainder of the questionnaire investigated the use of sand and gravel by the respondent and their overall feelings concerning the extraction of this resource on the whole community (see Appendix C). Exactly 50 percent of respondents have purchased sand or gravel before, of which the majority found it to be reasonably priced. The purposes for which the materials were purchased include:

- Driveway construction/maintenance (28.1 percent of respondents)
- Landscaping and gardening (16.6 percent)
- Fill (9.4 percent)
- To make concrete (6.3 percent)
- To fill sand bags for winter driving (3.1 percent)

In general, sand and gravel are utilized by residents primarily for small maintenance or construction projects around the home.

Finally, survey participants were asked to indicate the degree of positive and negative social, economic and environmental impact they feel that sand and gravel extraction has upon the city of Prince George. The majority of respondents (59.4 percent) feel that socially, this activity has had 'no' (40.6 percent) or 'low' (18.8) positive impact on the community. Economically, 75 percent of the respondents feel this industry has had 'some' (46.9 percent) or 'high' (28.1 percent) positive impact in Prince George, while from an environmental standpoint 68.8 percent of respondents recorded either 'no' (37.5 percent) or 'low' (31.3 percent) positive impact on the environment.

Respondents were also asked to describe both the positive and negative impacts they have experienced in Prince George. A summary of the impacts is listed below (Table 6.8).

Table 6.8 : Positive and Negative Impacts Identified by Residents

Positive Impacts Identified	Negative Impacts Identified
• Employment opportunities • Provides development areas • It is a business opportunity • It is an opportunity for community improvement • It permits for road improvements • Provides opportunity for landscape enhancement	• Scars the environment • Disrupts drainage • Dangerous area for children • Noise • Dirties the roads • Degrades the environment • Creates derelict land • Reduces wildlife • There is a lack of reclamation • Pits are used as dumps • Lower the quality of life • Lower property value • No direction to development

6.2.6 Summary

Although the response rate of the questionnaire are not as high as I hoped, the information derived is still useful. It provides insight as to how some members of the general public feel about aggregate extraction in Prince George. In addition, the rate of response as well as the kind of responses are informative in revealing the degree of understanding of the issues surrounding the aggregate industry held by the general population. The response rate indicates that residents in the Northwest and Southwest quadrants of the city were more willing to reply to the questionnaire. The bulk of aggregate extraction presently takes place in these areas of Prince George and may have increased the rate of response.

In general, respondents expressed indifference, or a lack of familiarity, with the issues. This is evident with respect to the planning process, the performance of operators and the state of reclamation throughout the city. In addition, most people reported that their residence has not experienced impacts from operations and that they could live near a pit operation. When presented with potential impacts and methods of reclamation, respondents were willing to comment on these issues.

Most people identify reclamation as the primary issue or concern, followed by public safety, dust, noise and erosion impacts. The establishment of vegetative growth on a disturbed site is the most important issue in the task of reclamation and ensuring that an end land use is planned for. Many of the concerns are similar to those expressed in the interviews by the active community representatives. Collectively, the issues are similar among city residents who have directly experienced the impacts of removal in their neighborhood (the residents association), and those residents who responded to the questionnaire but also expressed a degree of indifference with the issue.

Indifference to the issue is, in itself, relevant. One of the problems associated with aggregate resource management has often been a lack of understanding about to the need for this resource and the means by which it is exploited. While indifference may not indicate a precise stance on the issues, it does not preclude a future stance with such residents. Indifference may indicate the need to increase educational opportunities and the positive exposure of the industry in the community.

6.3 Participant Observation

As some of the interview subjects revealed, the City is becoming more responsive and active in dealing with aggregate resource management within the municipality. This is reflected in the handling of recent applications by the City and the development of a new soil removal by-law. Information derived from these efforts provides insight as to how City planning officials and City Council are attempting to change the local management approach to aggregate resources. This section highlights the efforts of the City through:

- Observation at relevant public hearings, City Council Meetings and Development Services meetings; and
- Participation on the Soil Removal By-law Committee.

6.3.1 Public Hearings and Development Services

The North Nechako Road and Foothills Boulevard area has been identified as an area of intense conflict and opposition to aggregate extraction in the city. In the spring of 1995, an application was brought to the City to expand the soil removal designation along the north side of the Nechako River at Foothills Boulevard. This application initiated a series of public hearings and a negotiation process that extended throughout the summer and into the fall of 1995. The City attempted to address the concerns of the North Nechako Bench Residents Association and facilitate an acceptable decision to both the applicant and the residents group.

The initial application was denied by Council on May 29, 1995. A planning report prepared by Development Services recommended that the application be denied for the following reasons:

- The existence of extensive soil removal areas and active operations already in the area; and
- The proximity of the proposal to residential development and the Nechako River.

Despite initial denial, a portion of the applicant's property was already designated for removal. As per section 5.4.2 of the OCP Supplement, once a designation is in place the City is required to issue a soil removal permit, "it may not refuse" (1993, p. 43). The area of the applicant's property with the appropriate designation is that area closest to the residents to the west of the application. The applicant indicated that removal would begin to take place in this area regardless of the refusal to expand the soil removal designation on the property. It was at this time that Development Services initiated a process to bring the stakeholder groups together and to negotiate a consensus on the issue. Two meetings in July of 1995 were held that included City planning officials, the applicant and residents from the area.

The first meeting resulted in a compromise by residents and the applicant, such that residents would not oppose the expansion of the soil removal designation south to the greenbelt along the Nechako River if a 250 meter buffer was provided

from the residential property line. A consensus was reached on this agreement to exchange the designation, and a second meeting scheduled whereby the applicant could present the revised plan.

The revised plan was presented to the group at the end of July, 1995. Residents agreed to support an expanded soil removal designation as long as the present designation closest to residents properties was removed. In August, Council approved the designation and soil removal plan without any opposition from residents in the area. A planning report prepared by Development Services recommended that the application be approved for the following reasons:

- The exchange of designations provides a significant buffer between operations and residents;
- Extraction will not occur in greenbelt areas along the Nechako River; and
- The proposed plan is conducive to future residential development on the property.

Through a consensus building approach among stakeholder groups, the City was able to address the concerns of residents, provide access to aggregate resources and direct extraction to prepare the land for future subdivision development. In essence, this approach brought opposing parties together to develop an understanding of each others' position, reducing hostility between the parties and the historic polarity between the aggregate industry and residents groups (Walther, 1987). This effort greatly reduces the potential for future conflict on these lands, is an example of efficient management of municipal land resources, and could be incorporated into the application process as a standard practice where conflict arises. The City could initiate a mediation process within the process of application approval that allows for participation, fostering an understanding among groups and reducing the impacts from operations on other land uses throughout the city .

6.3.2 Developing a new Soil Removal By-law

Because of the ineffectiveness of the Soil Removal By-law #3000 and increasing resident opposition to aggregate operations, the City undertook the preparation of a new soil removal by-law in the summer of 1995. The City has become increasingly aware of extraction taking place with MEMPR approval, but operating without a permit from the City. In order to establish regulatory control of the industry, the City established a Soil Removal By-law Committee to prepare the new by-law.

Issues Triggering By-law Development

A number of issues contributed to the preparation of a new soil removal by-law. One of the main issues was the appearance of operations throughout the city. The impacts surrounding operations in the city were becoming magnified in areas of increased removal activity, most apparent in the Nechako and Foothills Boulevard area. There was a need to provide a process by which the community could be involved in addressing these impacts. Ensuring reclamation and slope stabilization were also reasons. It is evident throughout the city that reclamation is not an current objective of the operators. Finally, a new by-law would serve to provide a monitoring and control mechanism through which extraction is regulated and the sand and gravel resource supply is sustained for widespread use throughout the city (City of Prince George [c], 1986).

Process

The previous soil removal by-law was developed 'in-house' by City departments. In preparing the new by-law, the City adopted an entirely different approach. In May 1995, a Soil Removal By-law Committee was established consisting of twelve members which included representatives from the four levels of government (federal, provincial, regional, and municipal), the aggregate industry, the Association of Professional Engineers and Geoscientists of British Columbia, the North Nechako Bench Residents Association, the Rivers Committee, UNBC Faculty

of Natural Resources and Environmental Studies, and a member of the 'interested public'. The composition of the Committee was designed to incorporate input from all stakeholders groups in the design and composition of the new by-law.

The process of developing the by-law consisted of six meetings. The first five were held every two weeks between May and July of 1995. The Committee began the process with a by-law framework presented by Development Services. Through an iterative process of discussion and consensus, the by-law was built over the course of these five meetings. The draft by-law was then circulated to agency departments for comment, after which the Committee met a last time to review and discuss recommended changes to the by-law.

Many issues were addressed at the meetings that included topics such as environmental protection, industry equity, community concerns, and by-law applicability. Some of the more complex issues centered around strengthening the regulatory requirements of the by-law without placing aggregate producers at an economic disadvantage. It was seen as important not to jeopardize the viability of the industry in Prince George and thereby reduce the availability of the resource. Producer participation indicated what requirements were feasible. Efforts at improving environmental responsibility and minimizing the impacts to surrounding land uses was balanced with realistic input addressing berm construction, progressive rehabilitation, increased processing on site, topsoil preservation and the control of runoff and erosion.

After circulation of the draft by-law, small changes were made. By the end of the process Committee members were satisfied that the new by-law was prepared for reading by Council. One issue on which consensus was not reached was that of hours of operation. Resident representatives would have preferred a decrease in the weekly hours a pit could operate because of concerns of noise disturbance. Some Committee members felt that, given the increased requirements with respect to berms and buffers, that it was 'fair' to provide operators with a degree of flexibility

in this regard. It was agreed that any changes could be made by Council through presentation at the public hearing for approval of the By-law. The process resulted in an improvement over the old by-law in many respects and represents the efforts of many segments of the community.

The New Soil Removal By-law (SRBL #1996)

The new SRBL attempts to address many of the operational concerns related to aggregate extraction in Prince George and aims to standardize the permit requirements of all operators in the city. An extensive increase in permitting procedures and environmental regulations characterize SRBL #1996 from that of SRBL #3000 and represents an effort by the City to increase their control over aggregate extraction. The new by-law addresses the technical aspects of establishing a mine site in Prince George, but also incorporates the concerns of residents about the day-to-day activity of this industry in the city. SRBL #1996 is examined under the same topic areas as that of SRBL #3000: procedural requirements, information requirements, conditions of approval and remuneration.

Procedural Requirements: Development Services administers SRBL #1996. Applicants are required to retain a qualified professional to act as the prime consultant for the duration of operations in the preparation and validation of reports and plans for application and renewal. Permit renewal is dependent upon a yearly report and/or plan that illustrates compliance with the by-law. Changes to original plans are to be represented in these annual reports for the approval of the Director.

Designation is similar to that of the old by-law. The lands upon which the application is made must first be designated as a Soil Removal Area within Schedule 'A' of the soil removal by-law, and Schedule 'D' of the OCP. Amendments to Schedule 'A' of the by-law can be made but not prior to a public

hearing as required under the *Municipal Act.* Notice of the public hearing is to be issued in local newspapers and any additional requirements under the *Municipal Act.* Amendments to Schedule 'A' of the soil removal by-law may be subject to any conditions placed on the issuance of a permit that Council deems necessary. Once a designation is in place however, Council is obligated to issue a soil removal permit.

Information Requirements: By-law #1996 requires the submission of more information at a public hearing in front of Council. This stage in the process allows for an earlier identification of the potential impacts and conflicts with a forum of public participation. Requiring the bulk of the proposal's details after a designation is in place can lead to problems in that Council is required to issue a permit once such a designation is approved. The new by-law aims to have most of the information up front prior to the approval of a designation for soil removal.

The City of Prince George By-law #1996 has extensive requirements in terms of plan and information submissions as part of the designation and permit approval process: Three separate plans are required in addition to a report detailing the specifications of the proposal:

- a site plan of existing land use and land cover characteristics must be submitted;
- a progressive development and reclamation plan detailing stages of development, duration of excavation and the reclamation of previous stages as development proceeds is also required;
- a final reclamation plan detailing slopes and grading of the site upon completion of operations is also to be submitted with the application; and
- a report is to describe in detail the operational methods to be used in excavation as well as proposed future land uses for the reclaimed site.

This information, allows more consideration of the biophysical and social elements affected as a result of aggregate extraction. The plans and report should combine to provide the necessary baseline information to assess the resource

development impacts. The data collected specifically pertains to the land use circumstances prior to extraction, operational methodologies, reclaimed land uses, and the staging and phasing of the site as it is developed and reclaimed. Landscape and societal opportunities are considered by addressing end land use prior to the start of operations. These opportunities are further enhanced through Section 14 of the by-law which requires that the reclaimed land use conform to the strategic policies and land use designations of the OCP. This serves to link the implementation of the new by-law with the land use goals and objectives of the OCP.

Conditions of Approval: Operational elements of soil removal are regulated as a condition of permit approval under Section 12 of the soil removal by-law. In addition, Sections 13-15 include additional regulations addressing sediment and erosion control as well as site reclamation.

Soil Removal By-Law #1996 is different from many municipal soil removal by-laws in that it has incorporated specific standards into the regulations. These include elements such as sediment loading levels, berm construction and minimum distance separation standards. In addition, links to Provincial guidelines such as the Land Development Guidelines for the Protection of Aquatic Habitat (DFO), the *Waste Management Act*, and the *Mines Act* are also incorporated into SRBL #1996. Thus, while the by-law is very specific in one sense, in another it has a significantly widened scope.

This By-law provides a very clear picture to operators as to how their operation are to run in Prince George. It provides for assurances through professionally validated reports submitted yearly. Overall, SRBL #1996 is an attempt to produce more efficient operations, minimize operational impacts and reduce the land area disturbed by mining operations.

Another significant change in the new By-law is permission of screening and washing of material on site without the need for zoning. This enables the producer more flexibility in producing products on site as well as eliminating some of the transportation costs associated with removing material to processing facilities at other points in the city. This contributes to maximization of resource use on site, and containment of impacts generated from increased transport of materials.

Remuneration: The applicant is required to submit a security deposit to cover haul routes, municipal road repair, site maintenance and reclamation. Inspection of operations can take place without notice at all reasonable times and operations in contravention of the by-law may be issued a stop work order until operations return to compliance. Financial penalties may be levied if an operator is found to be in contravention of the by-law. By-law #1996 requires greater security from the applicant, and provides clear description as to where the deposit will be spent by the City if necessary.

It is apparent by the process by which Soil Removal By-law #1996 was developed and its content, that Prince George is attempting to greatly improve the management of sand and gravel operations in the City. The City has consolidated the management of sand and gravel resources within one City department.

In general, the new By-law demands much more from the proponent of an extraction operation in terms of permit fees, security deposits and potential fines or penalties that may be served. These requirements place greater responsibility and onus on the operator to conform to the requirements of the By-law, as well as provide operators with specific expectations spelled out in the By-law.

The City is very specific in the proposed by-law about operational requirements and environmental standards to which it expects operators to conform. This includes decibels generated on site, particulate running off site and into adjacent

watercourses, soil coverage and depth upon rehabilitation, hours of operation, berm construction and minimum distance separation. The By-Law standardizes operations throughout the City by establishing specific requirements for all operators.

Finally, the new By-law is procedurally more sound. The designation of land for soil removal requires all the pertinent information at the initiation of the application stage where it is presented to Council at a public hearing. By-law #3000 did not require all the information to obtain a soil removal designation until the designation was in place and a permit required. In summary, By-Law #1996 permits more meaningful public consultation and permits Council to make a more informed decision with respect to land use designation in the city.

6.4 Summary

I have brought to the forefront the perceptions of stakeholders about aggregate management in Prince George. I revealed problem identification with the planning and permitting process, jurisdictional matters, and the coordination and cooperation between administrative agencies. In addition, the relevant impacts and concerns associated with the mining and processing of aggregate resources was developed such that those issues most important to the community have been identified. Reclamation is one of the most pronounced problems expressed by all the stakeholder groups. The resolution of these issues requires the development of a new management approach to resource management at the local level. Coordination of SRBL #1996 with the efficient use of other planning instruments, incorporating stakeholder perceptions and embodying an environmental planning perspective is required. Valued environmental components and resource management needs will contribute to the development of an integrated approach to resource harvesting in Prince George.

Conclusion: A Conceptual Framework for Aggregate Resources Management in the City of Prince George

7.0 Introduction

In this chapter, I develop and present a management directive for the City of Prince George for aggregate resource management. Using the Sustainable Resource Management Framework presented in Chapter Three, I propose to integrate aggregate resource harvesting values with those of the community. The goal of this approach is to improve decision making, mitigate impacts, and reduce conflict with respect to aggregate mining in Prince George. The proposed management directive is presented in the context of the components of the Sustainable Resource Management Framework and addresses problem identification, impact assessment, and interest representation. Through the use of impact assessment methodologies at the normative, strategic and operational levels of planning in Prince George, the environmental planning of aggregate resources at the municipal level can be realized.

7.1 Problem Identification

The starting point for resource management is the identification of problems as they arise in the environment, economy and/or society (Smith [a], 1993). An aim of problem identification is to establish the temporal context and scale of the problem addressed in the research.

With respect to aggregate resources, problem identification has been examined from two standpoints in this thesis. First, there are the overlying problems inherent in aggregate management that deal specifically with protection of the resource from loss due to development and facilitating its removal with minimum impact on the community and environment. Second, are those underlying problems or concerns

that are specific to the research and directly related to aggregate management in Prince George. Chapters Five and Six both revealed a number of shortcomings with regard to aggregate management in Prince George:

- Jurisdictional conflict exists between the City of Prince George and MEMPR;
- There is a lack of provincial direction to municipalities as to how aggregate resources should be managed at the local level;
- The OCP is not fulfilling its potential as a local resource management instrument;
- SRBL #3000 is ineffective at controlling operations throughout the city;
- Operational impacts (dust, noise, safety and visual disturbances) are a concern and require mitigation in areas throughout the city;
- There has been a lack of public consultation with respect to the management of this resource in the city;
- There is a need for increased public participation at the beginning of the resource management process; and
- Reclamation of disturbed areas is one of the primary concerns of regulators, professionals and community groups in the city.

With respect to the Sustainable Resource Management Framework, elements that should be considered in addressing, or defining a problem include comprehensiveness, interconnectivity, and strategic reductionism (Borne and Sonzogni, 1995).

The scope and scale of aggregate resource management may be described as ensuring the sequential and compatible use of the community landscape while satisfying resource harvesting objectives. That is, providing the necessary supply of aggregates to meet community needs with particular attention to the reclamation of the mine sites from which it is removed. The process by which this is accomplished should connect stakeholder representatives and provide participatory opportunities throughout the process. In addition, the management approach should not look at aggregate resources in isolation, but rather in the context of the community resources of which aggregates are one element. Finally, the management approach

should explore the capabilities of local planning tools as instruments of resource management and refine these tools to address resource management challenges at the local level, such as the OCP and by-law approval powers. The prescribed management approach addresses these issues as a means to address the aggregate resource management problems in the city.

7.2 Resource Management

Resource management consists of three components: institutional arrangements, interest representation, and impact assessment (Smith [a], 1993). Collectively these three elements define a political process that plans for and controls the development of resources.

Institutional arrangements define the structure of management and should provide an effective decision making process. If institutional arrangements are not well defined or understood, the potential for ineffective decision making and poor resource management increases.

Interest representation serves to identify stakeholder groups and identify avenues of participation for these groups throughout the decision making processes (Burdge, 1995). Stakeholders usually include proponents of projects, regulatory agencies, interests groups and members of the general public who are directly affected by the proposal (Smith [a], 1993). Without sufficient stakeholder representation, the quality of resource management decreases. Conflict between groups may arise, impediments to effective decision making occur, and local knowledge in community related decisions is lost.

Impact assessment should incorporate planning at three levels: the normative level (policies guiding what ought to be done), the strategic level (programs guiding what can be done), and the operational level (what is done in practice). Smith (1993) states that impact assessment "should be viewed as a process of environmental planning" (p. 100). This process should incorporate impact assessment principles

which include scoping, prediction, significance assessment, evaluation, monitoring and mitigation.

7.2.1 Institutional Arrangements

The research identified two problems associated with the institutional arrangements surrounding aggregate resource management. The first is that there is no expressed provincial direction for municipalities to follow in managing aggregate resources. Second, in Prince George conflict exists between the City and MEMPR where, in some cases, provincial approval of a mine has been granted without the involvement of the City. These two problems need to be clarified in order to provide Prince George with clearly defined responsibilities in managing aggregate resources.

In 1989, the MEMPR solicited a study entitled The Sand and Gravel Industry of British Columbia from Thurber Engineering Ltd.. This report emphasized the improvement of administrative policies affecting the industry. One of the objectives of the study was to develop a regulatory framework that would ensure the proper management of aggregate resources in the province. The study extensively examined the existing policies of Ontario and evaluated the approach adopted in that province for its application in British Columbia. The MEMPR supported the four following acknowledgments with respect to aggregate management (Thurber, 1990):

- Local involvement is essential in the planning and approval process if concerns are to be effectively stated and considered;
- Without proper planning, there is no way to protect resources for the future;
- Acceptable standards of operations are so varied that they defy generalization. Therefore, regulations must allow for local choices and participation; and
- The most effective way to properly control pits and quarries is through shared provincial-municipal control.

It is evident that the Province recognizes the need to establish a joint planning effort for aggregate resources and that the management emphasis should reside at the local level. As of yet however, the Province has not officially released policy or guidelines for municipalities to consider. As such, it is presently the onus of municipalities to plan for and control the management of aggregate resources within their jurisdiction. As is clear in Prince George, the degree to which a municipality can control operations is not well defined (Thurber, 1990).

In the Lower Mainland, municipalities were considered to be alienating resources through zoning or by-law restrictions. In 1989 the *Municipal Act* was amended to require joint approval of by-laws by the MMA and MEMPR affecting aggregate resources in municipalities. The intent was to encourage management of the resource, rather than prohibition.

In Prince George however, the situation is different compared to that of the Lower Mainland. The geographic isolation of the city from other urban centers in the province requires that the city provide its own service and supply functions (Johnson, 1991). As such, aggregate supply must originate in proximity to the major demand center of the area. Because of the changes in legislation, Prince George has had difficulty in determining the degree to which it can address land use issues surrounding the management and control of the industry. In the past, the City has often been in disagreement with MEMPR as to which agency possesses the management portfolio for aggregate resources. As stated in the MEMPR (1990) report "It is important to remember that soil removal by-laws adopted by municipalities cannot usurp provincial regulatory authority, but can duplicate it, often unnecessarily..." (p. 23).

While the province has not provided an expressed direction to municipalities with respect to aggregate resource management, the courts have. In Chapter Two, I detailed recent case law that has defined municipal authority. The recent legal challenge by Pitt River Quarries Ltd. indicates that municipalities can control

extractive operations through zoning, and address land use issues such as impacts and conflict through the powers delegated to them under the *Municipal Act* (Mascarin, 1995). The British Columbia Courts have defined the institutional arrangements regarding aggregate resource management at the municipal level. What is needed is an appropriate process by which local municipalities can manage this resource. As one interview subject indicated, at this time in Prince George "it doesn't really mater how much the local government gets involved, the city has no process."

7.2.2 Impact Assessment

Smith (1993) supports invoking impact assessment principles as a form of environmental planning and as a means to improve decision making, mitigate impacts and address conflict. These principles consist of six exercises at the policy, program and project levels of planning. The application of each of these principles is dependent upon where planning is to take place. Smith states:

> *"Where planning occurs at all three levels, the iterative sequencing of these activities would involve a shifting emphasis with normative planning stressing scoping, prediction and significance assessment; strategic planning emphasizing prediction, significance assessment and evaluation; and the final operational planning focused around the activities of evaluation, monitoring and mitigation" (p. 103).*

With respect to the research findings and Sustainable Resource management Framework, it may be concluded that the City should undertake a number of additional planning initiatives at the normative, strategic and operational levels of planning. The following activities should be considered by the City of Prince George

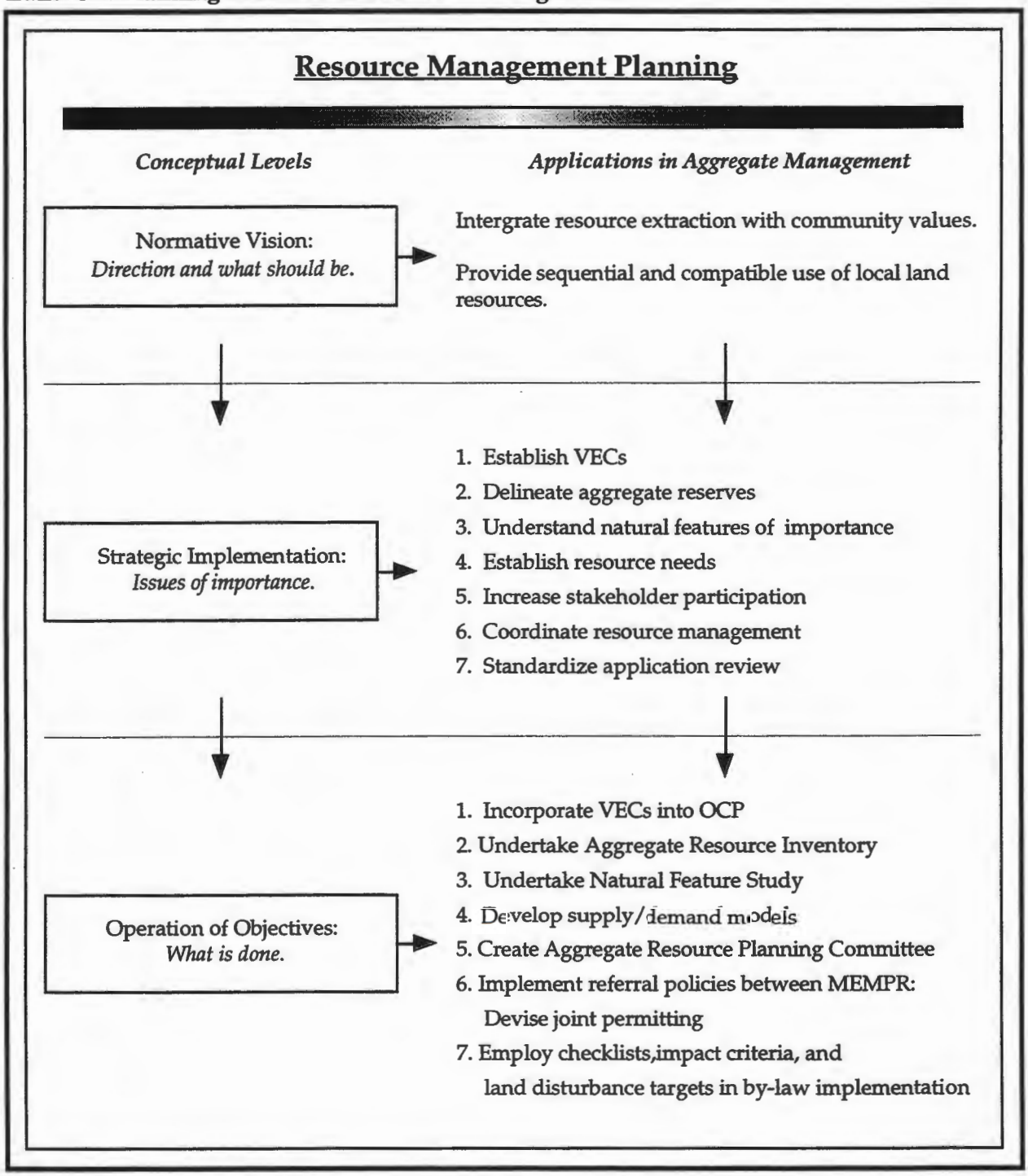
in managing aggregate resources:

- The City should consolidate the OCP incorporating aggregate resource polices and industrial extraction land use zones;
- The City should undertake a natural resources inventory that incorporates aggregate resource areas and natural features throughout, and immediately surrounding, the city;
- The City should use supply and demand modeling to assess future resource needs and supply;
- The City should incorporate environmental assessment criteria into the review of applications to designate extraction areas;
- The City should establish an Resource Planning Committee; and
- The City should encourage the shared use of pits where possible.

At each level, a variety of practices need to occur in order to produce the most effective approach to aggregate resource management in Prince George. This includes policy development, program initiation and project regulation. These tasks may be defined as local land use planning practices coordinated to occur within the principles of the sustainable resource management model (Figure 7.0).

Normative, strategic and operational land use planning initiatives such as OCP policy development, resource inventories, and project assessment criteria are undertaken at the municipal level as a means to manage local natural resources. These activities should occur within the realm of sustainable resource management principles. The achievement of operational objectives must occur in the context of impact assessment. As such, these initiatives should be comprised of elements addressing the seven tasks in impact assessment: scoping, prediction, significance assessment, evaluation, monitoring and mitigation.

Figure 7.0:
Land Use Planning Practices in Resource Management



7.2.3 Recommended Management Tools

Consolidation of the Official Community Plan (Policies)

One of the primary planning tools by which the City may express its management approach to aggregate resources is through the Official Community Plan (OCP). The OCP needs to move from a descriptive function to one that clearly identifies 'how' the City intends to manage aggregate resources. It needs to be informative to provide a degree of assurance and confidence in land use and development in the city. The existing OCP must be consolidated in order for this to occur. The following elements should be incorporated into the existing OCP: 1) the creation of a designation and zone specifically identifying areas of extraction; 2) the identification of primary, secondary and tertiary reserve areas; 3) the incorporation of mineral aggregate policies clearly stating the goals and objectives for lands subject to extraction; and 4) the inclusion and recognition of valued environmental components within these policies and the OCP.

Areas of resource extraction should be identified on Schedule 'B' of the OCP as a land use designation and accompanied by appropriate zoning. These areas should be identified as extractive industrial areas with a policy component contained in the narrative of the OCP. Once the inventories are complete, the existing Schedule 'D': Soil Removal Areas, should be used for long range resource development by identifying and prioritizing primary, secondary and tertiary policy areas. In this manner, extractive land uses are integrated and recognized on the main land use plan of the OCP, while users interested in resource development may refer to the revised inventory plan Schedule 'D'.

Section 9.6 of the OCP contains the soil removal policies of the City. These policies are primarily descriptive in nature. The City needs to incorporate policies that express a philosophy and vision for resource management in Prince George. In

addition to the existing policies the should City incorporate policies that:

- clearly define aggregate (soil) resources, their composition and geographic distribution;
- include the parameters of public concern, City planning objectives and agency concerns with respect to establishing extractive operations;
- indicate that the City will not support an MEMPR Order of Work Permit until the appropriate land use designations have been approved by City Council;
- prioritize considerations in land use designation approval such as scenic areas or vistas, natural features and adverse impacts;
- identify how and where the public will be involved in the decision making process in land use designation;
- classify extractive industrial areas as interim land uses that provide for future land use opportunities in the community;
- express the importance of progressive rehabilitation and the manner by which it will be pursued in the city; and
- encourage the shared use of pits in the city between willing participants such as the Ministry of Transportation and Highways and the City.

The incorporation of identified valued environmental components (VECs) should also be part of the OCP policies. The VECs should be part of, or separate from the aggregate policies (possibly with the environmental stewardship policies) but need to express the intent to address or protect those issues for which there is an expressed value or concern. The acknowledgment of these components may be expressed at various stages of the development process. For example, at the application review stage, air quality, degradation of city viewscapes, and protection of the river valley environment are elements for which expressed concerns have been identified and should be addressed in the processing of applications. Alternately, in considering reclamation opportunities, other land uses such as residential, recreational, or natural areas have been identified as desirable.

The consolidation of the OCP policies is a normative planning activity that expresses how management of aggregate resources should take place. The polices identify who is involved in the management activity, express long term coordinated

development of City resources, and define the process and parameters by which resource development applications will be evaluated.

Natural Resource Inventories (Programs)

In order for the City to predict its reserve supply of aggregate resources, an aggregate inventory must be developed. A coordinated inventory among private land owners, Crown Lands, the Ministry of Transportation and Highways, and the City determining the quantity and quality of aggregate reserves is a necessary first step in establishing the phased development of resource deposits in the area.

In addition, natural features and resource use inventories are needed to complement identified aggregate reserve areas. The identification of reserve areas alone is not sufficient to improve decision making, mitigate impacts or reduce conflict. The identification of sensitive natural features and those of natural or scientific interest is also required, along with areas of alternate resource uses such as agriculture, forestry and recreational uses. The information derived from such inventories is necessary in identifying opportunities and constraints for aggregate resources development. With adequate inventories in place, it is possible to begin to protect mineral deposits for future development, project and coordinate extraction in identified areas, and reduce nuisance and environmental impacts.

Modeling (Program)

Once the necessary resource inventories have been completed, the City should undertake a supply and demand modeling exercise in order to develop a planned horizon of aggregate resource development and use throughout the city. From a demand perspective it is necessary for the city to determine a quantitative demand for the resource based upon development and infrastructure forecasts in the area. A number of methods exist by which demand may be determined such as mathematical models utilizing correlation analysis, linear regression, and/or

demographic variables (housing starts, construction activity) (Hora and Basham, 1980; Poulin, 1995). Demand estimates for aggregate resources will assist the City in determining land use objectives in areas where the resource is identified. That is, using areas when needed, and releasing other areas to alternate uses once depleted.

From a supply perspective, once demand has been determined, the City may begin to assemble the necessary supply areas to meet the estimated demand. Based upon the resource inventories, supply area selection should be comprised of aggregate quantity, quality, environmental constraints/opportunities and socio-economic constraints/opportunities. This information enables the City to identify primary, secondary and tertiary supply areas. A classification of supply areas permits flexibility in decision making where trade-offs may be made in the event of conflict, and accounts for elements of uncertainty in predicting growth. Primary supply areas should be those that offer the highest aggregate resource value, provide for environmentally and socially sensitive development, and offer foreseeable reclamation opportunities. Secondary and tertiary supply areas should be identified as those where an imbalance of these criteria exist. For example, a secondary or tertiary supply area may possess a high quality aggregate, but its location may be within an identified environmentally sensitive area. These areas should be considered last for resource development.

Resource inventories and supply and demand models will enable the City to predict future effects of aggregate development within the municipality. It also provides the ability to observe 'with' and 'without' resource development comparisons. Thus, it assists in evaluating, predicting and identifying the significance of potential reserves throughout the city.

Application and Permit Review (project assessment)

At the operational level of planning, the City has already made some progress with the development of SRBL #1996. However, there remains opportunities to

further enhance efforts at evaluating, mitigating and monitoring impacts at this level. In administering the new SRBL and implementing the policies of the OCP the City should establish a Resource Planning Committee that operates in conjunction with the existing Advisory Planning Commission. The Committee would review and evaluate applications for land use designations, operating permits and permit renewal with respect to aggregate resources and also be involved with other resource issues in the city such as tree removal, river valley protection, forestry and agriculture management.

The Committee should be responsible for receiving, evaluating and negotiating applications to develop identified aggregate reserves. In addition, the Committee should participate at the strategic (inventories) and normative planning levels (policy development). Such a Committee could be comprised of the identified stakeholder groups (as in the development of the new SRBL) and be responsible to Development Services, who in turn is responsible to Council. The Resource Planning Committee could employ a variety of techniques to evaluate, monitor and mitigate activities or responses associated with aggregate resource development. These could include questionnaire checklists for summarizing impacts (Canter & Kamath, 1995), impacts assessment rating criteria (Barnes & Westworth, 1994) and land suitability evaluation (Smit & Spaling, 1995).

The use of a questionnaire checklist is a simplistic yet comprehensive method that allows for a generalized, but extensive analysis of land use practices and project specific issues (Canter & Kamath, 1995). It would be beneficial in linking broad land use policies with application and permit evaluation. Canter and Kamath suggest the use of a checklist that is flexible in terms of time and space and enables multiple land use practices to be addressed. As such, the use of a checklist in policy and project review would assist standardizing impact evaluation in Prince George. A potential checklist should include environmental categories in one column such as physical landform criteria, air quality, water and noise impacts among others. A

neighboring column would then provide space to indicate whether impacts can be expected, not expected or possibly expected (Appendix 'G').

Upon the determination of where impacts can be expected, it is then possible to rate such impacts. Barnes and Westworth (1994) have utilized ranking criteria for both biophysical and socio-economic related impacts to assess the impacts of military bases on the surrounding valued environmental components. A similar approach could be use in conjunction with the checklist above, to rank the determined impacts of resource development in Prince George. The rating criteria determine the magnitude of impacts based upon a major, moderate, minor or negligible scale and account for the duration and spatial extent of identified impacts. The information derived from these exercises would identify which environmental components can be expected to be affected by proposed policy or projects within the city, and assist in defining mitigation efforts and reclamation initiatives to remediate those impacts. Alternately, projects or policies could also be rejected where impacts are consider to be too severe (Appendix 'H').

A final method the City may consider is that of land disturbance targeting as a means to address time and space crowding of intrusive land uses in specific areas. Such methods address the need to consider cumulative impacts (Rees, 1995). Smit and Spaling (1995) indicate that establishing disturbance targets enables decisions to be made based upon pre-defined targets of acceptable disturbance and in turn, can direct where future development is allowed or prohibited. This exercise involves the selection of an indicator which is then used as a decision criterion to evaluate the effects of existing and future development in an area. In the case of aggregate extraction, an indicator such as the percentage of disturbed landscape due to mining could be established. This could be particularly useful in developing policy with respect to extraction in the Otway Road and Foothills Boulevard area. As Smit and Spaling state: "Applications [of land disturbance targets] are particularly suitable for development planning at the local and regional levels" (p. 99).

The assembly of a Resource Planning Committee and the use of all or a combination of these impact assessment methodologies would serve to enhance decision making, mitigate impacts and reduce conflict with respect to resource issues in the city and in particular, aggregate resources. The Committee could be involved at all the various levels of planning by participating in the inventory exercise, policy development and application review, and operating within a sound assessment methodology. From this, plan and policy may be developed, and future operations regulated.

7.2.3 Interest Representation

Within the execution of all these activities, representation of all stakeholders is imperative. The research revealed that there has been a lack of public consultation with respect to managing aggregate resources in Prince George and that participation earlier on in the process would assist in resolving this issue. A number of factors have contributed to this and include: 1) the lack of a proactive management approach that is inclusive of stakeholders; 2) reliance upon the minimum public participation requirements of the *Municipal Act*; and 3) the ineffectiveness of the existing SRBL #3000. The absence of a strategic management plan for aggregate resources in Prince George precludes public participation. Throughout the years, the City has assumed a responsive role with respect to management while the public has assumed one of complainant. Management efforts are therefore aimed at addressing concerns as they arise, rather than forecasting, predicting and mitigating (or eliminating) them in the long term. The establishment of a Resources Planning Committee coupled with the legislated public involvement at the policy and by-law approval stages, is a step forward in this respect.

Through the adoption and application of the initiatives discussed above, interest representation will increase at all levels in planning for the development of aggregate resources. Additional efforts that could be incorporated into the process

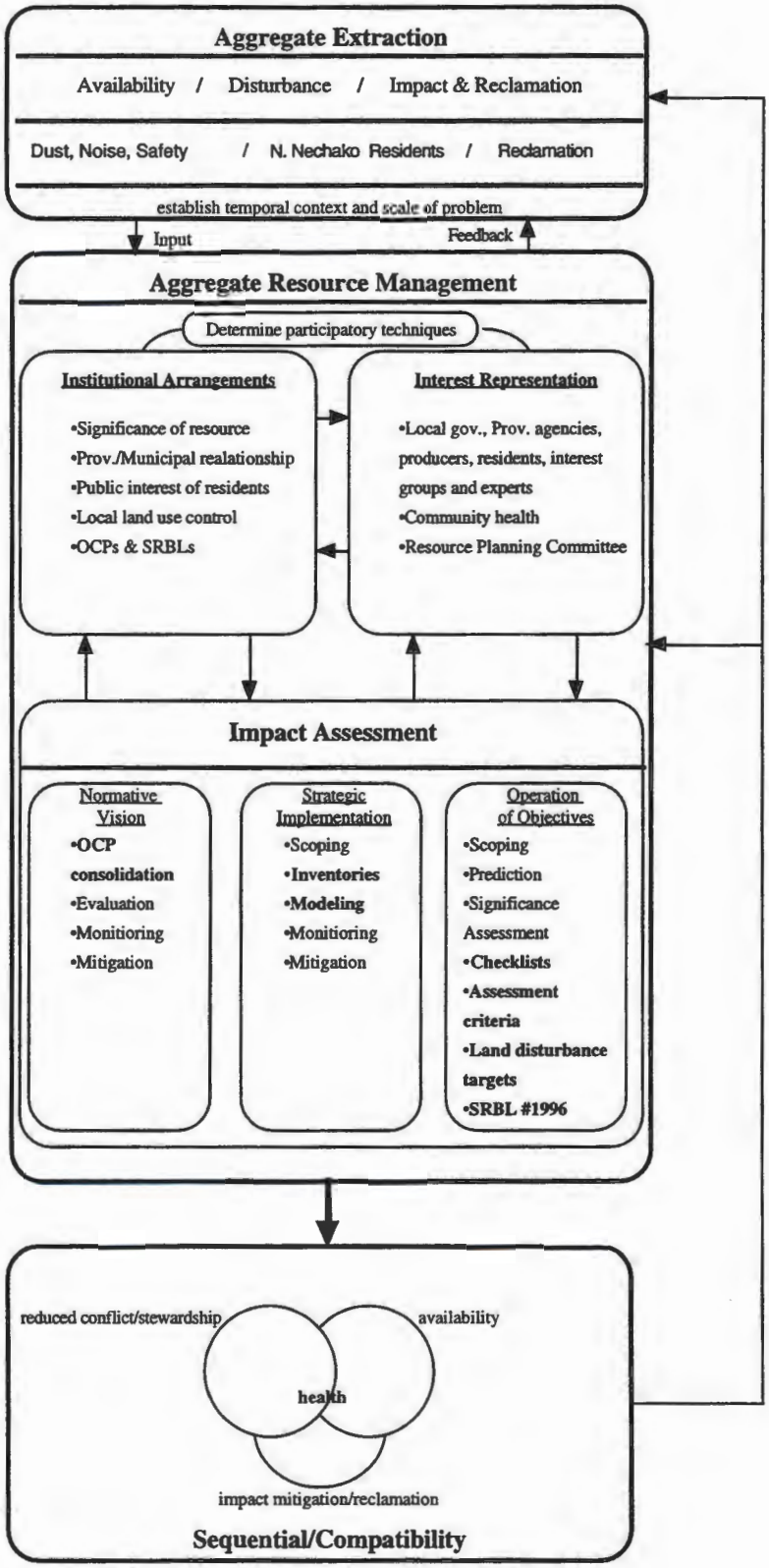
include open houses serving to identify social and natural features valued by the community, the elicitation of value trees, and in the delineation of resource reserve areas (Webler et al., 1994). In particular, the Resource Planning Committee should be comprised of public representatives augmented by stakeholder and expert groups. This composition of individuals, active at the various levels of the planning process, encourages a cooperative discourse among participants and in turn incorporates a social learning perspective into the decision making framework (Webler et al., 1994; Friedman, 1987). Thus, this type of planning is a move away from a purely technocratic, or egoist approach, by emphasizing education and understanding of participant values, beliefs, and perspectives. By integrating this type of approach, the City will serve to increase the understanding of not only aggregate management issues but also resource management on a broader scale in Prince George.

7.3 A Conceptual Framework For Sustainable Aggregate Resource management

The integration of harvesting values and community values is possible at the municipal level using the Sustainable Resource Management model in the context of aggregate resource management (Figure 7.1).

The use of this model in investigating the management of aggregate resources at the municipal level has clarified administrative structures, invoked social learning in the decision making process through consensus building and committee methods, and used impact assessment principles in policy, program and project initiatives. The formation of a Resource Planning Committee that assesses policy and projects with the methods proposed incorporates stakeholder input throughout the process and standardizes the review of applications and new policy proposals. Theoretically, if this approach were adopted in Prince George, it would contribute to a more healthy and sustainable community. A review of the applied methods in the context of decision making, impact mitigation and conflict resolution supports this.

Figure 7.1: Sustainable Aggregate Resources Managment



The model contributes to defining administrative roles between the province and the City with respect to aggregate resources. Currently, local jurisdictions possess the right to control extraction as a land use in the interests of planned development, addressing impacts and general environmental protection. The model invokes impact assessment principles at all levels of planning. With respect to aggregate resources: the OCP consolidation scopes the issues, predicts resource development and allows for the development of resource areas based on the relative significance of all community resources; inventories and modeling enable prediction, significance assessment and evaluation; while the use of checklists, impact ranking and disturbance targets by the Resource Planning Committee permits evaluation, monitoring and mitigation of projects and policy proposed in the city. The involvement by various means of stakeholder groups at the three levels of planning contributes to a cooperative discourse in decision making. This can serve to reduce conflict as well as provide a method by which conflict may be resolved in the event it does arise.

7.4 Conclusion

This thesis has applied an environmental planning approach to aggregate resources as a feasible method by which sequential and compatible use of municipal land resources can be realized in Prince George. This approach contributes to, the goals of sustainability and community health. In turn, economic health is improved through long range strategic planning that ensures resource quality and availability to the Prince George demand centre. Community health will increase through the recognition of VECs into plan and policy development. This serves to provide development guide posts that will preserve and/or improve elements of the city for which there is an expressed concern. In addition, the standard assessment of impacts on a continuing basis will reduce the magnitude of such impacts on the community over the long term. Environmental health improves by also addressing impacts, but

primarily through ensuring the rehabilitation of landscapes disturbed or previously alienated by mining in the city. This will reduce the amount of land area exposed to the elements at any one time throughout the city and return landscapes to productive capacity more expediently than before. The use of the methods proposed in this thesis would benefit community health in Prince George. They represent a means by which the municipality may plan environmentally.

Zimmermann has noted (1964, p. 21) "resources are not, they become". When resources 'become' it is important that, as stewards of natural resources, administrative bodies assume and express a responsibility to resource management at all levels. In exercising this responsibility, it is important that resource management reflect the needs of industrialized society, but also respect the intrinsic value of the environment in which we exist. As cohabitants among a multitude of other abiotic, biotic and cultural environments we need to establish and preserve linkages between societal and natural environments. Resource management is one means to accomplish this goal. How we manage our resources is a reflection of how we perceive ourselves and others within our environment. If sustainability and health are our goals, then the exploration of new methods and processes by which to manage our resources needs to assume an iterative approach; an exercise where we build upon and apply what we have learned from past successes and failures. In this manner, layers of knowledge build upon layers of action, and the dynamic relationship between humans and resources shall continue to evolve.

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Glossary

Chi-square Test of Statistical Significance

A class of statistical computation that indicates the likelihood that the relationship observed between variables in a sample can be attributed to sampling error (Babbie, 1989).

Community Health

A community that is livable, equitable and convivial (Hancock, 1990 as in Crombie, 1991).

Cumulative Effects

The additive environmental impacts of a persistent agent over time. Such impacts may occur when: a) the affected system is being perturbed repeatedly by the same local agent with sufficient frequency so that it does not have time to recover between events (time-crowding), or; b) the affected system is being perturbed by several similar agents or activities, in an area too small to assimilate the combined impacts (space crowding) and...

The gross (or net) environmental impacts of a number of unrelated projects or activities (multiple, qualitatively different impacts from a variety of causes -multiple impacts- and the interactions of these impacts - synergistic relations-) under conditions that result in time- or space-crowding (Rees, 1995).

Economic Health

An economy that is equitable, sustainable, and adequately prosperous (Hancock, 1990 as in Crombie, 1991).

Ecosystems Approach

A scientific approach to impact assessment that makes use of ecological principles and concepts in the design and conduct of assessment studies and in the prediction of impacts (Beanlands and Duinker, 1983).

Environmental Health

An environment that is viable, supporting human and non-human life, livable and sustainable (Hancock, 1990 as in Crombie, 1991).

Environmental Impact Assessment

A process for resource management and environmental planning that provides for the achievement of the goal of sustainability (Smith, 1993). A set of activities designed to contribute pertinent information to project or program decision making (Beanlands and Duinker, 1983). A process that addresses the consequences of public or private actions that alter the way in which people live, work, play, and generally cope as members of society Burdge et al., 1995).

Environmental Planning	Purposeful action directed towards specific environments or environmental resources for the overall purpose of optimal enhancement of environmental capacity and quality. It achieves compatibility in land use determination and a harmonic relationship between land uses and the surrounding natural and human environment (Land and Armour, 1980).
Esker	A long, narrow sinuous, steep-sided ridge or mound of irregularly stratified sand and gravel representing the course of a stream below or within a melting and retreating glacier. Typically up to 20 metres high and possibly tens of kilometers long (Smith [a], 1993).
Fluvatile Deposit	The product of river action. A deposit produced by the action of a river (Smith [a], 1993).
Impact Mitigation	To reduce, or make less severe, the effects of program and/or project development.
Integrated Resource Management	An approach to environmental stewardship comprised of multidisciplinary and integrated elements in decision making (Born & Sonzogni, 1995). It requires the design of a framework for communication and decision making, and the adoption of strategies and techniques by which group decisions can be enforced (Walther, 1987).
Local Land Resources	Lands within a municipality for which there is the potential for social, economic and/or environmental enhancement.
Mineral Aggregate Resources	Sand, gravel and/or bedrock deposits of extractive and/or processing potential for use as construction materials.
Petrographic Analysis	Dealing with the description and systematic classification of rocks (Smith [a], 1993).
Reclamation	A process by which disturbed land area is returned to a state of equal or increased productivity prior to that of the land disturbance (McLellan, 1983).
Rehabilitation	A process by which a disturbed land area is returned to a form and productivity in conformity with a prior use plan. It implies that a stable condition will be established that will not deteriorate substantially with the projected land use consistent with surrounding aesthetic values. It also suggest that the selected land use should be both ecologically stable and of high value to society (McLellan, 1983).
Single Descriptive Case Study	The presentation of a complete description of a phenomenon within its particular context (Yin, 1993).

Social Learning

A process by which changes in the social condition occur. How structures and activities of group communication processes can influence the development of individuals in a positive and coordinated manner (Webler et al., 1995).

Sustainability

A goal of resource management directing efforts at balancing societal, economic and environmental objectives (Smith, 1993).

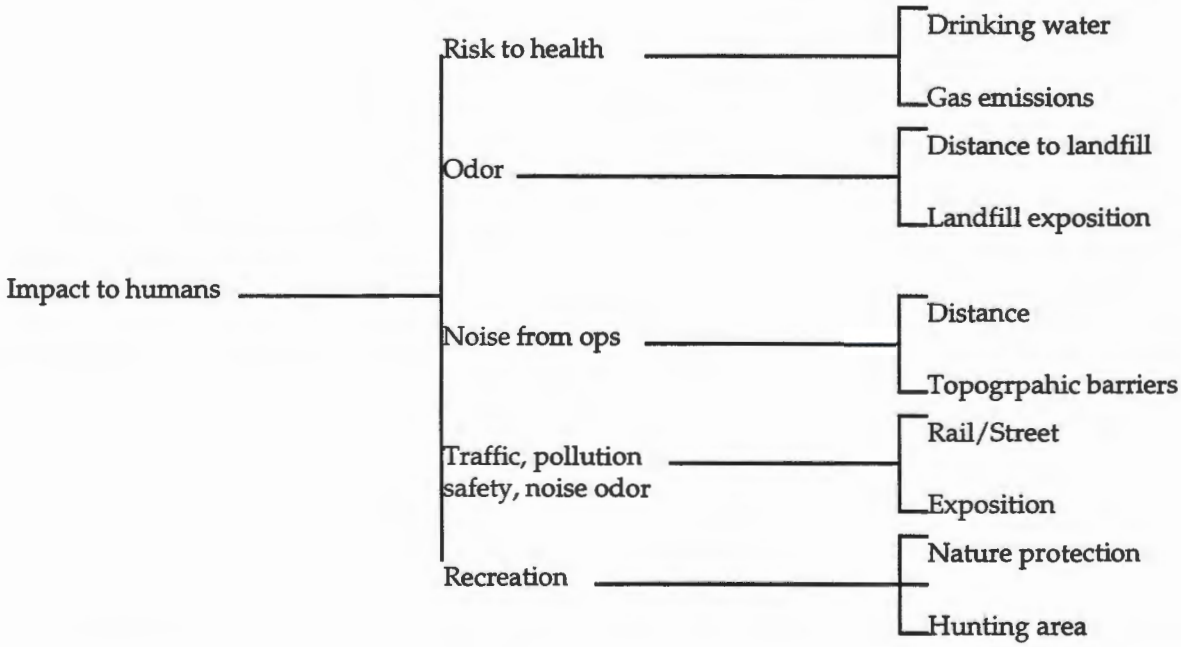
Sustainable Development

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development (1987).

The gross (or net) environmental impacts of a number of unrelated projects or activities (multiple, qualitatively different impacts from a variety of causes-multiple impacts-and the interactions of these impacts-synergistic relations) under conditions that result in time- or space-crowding (Rees, 1995; Peterson, 1987).

Value Tree

A method by which groups organize value positions in response to decision options and how these impact upon their interests or concerns. Value tress begin with broad indicators and move to the specific with the purpose of identifying indicators against which development alternatives may be evaluated(Webler et al., 1995).



Valued Environmental Components

Are those components of the environment for which there is professional or public concern including social, cultural, economic and natural components of the environment (Beanlands and Duinker, 1983).

Appendix A: Describing and Testing Aggregates

CLASSIFICATION AND DESCRIPTION OF AGGREGATE

1.	**AGGREGATE TYPE**						
1.1	Crushed Rock						✓
1.2	Gravel		Uncrushed		Land Won		
			Partly Crushed				
1.3	Sand		Crushed		Marine		
2.	**PHYSICAL CHARACTERISTICS**						
2.1	Nominal Size	5 mm down					
2.2	Shape	Angular					
2.3	Surface Texture	Rough					
2.4	Colour (sample condition)	Medium grey (sample dry)					
2.5	Presence of Fines	High content of dust					
2.6	Presence of Coatings	None present					
2.7	Extraneous Material	None present					
3.	**PETROLOGICAL CLASSIFICATION**						
3.1	Monomictic	✓	Polymictic				
3.2	Petrological Name	LIMESTONE					
		Visual Assessment		Quantitative Analysis			
3.3	Geological Age	Carboniferous					
4.	**PETROLOGICAL DESCRIPTION**						Yes
5.	**SAMPLE REF.**	0001	6. **CERTIFICATE OF SAMPLING**				Yes
7.	**SOURCE**	Incline Quarry, Isle of Soder					

CLASSIFICATION AND DESCRIPTION OF AGGREGATE

1.	**AGGREGATE TYPE**						
1.1	Crushed Rock						✓
1.2	Gravel		Uncrushed		Land Won		
			Partly Crushed				
1.3	Sand		Crushed		Marine		
2.	**PHYSICAL CHARACTERISTICS**						
2.1	Nominal Size	10 mm					
2.2	Shape	Angular and flaky					
2.3	Surface Texture	Rough					
2.4	Colour (sample condition)	Black and dark reddish brown (sample dry)					
2.5	Presence of Fines	Moderate content of red clay					
2.6	Presence of Coatings	None present					
2.7	Extraneous Material	None present					
3.	**PETROLOGICAL CLASSIFICATION**						
3.1	Monomictic	✓	Polymictic				
3.2	Petrological Name	BASALT Black fresh to slightly weathered particles 83% Brown moderately to highly weathered particles 17%					
		Visual Assessment		Quantitative Analysis			✓
3.3	Geological Age						
4.	**PETROLOGICAL DESCRIPTION**						Yes
5.	**SAMPLE REF.**	0002	6. **CERTIFICATE OF SAMPLING**				Yes
7.	**SOURCE**	New Quarry, Pargoose					

CLASSIFICATION AND DESCRIPTION OF AGGREGATE

1.	**AGGREGATE TYPE**						
1.1	Crushed Rock						✓
1.2	Gravel		Uncrushed		Land Won		
			Partly Crushed				
1.3	Sand		Crushed		Marine		
2.	**PHYSICAL CHARACTERISTICS**						
2.1	Nominal Size	20mm					
2.2	Shape	Angular					
2.3	Surface Texture	Rough					
2.4	Colour (sample condition)	Light grey (sample dry)					
2.5	Presence of Fines	Low content					
2.6	Presence of Coatings	None present					
2.7	Extraneous Material	Particles of slag					
3.	**PETROLOGICAL CLASSIFICATION**						
3.1	Monomictic		Polymictic				✓
3.2	Petrological Name	GNEISS 68% SCHIST 28% DOLERITE 3% SLAG 1%					
		Visual Assessment		Quantitative Analysis			✓
3.3	Geological Age						
4.	**PETROLOGICAL DESCRIPTION**						Yes
5.	**SAMPLE REF.**	0003	6. **CERTIFICATE OF SAMPLING**				Yes
7.	**SOURCE**	Underhill Quarry, Bangorshire					

CLASSIFICATION AND DESCRIPTION OF AGGREGATE

1.	**AGGREGATE TYPE**						
1.1	Crushed Rock						
1.2	Gravel	✓	Uncrushed	✓	Land Won		
			Partly Crushed				
1.3	Sand		Crushed		Marine	✓	
2.	**PHYSICAL CHARACTERISTICS**						
2.1	Nominal Size	20 mm					
2.2	Shape	Rounded to subangular					
2.3	Surface Texture	Smooth					
2.4	Colour (sample condition)	Dark greyish brown (sample wet)					
2.5	Presence of Fines	Low content					
2.6	Presence of Coatings	None present					
2.7	Extraneous Material	None present					
3.	**PETROLOGICAL CLASSIFICATION**						
3.1	Monomictic		Polymictic				✓
3.2	Petrological Name	FLINT 82% SANDSTONE 11% QUARTZITE 4% SHELL 3%					
		Visual Assessment		Quantitative Analysis			✓
3.3	Geological Age						
4.	**PETROLOGICAL DESCRIPTION**						Yes
5.	**SAMPLE REF.**	0004	6. **CERTIFICATE OF SAMPLING**				Yes
7.	**SOURCE**	River Estuary, Borchester					

Physical tests:	
(a) Aggregate grading	BS 882: 1983 BS 812: Part 103: 1985 ASTM Designations C33 and 136
(b) Aggregate shape, angularity, sphericity, roundness, surface texture	BS 812: Part 105: 1989/90
(c) Relative density, bulk density, unit weight	BS 812: 1975 ASTM Designations C29 and 127
(d) Water absorption	BS 812: 1975 ASTM Designations C127 and 128
(e) Aggregate shrinkage	BRS Digest 35
Petrographic examination	ASTM Designation C295
Mechanical tests:	
Strength	BS 812: Part 112: 1990
(a) Aggregate Impact Value	
(b) Aggregate Crushing Value	BS 812: Part 110: 1990
(c) Ten Percent Fines Value	BS 812: Part 111: 1990
(d) Franklin Point Load Test	Franklin (1970)
(e) Schmidt Rebound Number	Duncan (1969)
Durability	BS 812: Part 113: 1990
(a) Aggregate Abrasion Value	
(b) Aggregate Attrition Value	BS 812: 1943
(c) Los Angeles Abrasion Value	ASTM Designation C131
(d) Polished Stone Value	BS 812: Part 114: 1989
(e) Slake Durability Value	Franklin 1970
(f) Sulphate Soundness	ASTM Designation C88
Chemical tests:	
(a) Chloride content	BS 812: Part 117: 1988
(b) Sulphate content	BS 812: Part 118: 1988
(c) Organic content	BS 1377
(d) Adhesion Tests	Road Research Laboratory 1962

Appendix B: Interview Questions

COMMUNITY

1a. Could you please describe the purpose/or mandate of the North Nechako Bench Residents Association?
1b. Why did you volunteer to participate in this interview?
1c. What interest do you have in this research (as described)?

2. Why was it established and to what degree has it served it's purpose in the area?

3. How would you describe your relationship with the aggregate producers in the City?

4. How would you describe your relationship with the City of Prince George with respect to addressing community land use concerns?

5a. Could you describe some of your association's successes here in Prince George?
5b. What are the greatest sources of frustration in terms of meeting your mandate?

6. How would you propose to eliminate or reduce this frustration?

7a. Do you consider sand and gravel vital resources to the provincial/local economy? If yes, in what ways (employment, royalties, construction)?
7b. Should resources close to the demand centres be exploited first?

8 Do you feel that there is an adequate quantity of aggregate resources available in Prince George to meet future needs?

9a. Do you feel that there is an effort in the City to involve the community in the planning and development of sources of aggregate in the City?
9b. How could this effort be improved?

10. What can you identify as the greatest shortfalls in terms of regulating the approval and operation of extractive sites within the City of Prince George?

11. What role do you see the Official Community Plan as adopting in terms of the planning and management of aggregate resources?

12. From a community perspective, could the OCP be used better to address the concerns of residents and producers?

13. Who do you think should management aggregate resource extraction; the province or local government.

14. How should this control best be expressed? (policy/regulation/guidelines/delegation of power: define & describe to subject).

15. What do you see as the most pronounced impacts associated with sand and gravel extraction in your community?

16. What are the results of these impacts upon the environments (natural features/wildlife/cultural) in which they occur?

17. How do you feel about the disturbance of landscapes as a result of extractive operations?

18. To what degree is the reclamation of these areas an issue amongst the city, operators and the community?

19a. Is reclamation an important issue to you?
19b. When and how should it occur?
19c. Do you see a role for the community in terms of participating in reclamation efforts and decisions?

20. To what degree are you willing to accept tradeoffs (disturbance, for a say in reclamation strategies) in terms of permitting this industry to operate in your community? That is, if you were assured of participating in the establishment of end landuses post mining operation and of progressive reclamation throughout the lifetime of the pit, would you be more willing to permit this activity in your area?

21. Would you be in support of protecting identified aggregate resource reserve areas for future mining opportunities? Why?/Why not?

22. Would you support an increase in government control over the development rights to aggregate resources?

23. Do you feel that an increase in government control could provide other land owners with greater assurances as to how aggregate resources may be developed in their area?

24. The components of your environment are comprised of numerous social, cultural, economic and natural elements. What components of your environment are you most concerned for at this time in Prince George? Which of these components are the most threatened?

25. What is the most important community issue to you at this time in Prince George?

REGULATORS

1a. Do you consider sand and gravel vital resources to the provincial/local economy? If yes, in what ways (employment, royalties, construction)?

1b. Should resources close to the demand centres be exploited first?

2. Could you describe what interest your agency or office has in the management of aggregate resources?

3. Do you have an expressed direction or mandate as to how aggregate resources should be managed in your jurisdiction.

4a. At the present time, no less than thirteen agencies are involved in administering aggregate resources. Is this management structure effective on a province wide scale?

4b. Do you believe it to be effect with respect to community concerns on aggregate resource issues?

5. Can you identify any particular advantages or disadvantages inherent to having a number of different agencies administering aggregate resources in British Columbia?

6. Would you like to see an official provincial policy on the management of aggregate resources that would provide direction to all agencies involved in the regulation of this resource.

7. With respect to regulating, managing and planning for the mining of aggregate resources, do you see the need for one particular agency to take a lead role on this issue?

8. Which agency do you believe is best suited to appropriately handle such a portfolio?

9. In terms of the local management of aggregate resources, do you believe that more local/municipal control would provide for better management of aggregate resources over the long term (in terms of plan approval, by-law development and monitoring and enforcement of local regulations)?

10. Do you feel that there needs to be a stronger commitment to increased communication and cooperation between provincial agencies and local governments.

11. To what degree do you believe that a shared provincial-municipal control of aggregate resources would be more effective in facilitating efficient administration, and the sound management and planning of aggregate resources?

12. Should it be a matter of provincial interest that the availability of this resource is protected and managed concurrently with competing land uses? Should the province develop a specific policy on the management of aggregate resources in British Columbia?

13. If so, how should this interest be expressed? (policy/regulation/guidelines/delegation of power)

14. What do you see as the most pronounced impacts associated with sand and gravel extraction?

15. What are the results of these impacts upon the environments (natural areas/wildlife/cultural) in which they occur?

16. The 'shadow effect' is a term often used to describe impacts associated with mining that occur off site and at a distance from the actual mining operation, What do you see as the 'shadow effect' associated with sand and gravel extraction? Are there ways to control/minimize these off-site impacts?

17. In terms of the rehabilitation of the disturbed landscape post mining operations, there is a range of options available from complete restoration of the landscape to a level of productivity equal to that prior to mining (slopes/vegetation etc.), to minimal efforts that let the mine area regenerate naturally over time. How important is the rehabilitation of the disturbed landscape to you? What regulatory changes could be made to provide for more opportunities in the rehabilitation of disturbed landscapes in Prince George?

18. What type (if any) of guarantees to the community should be incorporated into reclamation efforts as prescribed in legislation and/or bylaws?

19. How would you describe the quality of aggregate resources in Prince George? Do you believe that this quality will increase, decrease or remain roughly the same in the future?

20. Do you feel that there is an adequate quantity of aggregate resources available in Prince George to meet future needs?

21. Would you be in support of protecting identified aggregate resource reserve areas for future mining opportunities? Why?/Why not?/How should it be done?

22. Would you support an increase in government control over the development rights to aggregate resources?

23. How much local involvement (public participation) do you feel is necessary to address concerns held by the community in the planning and approval process? At what stages of the process should this involvement occur?

24. The environment of Prince George is comprised of numerous social, cultural, economic and natural elements. For each element, what are the most important issues or concerns at this time in Prince George area?

OPERATORS

1a. Do you consider sand and gravel vital resources to the provincial/local economy? If yes, in what ways (employment, royalties, construction)?

1b. Should resources close to the demand centres be exploited first?

2. Do you feel that there is an adequate quantity of aggregate resources available in Prince George to meet future needs?

3. As an operator, you are subject to various requirements from a number of government agencies that regulate your type of operation - What comments would you like to make with respect to the approval process to establish a sand and gravel operation in Prince George?

4. Do you feel that there is too much regulation over this type of industry and if so, how should it be changed if it could?

5. What did you find to be some of the greatest stumbling blocks to obtaining the approval of your operation?

6. How much direct contact did you have with the community in the process of the approval of your operations?

7. Was it helpful? Do you feel that more or less contact would assist in developing aggregate resources in Prince George over the long term.

8. Could you describe the type of relationship your business has with the surrounding community?

9. Could you describe the type of relationship your business has with the City of Prince George?

10. Given the existing regulatory framework over this industry, do you feel that it enables you to compete with the other producers in the City?

11a. How would you describe the state of competition among producers in the city?

11b. How could stronger competition amongst the producers in Prince George be achieved?

12. What types of impacts on the surrounding environment can you identify that are a result of your operation? What measures do you undertake to reduce these impacts and how effective have you found them?

13. Prior to the 'start-up' of your operation, did you have an end land use in mind?

14. Are you now working towards a specific end land use as your operation proceeds?

15. What type of post-mining use for your site do you feel would be most compatible with the surrounding area?

16. Can you describe what type of reclamation efforts you are undertaking or plan to undertake throughout operations and upon completion of extraction?

17. Do you perceive reclamation of the mined land area as an opportunity or as something you are required to do as part of the approval process?

18. Do you believe that an increase in environmental regulation will reduce the availability of aggregate reserves to the consumer? If so, how do you think an adequate supply of aggregate resource reserves may be protected?

19. The 'shadow effect' is a term often used to describe impacts associated with mining that occur off site and at a distance form the actual mining operation, What do you see as the 'shadow effect' associated with your sand and gravel operation? Are there ways to control/minimize these off-site impacts?

20. How would you describe the quality of aggregate resources in Prince George? Do you believe that this quality will increase, decrease or remain roughly the same in the future?

21. Would you be in support of protecting identified aggregate resource reserve areas for future mining opportunities? Why?/Why not?/How should it be done?

22. Would you support an increase in government control over the development rights to aggregate resources?

23. Who do you believe should have more control over the management and planning of aggregate resources - the province or local jurisdictions where mining takes place?

24. Your operation is part of an environment composed of numerous social, cultural, economic and natural components - As an operator, what components or elements of the environment do you have a concern for in the operation of your facility and in the reclamation of the disturbed landscape from the standpoint of:

Letter of Informed Consent

Name:

Address:

Phone #

I understand that my participation in this interview is completely voluntary and that my responses will kept completely confidential. I know that I have the ability to stop the interview at any time and need only answer those questions I feel comfortable answering. This consent form cannot be linked to any questionnaire and the questionnaire does not have any identifying marks which can link to the form or responses. I understand that the information obtained from the interview will be used in a thesis report however the report will not identify the responses of individuals. I understand the data obtained through this interview will be included in the thesis project and that the above criteria will apply with regard to the use of the data. All the documentation from the interview will be destroyed once the project is completed.

---------- ----------

Signature Date

Appendix C: Survey Questionnaire

THE UNIVERSITY OF NORTHERN BRITISH COLUMBIA

Faculty of Natural Resources and Environmental Studies
P.O. Bag 1950, Station A
Prince George, B.C.
Canada V2L 5P2
Tel.: (604) 960-5830
Fax: (604) 960-5795

UNBC

July 24, 1995

Dear resident,

Thank you for taking the time to participate in research being conducted through the University of Northern British Columbia. My name is Brian Bowman and I am presently involved in completing my Masters Degree at UNBC. With assistance from the City of Prince George Planning Department, I am conducting a survey of residents with respect to sand and gravel extraction in Prince George.

Attached is a short questionnaire with a series of questions addressing issues related to planning for gravel removal, sand and gravel operations, reclaiming lands impacted by gravel removal and gravel operations that may exist in your vicinity. The purpose of this exercise is to gather information that will contribute to ongoing research examining the local management of sand and gravel resources in British Columbia. Your participation in this survey will provide important information related to community defined resource management efforts 'as you see them' in your community.

Completion of the questionnaire is completely voluntary and your response is entirely anonymous. All you need to do is take a few brief moments to mark down your responses, enclose the questionnaire in the postage-paid self addressed enveloped included with this package and return it to your nearest mail deposit. Your participation in this research is appreciated.

Sincerely,

Brian Bowman, B.E.S.
UNBC, Faculty of NRES

CITY OF PRINCE GEORGE
"B.C.'s NORTHERN CAPITAL"
1100 PATRICIA BOULEVARD, PRINCE GEORGE, B.C. V2L 3V9
TELEPHONE: (604) 561-7600

INCORPORATED A.D. 1915

July 20, 1995

Dear Resident,

The City of Prince George is supportive of this effort to gain understanding of local resident's opinions and perceptions respecting the operation of sand and gravel operations within the City of Prince George.

The results of this survey may prove to be a valuable resource in accessing the management of aggregate resources. The Development Services Department encourages that you respond to the questionnaire and let your opinions be known.

Sincerely,

Peter Bloodoff
Director of Development Services

JL/sc[Jason]Ltr-Resident-July20-95

Post-it® Fax Note 7671	Date July 20	# of pages ▶ 1
To Brian Bowman	From Peter Bloodoff	
Co./Dept.	Co.	
Phone #	Phone # 561-7679	
Fax # 960-5539	Fax #	

Thank you for taking the time to complete this questionnaire. Your participation in this research will assist in improving the management of our sand and gravel resources in conjunction with community concerns regarding their removal. If you feel there is anything else you would like to add to the research feel free to include it in the space provided below.

Please return your completed questionnaire in the postage-paid self addressed envelop to:

Brian Bowman
Faculty of Natural Resources and Environmental Studies
UNBC, 3333 University Way
Prince George, British Columbia
V2N 4Z9

SAND AND GRAVEL EXTRACTION IN YOUR COMMUNITY

A Survey of Residents from the City of Prince George

Brian Bowman
Faculty of Natural Resources and Environmental Studies
UNBC, 3333 University Way
Prince George, B.C.
V2N 4Z9

PLANNING FOR EXTRACTION

We'd like to begin with some of the management aspects involved in the planning and permitting of sand and gravel extraction in Prince George. With an 'x', please check the box which represent your response to each question or statement below .

Q-1. Are you satisfied with the planning and permitting of sand and gravel operations in Prince George?

[ ] Yes [ ] No [ ] Indifferent

Please provide below any comments you feel would assist in improving this process.

Q-2 Do you think sand and gravel extraction should be conducted within the City of Prince George?

[ ] Yes [ ] No

If you answered 'No' above, where do you feel it should be extracted?

Q-3. Listed below are some of the factors associated with the planning and permitting of sand and gravel operations. Please indicate your feelings for each with respect to its importance in the planning and permitting of sand and gravel extraction. Please circle the appropriate number in the identified columns. Feel free to list additional concerns in the space provided below the list.

Concern	Not Important	Somewhat Important	Very Important	Extremely Important
government agency cooperation	0	1	2	3
information available to public	0	1	2	3
public input in approval process	0	1	2	3
information required from applicant to permit pit	0	1	2	3
review of applications by appropriate agencies	0	1	2	3
land use conflict considerations	0	1	2	3

RESIDENT INFORMATION

Finally, we would like to ask you a few questions about yourself for the statistical analysis.

Q-21. Are you:

[ ] male [ ] female

Q-22. Which age group do you presently fall into?

[ ] 15 and under
[ ] 16 to 25
[ ] 26 to 35
[ ] 36 to 45
[ ] 46 to 55
[ ] 56 to 65
[ ] 66 and above

Q-23. How long have you been a resident of Prince George?

_____yrs.

Q-24. What is the highest level of education you have completed?

[ ] No formal education
[ ] Grade School
[ ] High School
[ ] College
[ ] Technical School
[ ] University undergraduate
[ ] Graduate School

Q-25. Finally, which of these broad categories describes your total household income before taxes in 1994?

[ ] Less than $5,000
[ ] $5,000 to $14,999
[ ] $15,000 to $24,999
[ ] $25,000 to $34,999
[ ] $35,000 to $44,999
[ ] $45,000 to $54,999
[ ] $55,000 or more

Q-5. Has your residence been impacted in any way by the operation of a sand and gravel operation near you residence?

[ ] Yes [ ] No

Q-6. If you answered Yes to Q-5 please describe the impact(s) in the space below. If you answered 'No' please proceed to Q-7.

_____
_____
_____

Q-7. If you have any suggestions as to how to reduce or eliminate the(se) impact(s) please identify them in the space provided below.

_____
_____
_____

Q-8. Do you feel that you could live near a sand and gravel operation without being negatively impacted if improved management measures were developed and enforced within the City of Prince George?

[ ] Yes [ ] No [ ] Uncertain

Q-9. Please complete the statement below by circling the appropriate number with respect to how you feel existing operators in Prince George are managing their operations.

Sand and gravel operators in Prince George are:

1 performing inadequately
2 performing poorly
3 performing well
4 performing very well
5 uncertain how they are performing
6 other, please comment _____
_____

SAND AND GRAVEL IN YOUR NEIGHBOURHOOD

Now, we'd like to ask you a few questions with respect to sand and gravel extraction and your neigbourhood.

Q-14. Have you ever purchased sand or gravel for personal projects from a producer within Prince George?

[ ] Yes [ ] No

Q-15 If you have purchased sand and gravel before, did you find that the price was reasonable?

[ ] Yes [ ] No

Q-16. For what purposes was the material used?

_____
_____
_____

Q-17. To what degree do you feel sand and gravel extraction has had a positive social, economic and environmental impact on the community in which you live? Please check a degree of impact for each impact listed on the left in the Table below.

Impacts	High Positive Impact	Some Positive Impact	Low Positive Impact	No Positive Impact
Social				
Economic				
Environmental				

Q-18. Could you please describe the positive impacts you have experienced?

_____
_____
_____

RECLAIMING SAND AND GRAVEL PITS

nNow we'd like to ask you some questions about restoring areas impacted by sand and gravel extraction. The landscape from which sand and gravel is removed is generally entirely disrupted by operations. The process by which this disturbance is remedied is referred to as reclamation. Reclamation returns the disturbed landscape to a productive state.

Q-10. Please complete the statement below by circling the appropriate number with respect to how you feel about reclamation efforts in Prince George in relation to sand and gravel extraction.

Reclamation efforts in Prince George are:

1 unacceptable
2 poor
3 good
4 excellent
5 don't know
6 other: please comment_____
_____

Q-11. Reclamation can be comprised of a number of activities, each of which can return the landscape to varying stages of productivity. The list below identifies activities associated with reclamation. Please circle what you feel to be the importance of each activity with respect to reclaiming lands impacted by sand and gravel extraction in Prince George.

Activity	Not Important	Somewhat Important	Very Important	Extremely Important
reducing steep slopes	0	1	2	3
defining an end land use	0	1	2	3
ongoing reclamation	0	1	2	3
seeding & fertilizing	0	1	2	3
tree planting	0	1	2	3
screened buffers	0	1	2	3
wildlife enhancement	0	1	2	3
post mine site maintenance	0	1	2	3

SAND AND GRAVEL OPERATIONS

Now, we'd like to ask you about some of the operational impacts associated with the removal of sand and gravel in Prince George.

Q-4. Listed below are some of the potential issues associated with extractive operations. Please indicate the importance of each issue to you in the extraction of sand and gravel by circling the appropriate number in the identified columns. Feel free to list additional issues or concerns in the space provided below the list.

Concerns	Not Important	Somewhat Important	Very Important	Extremely Important
tree removal	0	1	2	3
pedestrian safety	0	1	2	3
appropriate signage	0	1	2	3
property values	0	1	2	3
home resale problems	0	1	2	3
hours of operation	0	1	2	3
unsightliness	0	1	2	3
loss of wildlife	0	1	2	3
truck traffic	0	1	2	3
noise	0	1	2	3
dust	0	1	2	3
fencing	0	1	2	3
access points to pit	0	1	2	3
road damage	0	1	2	3
lifestyle degradation	0	1	2	3
size of operations	0	1	2	3
smell	0	1	2	3
health risks	0	1	2	3
buffers between uses	0	1	2	3
erosion	0	1	2	3
lower well water level	0	1	2	3
watercourse sedimentation	0	1	2	3
reclamation	0	1	2	3
duration of operations	0	1	2	3
the environment	0	1	2	3

_____
_____
_____

Q-12. Reclamation can offer opportunities to communities in obtaining desirable land uses for their area. Listed below are a variety of land uses for which sand and gravel operations can be reclaimed. Please identify which uses you feel to be most desirable for lands which need to be reclaimed in Prince George.

Use of Land	Not Desirable	Somewhat Desirable	Very Desirable	Extremely Desirable
agricultural uses	0	1	2	3
recreational uses	0	1	2	3
wildlife habitat	0	1	2	3
forestry uses	0	1	2	3
industrial uses	0	1	2	3
fish and water fowl habitat	0	1	2	3
residential uses	0	1	2	3
commercial uses	0	1	2	3
urban use	0	1	2	3

Q-13. Listed below is the same list of land uses as in Q-12. Please identify which uses you feel to be most desirable for lands within and around you neighbourhood.

Use of Land	Not Desirable	Somewhat Desirable	Very Desirable	Extremely Desirable
agricultural uses	0	1	2	3
recreational uses	0	1	2	3
wildlife habitat	0	1	2	3
forestry uses	0	1	2	3
industrial uses	0	1	2	3
fish and water fowl habitat	0	1	2	3
residential uses	0	1	2	3
commercial uses	0	1	2	3
urban use	0	1	2	3

Appendix D: Sample Soil Removal File Record Sheet

Table ##: Sample Aggregate Extraction Activity Sheet

Permit file no.: SR-####	
District Lot No. : ###	
Name: Pennsylvania Railroad	
Status: Active	Material: Gravel
Quanitity Approved: 2,100,000m3	Site Area: 7.2 hectares
Operation: extraction/processing	Operating Hours: 7:00-9:00
Maximum Depth of Extraction: 50m	Average Depth: 28m
Finished Slopes: 2:1 cut slopes	
Erosion Control: replanting and landscaping	
Drainage Control: surficial/positive gravity	
Dust Control: paved haul roads	
Past Land Use: n.a. (designated F in OCP)	Future Land Use: industrial
Surrounding Land Uses: F-ON-MH-ML	
Reclamation Bond: n.a.	
Other Comments: significant visual impact...	
Permit issued: Yes	

Appendix E: Soil Removal File Review Data

File Review Summary

Files Reviewed	47
Permits Approved under by-law #3000	47
Permits Denied	14
Active Pits	25
Pits Exhausted with Reclamation	7
Pits Exhausted no Reclamation	11
Abandoned Pits	1
n/a	3
Pit Size Range (ha)	1 to 10
	12 to 50
Quantity approved 1979 to present (cubic metres)	49,696,000
Quantity approved among active pits (cubic metr	44,246,000

Hours of operation		
daily average		11hrs
range		6am to 9am
Mitigation Indicated		counts
Slopes	3 to 1	4
	2.5 to 1	1
	2 to 1	8
	1.5 to 1	1
Erosion Control		
	seeding	8
	terracing and sloping	3
	seeding and landscaping	2
	reroute drainage	2
Drainage Control		
	sloping/ditich	5
	pooling ponds	4
	natural percolation	2
Dust Control		
	water	6
	calcium chloride	6
	oil	1
	paving	1

Predominant Surrounding Land Use Designations
All Files

designation rank	designation	occurance on bdy
1	ON	34
2	F	26
3	RL	19
4	RU	15
5	OP	11
6	MH	7
7	OA	7
8	RM	5
9	PW	3
10	PU	3
11	ML	2
12	PS	2
13	RH	1
14	CL	1
15	PL	1
16	PI	1

Land area disturbed (ha)	
active	312
exhausted reclaimed	51
exhausted not reclaimed	150
abandoned	29
temporary	29

Georgraphic concentration of activity (tonn. approved)	
Nechako Road South	60 to 62 %
Nechako Road North	12 to 14 %
Prince George East	13 to 14 %
College Heights	6 to 7 %
Hart Highway	3%

Appendix F: Chi-Square Tests Sex and Education

Chi-Square Contingency Tests for Responses of Sex and Age						
n=32						
Ho: The observed sample is derived From the population						
sex		female	male			
	expected	16	16			
	observed	10	22			
	(O-E) sq	36	36			
	/E	2.25	2.25			
	chi sq=	4.5				
	df	1				
	alpha	0.05				
	reject	>3.841				
Reject: The observed sample does not come from the population						
Ho: The observed sample is derived form the population						
education		less highschool	highschool	les/colle	university	
	expected	9	3.7	7.04	5.4	
	observed	1	10	13	8	
	(O-E) sq	64	39.6	34.8	6.76	
	/E	7.1	10.7	4.9	1.25	
	chi sq=	23.95				
	df	3				
	alpha	0.05				
	reject	>7.815				
	Reject: The observed sample does not come form the population					

Appendix G: Sample Impact Checklist

TABLE 4. *Continued*

Environmental Category	Will the Project Result in Yes	Maybe	No	Comments	Will the Cumulative Impacts of Projects Result in Yes	Maybe	No	Comments
• impact to wilderness qualitites and open-space qualities?								
• impact to or destruction of wetlands?								
• impact to Special Management Areas (SMAs)?								
Recreation:								
• impact to hunting, fishing, boating, swimming, camping and hiking, picnicking and holiday resorts?								
Aesthetics:								
• impact to scenic views and vistas?								
• impact to landscape design?								
• impact to unique physical features?								
• impact to parklands and reserves?								
• impact to monuments?								
• presence of misfits (out of place)?								
Archaeological sites:								
• impact to or destruction of historical, archaeological, cultural and paleontological sites or objects?								
Health and safety:								
• health hazard or potential health hazards?								
• exposure of people to potential health hazards?								
• risk of accidents due to explosion, release of oil, radioactive materials, toxic substances, etc.?								
Cultural patterns:								
• change existing cultural patterns (or life style)?								
Local services:								
Need for new or altered services in any of the following areas:								
• health care?								
• police?								

(continued)

TABLE 4. *Continued*

Environmental Category	Will the Project Result in Yes	Maybe	No	Comments	Will the Cumulative Impacts of Projects Result in Yes	Maybe	No	Comments
• fire protection?								
• education?								
• churches?								
• child care?								
• other services?								
Public utilities:								
Need for a new or alterations to the following utilities:								
• electricity?								
• natural gas?								
• potable water?								
• wastewater treatment and disposal?								
• stormwater control?								
• solid waste collection and disposal?								
• communication systems?								
• transmission pipelines?								
• other utilities?								
Population:								
• alteration of location or distribution of human population in the area?								
• change to demographic characteristics in the area?								
• change to housing and household?								
Economic:								
• adverse effect on local or regional economy?								
• changes in per capita income?								
• changes in the standard of living?								
• employment?								

(continued)

Appendix H: Sample Impact Rating Criteria

Table 1. Impact assessment rating criteria	
Biophysical	Socioeconomic
• A major impact was defined as one affecting a whole stock or population of a species in sufficient magnitude to cause a decline in abundance and/or change in distribution beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return that population, or any populations or species dependent upon it, to its former level within several generations.	• A major impact was defined as either one of long duration (lasting several generations) or one affecting an entire definable group of people in significant magnitude to cause a significant change in economic, physical or psychosocial well-being or in long established activity patterns that would not return to pre-project levels or patterns within several generations.
• A moderate impact was defined as one affecting a portion of a population that results in a change in abundance and/or distribution over one or more generations of that portion of the population or any population dependent upon it, but does not change the integrity of any population as a whole; it may be localized.	• A moderate impact was defined either as one which is of medium-term duration (one which affects one or two generations and/or the portion of the population dependent upon it) or one which affects a moderate portion of the population without affecting the integrity of the population as a whole.
• A minor impact was defined as one affecting a specific group of individuals in a population at a localized area and/or over a short period (one generation or less), but not affecting other trophic levels or the integrity of the population itself.	• A minor impact was defined as either one of short-term duration or affecting a specific group of people in a localized area but not necessarily affecting the integrity of the entire group itself.
• A negligible impact was one affecting the population or a specific group of individuals at a localized area and/or over a short period in such a way as to be similar in effect to small random changes in the population due to environmental irregularities, but having no measurable effect on the population as a whole.	• A negligible impact was one of either very short duration or one which affects a small group of people or which occurs in a localized area in a manner similar to small random changes due to extraneous irregularities, but having no measurable effect on the population as a whole.