COMMERCIALLY VIABLE INDOOR MARIHUANA GROWING OPERATIONS IN BRITISH COLUMBIA: WHAT MAKES THEM SUCH A SERIOUS ISSUE?

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ABSTRACT

While cases of large-scale illicit indoor marihuana production in British Columbia have become commonplace in media reporting, there is little detailed information the many facets of harm posed by this illegal industry. This article brings together what is currently known about the impact of the marihuana production industry to answer some of the most pressing questions facing policy makers, prosecutors, law enforcement, and the general public on this topic. With an emphasis on those growing operations intended for profit within the illegal drug trade, this article demonstrates the seriousness of this increasingly large, sophisticated, and pervasive type of criminal activity.

Keywords: Marihuana; Drug Production; Health Risks; Social Problems; Illegal Drug Markets; Commercial Viability

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Len Garis has served as the Fire Chief for the City of Surrey since 2001, when he was promoted from his previous job as Assistant Fire Chief. He has undertaken extensive training related to fire fighting and emergency response. In addition to a long list of previous awards, in 2005, he received the Lieutenant Governor of British Columbia's award for Public Safety for his Electrical and Fire Safety Inspection Initiative. He has worked to develop innovative techniques to detect and eliminate illegal marihuana and chemical drug production sites.

INTRODUCTION

Media reports of law enforcement efforts targeted at marihuana growing operations or 'grow ops' in British Columbia has come to be so common in recent years we can appreciate why many people might have started taking them for granted. Indeed, any new media report about grow ops almost seems like old news. Further, while these reports will from time to time give attention to the violence, organized crime activity, and other harms associated to one aspect or another of marihuana industry in the province, few of them really get into the details. Consequently, most British Columbians might have some sense that marihuana growing operations are a problem, but they do not get a level of the information that would be helpful to fully appreciating why grow ops in British Columbia are an extremely serious matter.

The issue of grow ops is also commonly linked to the very public and long-standing debate about the de-criminalization of marihuana, with its adjoining suggestions that marihuana is a benign drug, and that organized crime and the associated violence would largely disappear if government authorities would simply remove the criminal status of marihuana possession and production. Accordingly, attention regarding the seriousness of

the matter of marihuana grow ops is often overshadowed by arguments that the only reason marihuana grow ops are a problem is because of the way the government has chosen to look at them.

With the above in mind, and in the spirit of making more detailed information available, the purpose of this report is to call attention to what we have come to know about the harms associated to marihuana grow operations. Further, the purpose is to provide information about the number and commercial viability of grow operations so as to give the reader an appreciation that growing operations in British Columbia are not primarily so called "ma and pa" personal use operations, but rather highly profitable investments collectively contributing to a multi-billion dollar and largely export illicit drug industry.

The report is organized in a question and answer format. This format was selected to provide straightforward answers to some of the most pressing questions related to marihuana production that face policy makers, prosecutors, law enforcement, and the public as a whole. The report looks first at why marihuana use should be of concern to British Columbians. The question is relevant of course, because there would be less reason to care about growing operations if the product being produced was harmless. Subsequent sections focus specifically on questions related to indoor marihuana cultivation, first addressing the potential harms, and then providing information on the nature of the marihuana industry. Through the answers to following questions, we hope to emphasize why indoor marihuana growing operations should be considered an issue of great concern, and one which requires further effort to properly address.

WHAT ARE THE HARMS OF MARIHUANA USE?

Through a recent review of the current literature on marihuana use (Diplock, Cohen, and Plecas, 2009), we concluded that marihuana poses some considerable risks to users. There are a number of serious risks to users of the drug, specifically when it is smoked. Those risks related to a user's health are perhaps of most concern. Smoking marihuana can cause considerable harm to the lungs and airways. The inhalation of marihuana smoke can

lead to common respiratory ailments such as coughing on most days, wheezing, shortness of breath after exercise, nocturnal chest tightness, chest sounds without a cold, early morning phlegm and mucus, and acute and chronic bronchitis which may affect as much as 40% of the user population (Moore et al., 2005). Additional harms can occur to the user's immune system, potentially inhibiting the ability of the lungs to defend against foreign pathogens (Shay et al., 2003). Currently, the link between marihuana use and cancers has not been confirmed by research, but since marihuana smoke contains many of the same carcinogens as tobacco smoke, the plausibility of an association should be a concern (Mehra, Moore, Crothers, Tetrault, & Fiellin, 2006). Additional health concerns such as heart problems and threats to human reproduction are not common among marihuana users, but the risks should not be dismissed (Diplock et al., 2009).

Marihuana use is associated to risks related to the overall lifestyle of users. The development of psychosis and later schizophrenia has recently been recognized as a serious risk for a small proportion of those who use marihuana (Arendt, Rosenberg, Foldager, Perto, & Munk-Jorgensen, 2005; Degenhardt & Hall, 2006). It is unknown whether marihuana is a causal factor for these types of mental illness or a trigger for those already predisposed, but there is a general consensus that the use of the drug is associated to these mental afflictions (Raby, 2009). Dependency is also a real risk for some users (Hall, 2006; Looby & Earlywine, 2007). Academic performance and social development appear to be negatively affected by marihuana use (Lynskey & Hall, 2000), but the literature did not confirm a causal role for marihuana use in the lack of future success of young people (Schuster, O'Malley, Bachman, Johnson, & Schulenberg, 2001). Furthermore, findings regarding the drug's ability to cause short-term impairment, specifically to negatively affect driving ability (Bedard, Dubois, & Weaver, 2006), should be a concern to users and others. All of the harms discussed may be compounded by the fact the marihuana users have an increased likelihood of continuing on to other illicit drugs (Fergusson, Boden, & Horwood, 2006; Lynskey, Vink, & Boomsma, 2006).

While the most serious of the harms discussed here are not experienced by the majority of users, marihuana use is associated to health problems that range from those that might be considered minor to those that are life altering. It is important to recognize

that marihuana is neither harmless, nor is it particularly dangerous to the majority of users. However, given that marihuana is a widely used substance, it must be acknowledged that the lives of a small proportion of the population will be seriously disrupted by marihuana use.

WHAT ARE THE POTENTIAL ECONOMIC COSTS OF MARIHUANA USE?

The risks associated to marihuana use are likely to translate into economic costs in terms of health care expenditure and loss of productivity. Given that marihuana is commonly used in British Columbia, with approximately 16.8% of the population of those 15 years old and over using marihuana in a given year (Stockwell, Sturge, Jones, Fischer, and Carter, 2006), even if only a small portion of the user population is afflicted by serious health problems, the associated costs put increased pressure on our health care system and consequently on tax payers. Therefore, the harms of marihuana use cannot simply be understood in terms of potential risks to only the users themselves, but instead that the burden of marihuana use is faced collectively by all British Columbians.

Despite a belief among many users that the effects of marihuana smoking are benign compared to the widely accepted consequences of tobacco use, experts emphasize that marihuana smoking should be viewed as at least as harmful as tobacco, specifically to the lungs (Taylor & Hall, 2003). According to Bridge and Turpin (2004), tobacco smoking cost British Columbians $525 million annually in 2002, and an additional $904 million in productivity losses for the 542,240 tobacco smokers in the province. Using the 16.8% figure reported by Stockwell et al. (2006) in conjunction with population statistics for 2004 (BC Stats, 2009)[2], we can approximate the number of marihuana users in the province during that year at 580,541. That number is even greater than the number of tobacco smokers in 2002 reported by Bridge and Turpin (2004). Although, the average marihuana user smokes less regularly than the average tobacco user, some researchers (Aldington et al., 2007) suggest that each marihuana joint can have the obstructing effect of five tobacco cigarettes. Other research indicated that marihuana smokers generally show comparable

[2] There were 3,455,602 British Columbians aged 15 and over in 2004.

respiratory symptoms to tobacco smokers, but with much shorter smoking histories (Moore et al., 2005). In addition to some of the health consequences that marihuana smoking shares with tobacco smoking, marihuana use may be a factor in psychosis and later schizophrenia. The increased costs for mental health care and loss of productivity from these mental illnesses have the potential to raise the annual costs associated of marihuana use above those projected for tobacco smoking.

Because many marihuana users are also tobacco smokers and some may also partake in other unhealthy choices, it is difficult to estimate the extent to which marihuana use alone has put an economic burden on British Columbians. Despite this difficulty, it is apparent that marihuana use does put an added economic strain on British Columbia's health care system, tax payers, and the province's legitimate economy as a whole, potentially in the range of hundreds of millions of dollars. This is of particular concern since the illegal marihuana production industry is fuelling these problems while remaining free from taxation.

WHAT ARE THE DANGERS OF INDOOR MARIHUANA PRODUCTION?

The illicit nature of marihuana growing ultimately leads those who undertake in these operations to hide their activities from the authorities and the public. In order to avoid detection, along with other reasons, marihuana growing operations are often located indoors, in homes and other buildings that require substantial changes to make the environment suitable for growing. Although not all marihuana grow ops are large and sophisticated endeavours,[3] those that operate indoors with the intention of making commercial profit require large amounts of energy (commonly electricity), structural and mechanical changes to the site, pesticides, herbicides, and fertilizers, as well as measures to protect the site from detection. The changes made to facilitate the growing of marihuana involve practices that generally require specific training, certification, and inspection to ensure proper function and safety. The illicit and clandestine nature of marihuana growing

[3] According to estimates of the prevalence of marijuana growing operations in Quebec for 2000-2001 by Bouchard (2007), approximately 20% of indoor marihuana growing operations (both soil-based and hydroponic) involved 20 plants or fewer.

operations prevents the regulation and maintenance of safety standards within these sites. Furthermore, when a marihuana growing site is located within a residential neighbourhood, the risks associated to errors in or abuses of construction, ventilation, chemical usage, waste disposal, plumbing, electrical work, and security are assumed by others without their knowledge and consent.

To determine the nature and extent of the dangers of indoor marihuana growing operations, we elicited the help of a focus group of professionals in the field of environmental consulting and industrial hygiene. According to the focus group, who have seen marihuana grow ops first hand and have been responsible for the remediation process (Surrey Fire Service focus group, July 10, 2009), growing sites have one type of contamination or another in every case. The focus group identified improper ventilation in approximately 90% of growing sites, leading to high levels of relative humidity around 80%. Due to the high levels of moisture within grow ops, individuals within the site are often ultimately exposed to mold.

Growers may also try to improve the yield of their operation by using carbon dioxide (CO_2) and chemicals (Surrey Fire Service focus group, July 10, 2009). CO_2 is used to increase the rate of growth and tolerance to higher temperatures in growing sites. Exposure to higher than normal levels of CO_2 can be dangerous, and the problem may be further compounded when the increase of the gas coincides with displacement of oxygen (O_2). Chemical residues are almost always left behind by marihuana growing operations (Surrey Fire Service focus, July 10, 2009). Fertilizers are a common cause of these residues, as are herbicides and pesticides in more advanced grow ops. According to the focus group (Surrey Fire Service focus group, July 10, 2009), these chemicals are often found in high concentrations at growing sites, along with signs of spillage and on-site dumping. In testing residual pesticides in former growing operations, Blair and Wedman (2009) found the presence of 15 different pesticides used in 139 homes. The average levels found for the two most common pesticides were just below and just at the acceptable safe level, although the maximum levels found for most chemicals found were above a safe level (Blair & Wedman, 2009).

Because indoor marihuana grow ops require a great deal of electricity to power the typically 1000 watt bulbs used to provide the plants with light, these operations are susceptible to serious electrical hazards including fire. Garis (2008) outlined many of the electrical hazards common to marihuana growing operations that can increase the risk of fires. These included inadequate electrical protection of fuses and circuit breakers, improper installation of electrical systems, failure to enclose electrical by-passes, and improper monitoring of grow sites (Garis, 2008). Improper installation of electrical systems puts those within the grow site at risk of shock and electrocution, especially considering the high likelihood of the presence of water (Garis, 2008). Electrical by-passes are only one of many electrical hazards that inflate the risk of residential fires in marihuana growing operations to what Plecas, Malm, and Kinney (2005) estimated was 24 times as great as that faced by a regular home[4].

The danger presented to those living within marihuana grow ops is evident, as many of the previously described hazards are present in the vast majority of cases. Of particular concern is that the previously discussed dangers such as high humidity, increased CO_2 levels, high energy light systems, and improper and unregulated construction and electrical work make marihuana grow sites much more hazardous to children than a typical home. Of course, it is difficult to estimate the true number of children who live in and around marihuana growing sites on a daily basis, but it is evident that children have been exposed to the potential harms of marihuana production (Plecas et al., 2005).

These dangers are not limited to only the grow operators, but pose a serious threat to neighbours and first responders. Contamination from the chemicals used in the growing process is a major health concern for people in neighbouring properties. According to the focus group (Surrey Fire Service focus group, July 10, 2009), there is a real risk of drinking water contamination in the neighbourhood as a result of back flushing. Also, the spilling and dumping of chemicals can result in the migration of substances into neighbouring

[4] This figure assumes that those growing operations that did not come to the attention of police had the same likelihood of catching fire as those that did. However, it can be argued that the vast majority of growing operations that caught fire would have been discovered by police, and therefore, the actual risk is much lower. We still maintain that even if only one fifth of all marihuana growing operations came to the attention of police, the probability of a growing operation catching fire is nearly five times as great as that faced by a normal residence.

properties, which would require remediation to eliminate the danger. All of the aforementioned hazards present serious risks to law enforcement, fire crews, and other first responders who may enter the residence without prior knowledge that a grow op exists. Also, there is some indication that booby traps are sometimes (although uncommonly) used by grow operators to dissuade entrance into the grow site, posing another threat to emergency responders (Garis, 2008; Plecas et al., 2005; Surrey Fire Service focus group, July 10, 2009).

WHAT PROBLEMS DO MARIHUANA GROWING OPERATIONS CAUSE IN COMMUNITIES?

In addition to the health risks identified above, there is also the potential for marihuana production to cause social problems to communities. These problems include attracting and supporting criminal activity, lowering property values, increasing living costs, and impacting the environment. These problems may be of most concern for those living within close proximity to marihuana growing operations, but the negative effects of marihuana production influence all British Columbians.

Currently, there are no studies that investigate whether the presence of a marihuana growing operation causes a rise in other types of crimes in the surrounding neighbourhood. However, based on the findings of Plecas et al. (2005), between 1997 and 2003, 9% of all investigations of marihuana production started while responding to another crime, and another 3% began as a result of serving a warrant. These findings indicate that other crime does occur around marihuana growing operations, but whether the presence of the operations is a significant contributing factor for other crime is unknown. Despite a lack of empirical evidence that grow ops increase criminal activity, it is important to note that police sources (Royal Canadian Mounted Police, 2007) insist that marihuana grow ops are a major source of funding for organized criminal groups, many of which use violence to protect their criminal interests.

With organized crime group competing against each other within the drug production industry, it is conceivable and indeed probable that a marihuana growing

operation might be the target of a criminal attack. The term 'grow rip' has been used to describe the breaking and entering of a residence which houses a marihuana grow op to either steal or destroy the product of a rival. A brief search of the Canadian Newsstand database for newspaper articles on 'grow rips' allowed for the identification of six individual cases of this type of home invasion between January and May of 2009 in British Columbian newspapers. The cases described in these articles involved groups attacking homes that were found to contain marihuana plants (Baker, 2009a; Freeman, 2009; Hooper, 2009; Zytaruk, 2009a;b;c). Common in these accounts was that violence was used against the occupants of the houses, often involving weapons such as firearms and knives. In one case (Zytaruk, 2009a), five intruders mistakenly invaded a home that they though contained a marihuana growing operation and held two residents captive before leaving. What is alarming is that some organized crime groups have formed with their primary function being to commit home invasions of grow ops.

In addition to the potential for home invasions and other violence to increase as a result of the drug trade, the presence of marihuana growing operations also offers an avenue for young people to become involved in criminal activity. This is especially true for children who are raised in residences housing grow ops, since they are exposed to a lifestyle that includes illegal activities. Research by Bouchard, Alain, and Nguyen (2009) indicated that in some areas the existence of a marihuana cultivation industry provides the opportunity for youth to make money and become involved in crime. From their sample, Bouchard et al. (2009) reported that 12% of youth between age 13 and 17 in a region in Quebec had participated in the production of marihuana in the previous year. It is certainly a possibility that youth in parts of British Columbia are exposed to opportunities similar to of the adolescents in the Quebec community studied by Bouchard et al. (2009). Perhaps the allure of easy money, the access to marihuana, and the excitement of the criminal or gang lifestyle among other enticing factors that surround marihuana production could make marihuana cultivation the starting point in the criminal careers of some young people.

The indoor marihuana growing industry has negative effects that permeate into other aspects of society, influencing the lives of even those who may not be seem directly affected. Perhaps most problematic is the fact that, in many places, it may not be a safe

assumption that indoor marihuana growing is not occurring nearby. Based on calculations by Bouchard (2007), the risk of detection in one year for indoor marihuana growing operations in Quebec was less than 10%, even for the largest operations. If the large majority of grow ops go on undetected, this implies that there may be many contaminated residences that used to be former growing operations. The stigma of a past marihuana growing operation can greatly reduce the value of a property, and with the relatively low chance of detection, there have likely been a number of sales of former growing operations in the province that have gone undisclosed. In addition to the health and safety hazards associated to any tampering or leftover mold and chemicals, our focus group (Surrey Fire Service focus group, July 10, 2009) reports that the future discovery of those hazards will force the new owner to incur an expense around $25,000, which may increase depending on the extent of the contamination and the cost of additional repairs.

Even for those who do manage to avoid living near or buying a home that used to house an indoor marihuana growing operation, there are economic and environmental costs that affect everyone. One such example may be in the housing market, where home buyers are competing with prospective marihuana growers to purchase property. Not only are drug producers damaging and devaluing homes for future owners, but they may also be driving up the costs with the demand for new drug production sites. In cities where housing issues are a high priority, the use of family dwellings to produce illegal drugs should be a major concern.

Another example involves the economic and environmental costs of the electricity required to power the abundance of illegal marihuana growing operations. Based on the data from 2003, the average marihuana grow op in British Columbia had 15.5 lights[5] (Plecas et al., 2005). Assuming a growing cycle involves at least 18 hours of light each day for the first month, followed by two months of 12 hour per day, a grow op uses an average of 14KWh per day for each light over the course of a crop. This suggests that the average grow op uses 217 KWh each day, totalling 78,120 KWh over a year for lights alone. At a cost of $0.06 per KWh, the average operation uses $4,687.20 worth of electricity each year.

[5] According to Garis (2008), the most common lights used by growers were 1000W.

Estimates reported by Garis (2008) indicated that marihuana production accounts for more than 6% of the electricity supplied to residential customers in British Columbia, a total cost of more than $60 million per year. Reiterating the sentiments from that study (Garis, 2008), it is a serious concern that those within the indoor marihuana production industry consumes a highly disproportionate share of a valuable resource.

Of course, since marihuana production is often associated with electricity theft and the profits from the sale of the illegal product are not subject to taxation, grow ops amount to a considerable drain on the provinces resources and tax payers. In 2003, the average size of a grow op with a hydro-bypass to steal electricity was 28 lights. Therefore, the amount of electricity stolen by the each of the approximately 20% of marihuana growing operations[6] is about 141,120 KWh with an annual value of $8,467.20. The electricity consumption of the marihuana production industry in this province raises the costs of this resource for all consumers and, if the consumption patterns continue or increase, will result in the need for more energy producing dams and power plants. In British Columbia alone, it was estimated that the predicted 1,100 GWh per year consumption of marihuana growing operations would be comparable to the power generation of a recently started hydroelectric project estimated to cost $660 million (Garis, 2008).

HOW CAN THE POTENTIAL YIELD OF A MARIHUANA GROWING OPERATION BE ESTIMATED?

Estimating the potential yield of a marihuana growing operation has historically been very speculative. There are a lot of variables to consider when estimating the potential yield of these operations. Previously, estimates of the annual yield of marihuana growing operations have been predominantly based on the number of plants discovered at the growing site and the number of crops that can be produced in a year. As Bouchard (2008) noted, previous estimates tended to be largely exaggerated because the assumptions about the amount of marketable product per plant were inaccurate. Assuming that each of the marihuana plants in an operation could produce anywhere from 1lb to 1 kg

[6] According to Plecas et al. (2005), approximately 20% of growing operations involved a hydro-bypass.

(2.2lbs) greatly over estimates the potential yield of a marihuana growing operation. We have determined that even the 100 grams per plant estimate originally used by Plecas, Dandurand, Chin, & Segger, (2002) has now been determined to be an over-estimate.

Although the estimates for the amount of marketable product per plant have historically been overstated, researchers trying to understand illegal marihuana production have generally had a strong understanding of the number of crops that can be produced each year. In his estimates, Easton (2004) used the figure of four crops annually for a 100 plant operation. This reflects the figure used by Bouchard (2008), who suggested that large operations (more than 100 plants) would generally produce four crops, while medium and small operation (20 to 100 plants and 1 to 20 plants respectively) would produce three crops. Outdoor operations of any size were estimated to produce only one crop (Bouchard, 2008). For the remainder of this report, we are going to estimate that a grow op for personal use will produce three crops annually and one intended for profit will produce four crops annually.

Recent research from Toonen, Ribot, & Thissen (2006) reported that the yield per plant was 33.7 grams and that generally 15 plants were grown around a single lamp. These findings reflect the general consensus of growers and other researchers (Bouchard, 2008), and would present a better alternative to other grams per plant estimates. However, as much of the yield depends on the amount of light received by each plant, the yield of 33.7 grams per plant may only be accurate for those grow ops that are configured in a similar way with 15 plants around each lamp. Also, as even the best growers experience plant attrition at some time prior to harvesting the crop (Bouchard, 2008), estimating yield purely based on the number of plants present at a growing site may provide an estimate that is over or under the actual yield. As this is the case, an easier and potentially more accurate way to estimate the yield of a marihuana growing operation is to base the estimate on the number of lights rather than plants.

A grower's 'rule of thumb' that was reported by Bouchard (2008) which also reflects information provided to us by our contact, Brian Carlisle[7] (personal communication, October 1, 2009), is that the predictable yield for a marihuana growing operation can be approximated at 1 lb per active light each crop. As 1 lb is the equivalent of 454.5 grams, this easy 'rule of thumb' provides a conservative estimate that generally reflects the yield data from the studies of both Toonen et al. (2006) and Bouchard (2008). For the remainder of this report, estimates of the potential yield of marihuana growing operations will rely on the assumption that a light produces 454.5 grams each crop. Furthermore, the authors suggest that 1 lb per light estimate would provide an improved standard that can be adopted by criminal justice policy makers, law enforcement officers, crown prosecutors, and judges when dealing with cases of indoor marihuana production.

WHAT IS NEEDED TO SET UP AND MAINTAIN A MARIHUANA GROWING OPERATION?

The setting up and maintaining of a marihuana growing operation, especially one intended for commercial viability, has a number of prerequisites, chief among them the ability to fund the operation for a period before profits can be generated. As the start up and maintenance costs are key considerations for determining whether or not an operation of a particular size could be commercially viable, it is important to have an understanding of these costs. To answer this question, we list the required skills and funding for a ten light operation. Although this size of an operation is below the average reported in 2003, the estimated costs of a ten light operation can be used to easily extrapolate the costs for operations of any size. The estimates we use here are set to represent a minimum level of expenditure that when extrapolated would take into consideration economies of scale and increasing levels of sophistication.

With the help of our experienced grower contact, Brian Carlisle, we have listed below the equipment and services necessary to set up a commercially viable grow op along

[7] Brian Carlisle is a very knowledgeable source on the topic of marihuana growing. He is a former medical marihuana grower with 15 years of experience dealing with the market for both illegal and medical marihuana

with the estimated minimum costs associated to each. We concede that some, even the majority, of commercial operations might spend more on some components or use equipment not listed here, but this list is intended to represent the most basic of commercial operations.

Lights – $2500: Every indoor grow op requires lights. In the vast majority of cases in British Columbia, these lights used 1000 W bulbs. We estimate a cost of $250 per light.

Reflectors - $800: To increase the amount of light received by the plants, a reflector is used with each light. Each reflector is estimated at a cost of $80.

Timer - $200: A timer is used to control when the lights turn on and off. For this scenario, only one timer is used, although some operations may use more timers and use them for a variety of purposes. The timer is estimated at a cost of $200.

Wiring and Electrical Set Up - $3000: As residences are not originally intended to house marihuana grow ops, a new growing location will require extensive changes to the electrical system and wiring in order to power the high energy lights. Although there are many cases in which the electrical systems in grow ops are improperly installed, we assume that someone with the skills and training, or at least the experience of an electrician would be required to ensure the grow op could function. To account for the costs of the wiring, electrical panels, and the electrician's labour, we conservatively estimate the setup cost for the ten-light operation at $3000.

Retrofitting Growing Environment - $2000: In order to make the environment suitable for growing, structural changes need to be made to the grow room. The estimate of $2000 includes both supplies and the labour charges of a carpenter or handyman.

Fans - $200: In order to keep the necessary air flow within the grow room, fans are needed. The air movement can also strengthen the plants, allowing them to better support the growth of buds. We estimate two oscillating fans for the grow room at $100 each.

Cooling Unit - $1000: The high energy lights can raise the temperature of a grow room to levels that can jeopardize the plants. In order to keep the temperature at a suitable level,

some type of cooling unit is required. We conservatively estimate that a low quality cooling unit (e.g. either a chiller, air conditioner, or heat exchanger) would be an expense of $1000.

Dehumidifier - $100: To reduce the humidity of the growing environment, the operation would require at least one dehumidifier. We estimate the low range cost of a dehumidifier at $100.

Ventilation - $500: Outside air is required to keep the plants healthy, and consequently the indoor air needs to be displaced. By converting existing ventilation or creating new outlets for the grow op, we conservatively estimate the costs of venting at $500.

Charcoal Filter - $100: To avoid the smell of growing marihuana escaping through the ventilation port, a charcoal filter would need to be installed. We estimate a charcoal filter for one outward vent at $100.

CO_2 - $200: Carbon dioxide is widely used to improve the growing condition. A machine for increasing the carbon dioxide levels in the grow room is estimated at $200.

Pots - $200: With 15 plants around each light, the ten-light operation would require 150 pots in which to grow the plants. We estimate the cost for three 5 gallon pots at $4.00.

Soil - $300: With approximately 15 plants around each light, a ten light operation would require soil for about 150 plants. Although not all growing techniques require soil, for the purpose of this estimation we assume a soil-based operation. With each plant in a 5 gallon pot, we estimate that a 50 gallon bag of growing soil would cost $20, creating an expense of $300 for the necessary 15 bags.

Herbicides & Pesticides - $150: To protect the crop from potentially harmful pests, a supply of chemicals would likely be on site to be administered in the case of infestation. Based on the information from our focus group on the hazards of marihuana growing operations and the research of Blair and Wedman (2009), we know that the use of herbicide and pesticides in growing operations in not uncommon. We estimate the cost the necessary amount of chemicals for a ten light operation to be $150.

Clones - $750: The marihuana plants intended to be grown and harvested have to come from somewhere. Although the plants can be grown from seeds, it is most likely that commercial growing starts with clone plants purchased from another illicit source. We estimate that a tray of 50 clones would cost $250. The expense incurred from three trays is $750. We include this as a setup cost because we assume that additional clones can be taken from a mother plant from the first crop, but we acknowledge that some operations may choose to buy new plants for each crop.

The accumulation of all of the previously listed expenses adds up to a setup cost of $12,000 for the ten-light operation. In addition to these initial costs, a marihuana growing operation can incur considerable ongoing expenses. These include the rent or mortgage payments for the location, the electricity to run the growing lights and equipment, the nutrients for the plants, and additional bulbs and other supplies. Ongoing costs can be greatly reduced if the grow operator steals electricity or generates it onsite. Also, for those growers who do not have to rent or buy an additional property specifically for the purpose of marihuana production, the costs associated to the grow op are again reduced. However, we still estimate that ongoing costs for the supplies necessary to maintain a ten-light operation at around $1000 per crop.

WHAT IS A COMMERCIALLY VIABLE MARIHUANA GROWING OPERATION?

Marihuana production can be a lucrative illegal endeavour, but not all cases of marihuana cultivation are intended to turn a profit. Smaller operations intended for personal use are illegal and are still a concern, but those operations that are intended for large profits present greater risks and are a main source for the illicit drug trade. Therefore, it is important to have the ability to distinguish between those marihuana growing operations that are for personal use and those that are designed specifically to be commercially viable.

The concept of commercial viability in the marihuana production business is likely something that has changed over time. As innovative detection techniques are developed

and used by law enforcement, a grower's need for security and counter-detection strategies increase. What was required for a profitable marihuana growing operation in the late 1990s or early 2000s have no doubt changed somewhat from what is currently necessary in order to compete in the illegal market. The changing reality increases the costs of doing business and thus may force some growers out of the market, leaving marihuana production an industry predominated by high quantity producers who are very sophisticated and extremely competitive.

However, the marihuana growing operations that are intended for personal use may not differ from those that have existed historically. Since grow ops for personal use are separated from the larger illegal production and distribution industry and the chance of detection is generally much lower for small size operations (Bouchard, 2007), it is likely that the factors that may be forcing small and mid-sized commercial operations out of business would have little to no affect. If this is an accurate representation of current progression in the illegal marihuana production industry, it should become increasingly easier to distinguish between those operations that are commercially viable and those that are mainly for personal use.

In the meantime, however, to determine whether a grow op is or was intended for profit, it is important to explore two main factors. The first is how much marihuana is needed for personal use. If a grower is only growing enough for his or her own consumption, the number of plants and lights used in the operation should reflect that purpose. According to data from the 1991 National Household Survey on Drug Abuse (Gfroerer, Gustin, Virag, Folsom, & Rachel, 1991), the average marihuana user consumes the drug at a rate of 281 joints per year. A joint ranges between 0.5 and 1 gram[8] (Easton, 2004); therefore, the consumption for an average user would be between 11 - 23 grams per month, or 140.5 - 281 grams per year. Health Canada (2008) recognizes that most users of medical marihuana will consume 1 to 3 grams of dried marihuana per day. Consumption at the upper range for these users would require a supply of 1.095 kilograms per year.

[8] In general, the average marihuana smoker would likely smoke a half gram joint, while more frequent or 'chronic' users might larger joints of one gram. For the purpose of estimations later in this report, we assume the average joint to weigh 0.515 grams.

From the previous discussion of the yield of marihuana growing operations, it was concluded that a grower will generally produce 1lb or 454.5 grams per light for each crop harvested. Assuming that the grow op for personal use produces three crops annually, a one-light operation might yield 3 lbs (1.3635 kg) of dry marihuana each year. That roughly translates to the amount of marihuana used by those medical users in the upper range of Health Canada's (2008) figure for a period of 15 months. It is almost ten times more marihuana than the 140.5 grams smoked by the average user.

Given that the potential yield of a one light operation would be more than ten times what an average marihuana users might consume in a year, it would be fair to suggest that an operation consisting of more than one light has the potential produce more than what is needed for the average user. However, given that dried marihuana may not have a shelf life that lasts the period between each crop, it could be argued that an operation intended only for personal use may use four lights, each used to grow a crop that can be harvested at a different time. After operating for four months, the potential yield would still be around 12 lbs (5.454 kg) annually, but could produce a fresh 1 lb harvest each month. This potential annual production translates to more than 30 half-gram joints per day, nearly five times the yearly consumption of the medical user and nearly 40 times that of the average users.

Of course, the 1 lb per light approximation might be better suited for estimating the potential production of larger operations that are intended to make profit. It is possible that a grower with a few-light operation is not trying to produce to the 'rule of thumb'. This might be a necessary consideration that factors into the discretion of whoever needs to assess whether the operation is indeed intended for personal use. However, the fact still remains that the potential yield of the grow op is around the range of 1 lb per light or higher regardless of the grower's current skill or intentions. In conclusion, a very inclusive criterion for grow ops intended for personal use might be an operation with four or fewer lights.

The second factor in whether a marihuana growing operation is commercially viable is whether or not the potential for profit is larger than the costs incurred through set up and maintenance. Easton (2004) estimated the costs of running a 100 plant marihuana

growing operation at approximately $24,500, and earning around $76,000. Easton assumes a 50 / 50 split of the revenue between an investor and an operator, suggesting that the investor nets $13,600 over the year. His calculations demonstrate how even with such a business arrangement, a 100 plant operation was commercially viable in 2000.

For our own analysis we estimate that a grower can sell 1 lb of harvested marihuana for $2000[9]. Table 1 incorporates the estimated costs of setting up and maintaining marihuana growing operations to estimate the potential for profits for grow ops of various sizes. The estimated setup costs were extrapolated from the previously concluded cost of $12,000 for a ten-light operation to an estimated $1,200 per light. Inherent in these estimations is the recognition that quantities of scale would naturally reduce the costs per light for larger operations, but at the same time, with increased size comes a necessity for greater sophistication, and therefore the increased costs associated to greater sophistication may balance out the potential savings. Although we concede that the costs are a conservative estimate, Table 1 demonstrates that if a grower steals electricity and does not have to pay for an added rent or mortgage to house the grow, even a one-light operation has the potential to make some profit. Although a 50 /50 split between an investor and operator was assumed by Easton (2004), this table offers only the overall profit of the operation as a whole. Furthermore, the table does not take into account other costs such as those incurred for extra labour, counter detection, or security, which may be a pivotal expense for those operations that can continue successfully over time.

As the number of plants and the level of sophistication discovered in growing operations in British Columbia between 1997 and 2003 showed an increase (Plecas et al., 2005), there was likely a continuously changing concept of commercial viability. Using our data on grow ops in British Columbia for 2003, more than half of marihuana growing operations had more than 100 plants and the average number of lights used for a grow op was 15.5. While the 100 plant grow op discussed by Easton (2004) may have been the standard for commercial viability for the early years of the 2000s, without the detailed analysis of marihuana growing trends for the latter part of the decade, it may be difficult to

[9] $2000 per lb is consistent with the authors' information from police sources and even lower than the $2600 per pound used by Easton (2004) based on prices in 2000.

assess an appropriate standard for later growing periods. Although the table demonstrates that marihuana growing operations can be very lucrative, especially when the operation involves stealing electricity or generating it onsite, the risks associated to growing marihuana, the extent of a grower's black market connections, and the potential for added expenses are all further considerations necessary to assess whether an operation of a specific size is indeed commercially viable. However, it should also be emphasized that the value of the profits is considerably higher when one considers that it is accumulated tax free. Despite the uncertainty with regard a definitive answer on what represents a commercially viable grow op, what can be concluded is that even for very large operations, the setup costs are such that it is highly unlikely that such an operation would ever be intended for only a single crop.

HOW MANY MARIHUANA GROWING OPERATIONS ARE IN BRITISH COLUMBIA?

Presently, the number of marihuana growing operations in British Columbia cannot be known with any great certainty. The extent of marihuana production in the province must be estimated based on the information from available sources. Police information on the number of marihuana growing operations attended and dismantled is the most common source from which to base estimations of the true number of operations in the province. However, in recent years, some communities around the province have implemented non-traditional enforcement responses, namely Electrical and Fire Safety Inspection Initiatives (EFSI), to actively deal with some cases of suspected marihuana growing operations (Garis, 2008; Girn, 2007). Information from these EFSI teams presents an additional source for estimations of the extent of marihuana production.

Using the data from Plecas et al. (2002) on the number of marihuana growing operations discovered by police in 2000, Easton (2004) estimated the number of active grow ops in that year to be approximately 17,500. The number of founded grow ops decreased from over 2,800 in 2000 to just over 2,000 in 2003, potentially as a result of

fewer active grow ops. Since the value to cost ratio (1.5) used by Easton (2004) is consistent with the findings from Table 2[10], his formula can also be used to estimate the number of active grow ops in the province in 2003. Changing only the number of founded grow ops, Easton's method estimates that a total of 12,500[11] active grow ops in British Columbia in 2003. Again, without the detailed analysis of founded cases of marihuana production from 2004 to the present, a similar estimation of the number of active grow ops during latter years of this decade would only be tentative.

Bouchard (2007) proposed a method of estimating the actual size of the marihuana cultivation industry called a capture-recapture model. He estimated the annual number of marihuana growing operations in the province of Quebec to be approximately 13,000 for the years 2000 and 2001. As Bouchard's (2007) method is based on arrests for marihuana production and requires the average number of co-offenders per grow op, the method cannot be exactly replicated using our data on grow ops in British Columbia. Furthermore, Bouchard (2007) categorized marihuana growing operations by size, providing different specifications for each category. However, by inputting our data for the year 2003 into Bouchard's model, the resulting annual number of all sizes and types of marihuana growing operations comes to 11,500.[12] Although, the data may not fit well with Bouchard's model since it provides only a one-year window for recapture, the estimate is not too far removed from the one obtained using Easton's method.

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[10] Assuming the same 50/50 split between an investor and a grow operator, the ratio of value to cost (PQ/C) for the growing operations described in Table 2 ranged between 0.35 for a 1-light operation and 1.91 for a 1000 light operation. The ratio of value to cost (PQ/C) for the average 15.5 light growing operation was 1.41.

[11] Easton (2004) estimated the number of marihuana growing operation using the formula $T = B[1+PQ/C)]/[(PQ/C)-(1+R^*)$, where T is the total number of growing operations, PQ/C is a ratio of value to cost = 1.5, R* is the assumed return to legal activities, and B is number of founded marihuana growing operations discovered by police during the year.

[12] Bouchard's (2007) model used the formula $S=\sum(Z_i/C_i)\lambda_{i,n}$, where S is the total number of growing operations, Z is the estimated number of growers for each type i, C is the number of co-offenders required each type i, λ is the proportion of seizures of each type i and sizes n. To use this model, we did not separate the growers by type or the growing operations by size, adopting the formula S=Z/C. C was calculated using Easton's formula C=2.955 + 0.0057*p where p is the average number of plants seized per grow (p=208 in 2003). Z was estimated using Bouchard's capture-recapture model $Z=N/(1-e^{(-2*n2/n1)})$ where N is the number of individuals arrested, n_1 is the number of individuals arrested once, and n_2 is the number of individuals arrested twice. From the data of Plecas et al., (2005) N was 1,670 persons in 2003, n_2 was 26 persons, and n_1 was 1642. Z=53,572 and S = 11,494. Bouchard's model used a period of three years to assess capture and recapture then divided by three to determine the population of offenders for a single year. Limitations in the data prevented we from uses a three year period for the calculation of Z.

For the purpose of this report, we propose that an estimated 10,000 commercially viable marihuana growing operations were active around the year 2003. This estimate is based on information provided by BC Hydro (presentation to EFSI/PSIT Regional Meeting, District of Mission, B.C., Sept, 2009) that approximately 16,000 residential accounts were using electricity at a rate of more than the 93 KWh per day, the threshold for inspection define by the British Columbia's Electrical Safety Regulation (Safety Standards Act, 2004). Not all cases of high consumption are the result of an illegal marihuana growing operation, but a conservative estimate puts the proportion at 50% (discussion at EFSI/PSIT Regional Meeting, District of Mission, B.C., Sept, 2009). Furthermore, based on findings from Plecas et al. (2005) that on average 20% of marihuana growing operations exhibited signs of electricity theft, this implies an additional 2,000 operations were stealing electricity. With 8,000 residential operations identified through over-consumption and another 2,000 assumed to be stealing, we estimate that 10,000 commercially viable growing operations[13] were active in British Columbia in 2003. This estimate is below the 17,500 proposed by Easton (2004) for the year 2000 and the 2003 estimates reached following the methods of Easton and Bouchard. With growing sophistication and a likelihood that more operations are stealing electricity or providing power onsite, the current number of commercially viable marihuana growing operations may be much greater than the 10,000 suggested here. However, we are confident in concluding that for the period between 2000 and the present, the number of active commercially viable marihuana growing operations in any one year was not below 10,000.

HOW MUCH MARIHUANA IS PRODUCED BY BRITISH COLUMBIA'S COMMERCIALLY VIABLE MARIHUANA GROWING OPERATIONS?

Estimating the entire marihuana production in British Columbia requires the answers to many of the previously discussed questions. It requires an ability to estimate the yield of a marihuana growing operation, knowledge of size of operations, and a figure to

[13] As the 93 KWh threshold for over-consumption does not capture those operations with fewer than 5 – 6 lights (assuming 14 KWh per day for each light), and the average case of electricity theft involved 28 lights, this estimate conservatively reflects the number of commercially viable growing operations and is unlikely to include those small growing operations intended for personal use.

represent the total number of active operations contributing to the market. Using his estimates of the marihuana industry in 2000, Easton (2004) determined that British Columbia produced approximately 416,000 kg (915,200 lbs) of marihuana per year.

To provide an estimate of British Columbia's annual commercial marihuana production in the years following 2000, we will apply the figures concluded upon previously. Based on data from marihuana growing operations in 2003, the average size of an indoor operation in British Columbia was 15.5 lights. Given a yield of 1lb per light for each crop and a total of four crops in the year, the average growing operation produced 62 lbs (28.18 kg) over the year. With a population of 10,000 active commercial grow ops within the province, we can conclude that a total of 620,000 lbs of commercial marihuana was produced during the year. As we expect that the average number of lights per operation has been steadily increasing along with rates of electricity theft, it is likely that the province's current levels of production are even greater.

WHERE DOES THE PRODUCED MARIHUANA GO?

Based on the previous calculations, we can assume that at least 620,000 lbs of commercial marihuana is produced annually. Depending on the size of the domestic demand for the drug in British Columbia, a certain portion of the illegal product is exported to other provinces and other countries. Exportation of marihuana from British Columbia into the United States is of great concern to authorities on both sides of the border. From high profile cross-border seizures like in the case of Robert Shannon and Devon Quast (Baker, 2009) or UN Gang leader, Clayton Roueche (Bolan, 2008), we know that marihuana produced in British Columbia has been exported in large quantities to destinations within the United States, often with shipments of cocaine coming back into Canada. Reports from the US Department of Justice (2009) acknowledge the influence of Canadian marihuana into the American drug market. Overall, the extent of exporting of British Columbia's marihuana into the United States is unknown.

Using our previous estimate of 620,000 lbs of commercial marihuana produced annually, we can estimate the amount of marihuana that leaves British Columbia bound for

other parts of Canada and the United States. Research by Stockwell et al. (2006) indicated that about 16.8% of British Columbians aged 15 and older had used marihuana in 2004. Given that BC Stats (2009) reports that there were 3,455,602 British Columbians aged 15 and over in 2004, we can estimate that there were 580,541 marihuana users in the province during that year. As previously mentioned the average user smokes 281 joints per year (Gfroerer et al., 1991). If the average user smokes joints weighing 0.515 grams, British Columbia's domestic consumption in 2004 was approximately 84,040 kg (184,888 lbs).[14] Assuming the province's annual production in 2004 was in the range of 620,000 lbs, the domestic consumption represents only about 30% of the total commercial product, leaving 70% to be exported elsewhere. As our estimate of commercially produced marihuana does not take into account those operations intended for personal use, it is probable that the domestic consumption of commercially produced marihuana is even less than the estimate provided here. In conclusion, a substantial amount of British Columbia's commercially produced marihuana leaves the provincial borders, suggesting that our local problems with marihuana growing operations have a considerable impact on the drug situations in other jurisdictions.

WHAT IS THE VALUE OF BRITISH COLUMBIA'S MARIHUANA?

The revenue generated by British Columbia's commercial marihuana production industry is approximately $1.24 billion. Inherent in this figure is the assumption that the marihuana is sold by the pound at $2000/lb. We present this figure as a conservative estimate of the amount of money that British Columbia's marihuana growers generate from the sale of their product. However, we recognize that when the activities of the broader marihuana market are taken into consideration, the $1.24 billion figure increases substantially.

The price of British Columbia's marihuana varies depending on where it is sold and in what quantity. The potential retail value of British Columbia's marihuana sold on the

[14] As 16.8% of 3,455,602 provides a figure of 580,541.136 annual marihuana smokers, the estimated domestic consumption presented here is slightly higher than the 84,013 kg (184,829 lbs) that would be calculated if the 580,541 figure was used.

street by the joint would be much greater than $1.24 billion. Furthermore, with the risks of trading marihuana across national borders, it can be expected that the price of British Columbia's marihuana will be inflated somewhat in the United States. The Office of National Drug Control Policy (2003) reported that in the early years of this decade, 'BC bud' could be sold in some American metropolitan areas for as high as $5000 – $8000 USD per pound. If all of the 70% of British Columbia's commercially produced marihuana that leaves the province was sold in the United States for at least $3000 CAD[15], exporters would be earning approximately $1.305 billion. Exporting British Columbia's commercially produced marihuana is a lucrative business, as the revenue generated by exporters is greater than that generated by the growers even when selling only 70% of the total product. If we add the wholesale revenue from exported marihuana with the 30% sold domestically for $2000 per pound, the total value of the entire wholesale market for British Columbia's marihuana is $1.675billion.

SUMMARY

No doubt, at least for the short term, it will be difficult to get as specific as we might like in trying to describe the nature and extent of marihuana grow operations in British Columbia. Like so many other kinds of crime, and especially those involving organized crime, the size of the dark figure can assumed to be large, and the nature of the activity is ever-changing. Grow ops are becoming increasingly sophisticated and it is clear that those involved are changing their ways of doing business to grow more efficiently, produce more powerful strains, increase profitability, and avoid detection. Still, at this point, it is clear that given the cost to set up an initial grow it is not reasonable that any of those involving more than four lights are "one off" operations. Rather, they are harmful operations intended to generate on-going tax free profits for those who own them. Collectively across the province of British Columbia commercial marihuana growers take money out of the pockets of every taxpayer and worse and increasingly so, facilitate the ability of organized crime to become richer, stronger, and more pervasive. We emphasize since in making our calculations and

[15] To be conservative we estimated that a pound of marihuana could be sold for the equivalent of $3000 CAD in the United States. This number is consistent with source within the Royal Canadian Mounted Police.

estimates here, we have tried to be deliberately conservative at each step of the assessment. We present what can be viewed as the lower limit of what is a very large problem in British Columbia and elsewhere. We would expect the law enforcement and public safety officials who are close to the problem on a daily basis could give reason to be much less conservative.

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Table 1: Estimated Potential Profits of Marihuana Growing Operations of Various Sizes

			Ongoing Expenses			Profit After 1 Crop				Profit After 1 Year			
Lights	Earns / Crop	Set up Cost	Supplies / Crop	Hydro / Crop	Rent */ Crop	Paying Hydro & Rent	Stealing Hydro	No Rent	Stealing Hydro & No Rent	Paying Hydro & Rent	Stealing Hydro	No Rent	Stealing Hydro & No Rent
1	$2,000	$1,200	$100	$75.60	$2,400	-$1,775.60	-$1,700.00	$624	$700	-$3,502.40	$4,000	$6,097.60	$6,400
5	$10,000	$6,000	$500	$378.00	$2,400	$722.00	$1,100.00	$3,122	$3,500	$20,888.00	$29,600	$30,488.00	$32,000
10	$20,000	$12,000	$1,000	$756.00	$3,600	$2,644.00	$3,400.00	$6,244	$7,000	$46,576.00	$60,400	$60,976.00	$64,000
15	$30,000	$18,000	$1,500	$1,134.00	$3,600	$5,766.00	$6,900.00	$9,366	$10,500	$77,064.00	$92,400	$91,464.00	$96,000
50	$100,000	$60,000	$5,000	$3,780.00	$3,600	$27,620.00	$31,400.00	$31,220	$35,000	$290,480.00	$316,400	$304,880.00	$320,000
100	$200,000	$120,000	$10,000	$7,560.00	$4,800	$57,640.00	$65,200.00	$62,440	$70,000	$590,560.00	$635,200	$609,760.00	$640,000
250	$500,000	$300,000	$25,000	$18,900.00	$12,000	$144,100.00	$163,000.00	$156,100	$175,000	$1,476,400.00	$1,588,000	$1,524,400.00	$1,600,000
500	$1,000,000	$600,000	$50,000	$37,800.00	$24,000	$288,200.00	$326,000.00	$312,200	$350,000	$2,952,800.00	$3,176,000	$3,048,800.00	$3,200,000
1000	$2,000,000	$1,200,000	$100,000	$75,600.00	$48,000	$576,400.00	$652,000.00	$624,400	$700,000	$5,905,600.00	$6,352,000	$6,097,600.00	$6,400,000

*Rent was estimated to conservatively reflect the price for required space, assuming each light required at least 25 ft^2. For five or fewer lights, the estimate assumes at least a two bedroom apartment for $800 monthly. Between 10 and 50 lights assumes an average house with around 1,800 ft^2, costing $1,200 monthly. For 100 lights and larger, the figure of $185/$ft^2$ was used to determine the cost of a house large enough for the operation. The rent for these operations was calculated assuming an added 5% and monthly payments over 25 year.