

Salmonella Enteritidis in British Columbia

Provincial Control Strategy

*Salmonella Enteritidis Working Group**

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Preamble

The incidence of human cases of *Salmonella* Enteritidis (SE) has increased nearly five-fold in British Columbia (B.C.) between 2006 and 2016. This increase has occurred at a faster pace and to a much higher level than in the rest of Canada. Evidence from reported cases shows that consumption of contaminated eggs and chicken meat is responsible for most SE-related human illness in B.C. - simply put, more people in B.C. with SE report eating chicken and eggs. Additionally, the proportion of SE contaminated chicken meat very closely mirrors the increase in human SE cases for the last 10 years. It is important to note that for every one reported case of SE, there are an estimated 25 cases of SE that are not reported.

This document presents a provincial strategy to combat the rising incidence of human SE cases in British Columbia. The strategy was developed through analysis of the different exposure risks and existing surveillance and control measures for SE in the province.

Reducing human illness caused by SE is most effectively and efficiently accomplished by controlling the disease in poultry^{1,2}. Ideally, SE control should be implemented at the national level to avoid having the poultry industry in a given province carry an inordinate share of the cost. To this end, a national joint Government-Industry Working Group (Joint WG) on the Control of *Salmonella* and *Campylobacter* in poultry was established in 2015 of which B.C. is an active participant. However, given the unknown timeline of deliverables by the Joint WG and the continuing increase in the incidence of human illness caused by SE in B.C. and the associated health care and human costs, control measures at the provincial level should be implemented.

This document describes recommended actions to be taken at the provincial level from farm to fork, as well as items that the Province should actively promote at the federal level. These recommended actions would reduce human illness caused by SE in B.C. and are organized into six distinct areas of focus:

1. Control SE already circulating in the B.C. poultry supply chain (eggs and meat)
2. Prevent new SE from entering the B.C. poultry supply chain (eggs and meat)
3. Monitor the effectiveness of the control measures in the B.C. poultry industry
4. Minimise SE contamination of food
5. Manage foods where SE may be found through education and preventive actions
6. Address knowledge and information gaps

Each of these areas is important and should be addressed to achieve the ultimate goal of sustainably reducing human illness caused by SE. The feasibility and expected effectiveness of implementing each action should be explored in consultation with stakeholders. Priorities and a plan for implementation can be identified and developed accordingly. Some of the actions, such as whole genome sequencing, will

¹ Health Canada. 2015. National Strategy for the Control of Poultry-Related Human *Salmonella* Enteritidis Illness in Canada. Bureau of Microbial Hazards, Food Directorate, Health Products and Food Branch.

² Food and Agriculture Organization of the United Nations and World Health Organization (FAO/WHO). 2009. *Salmonella* and *Campylobacter* in Chicken Meat: Meeting Report. Microbiological Risk Assessment Series 19. Rome 56 pp.

require significant additional resources and capacity to implement. Others, however, such as enhancing transparency about the detection of positive flocks, have the potential to improve the disease situation considerably with minimal direct cost to industry or the public.

Background

Salmonella Enteritidis

SE is one of the most common *Salmonella* serotypes that cause human illness. Poultry are the primary reservoir for SE and the main source of human infection. SE caused human illness has been linked to consumption of raw or undercooked meat, poultry and eggs as well as other foods including fruits, vegetables, sprouted seeds and nuts. *Salmonella* is ubiquitous in the environment. Poultry products can also be a source of SE for other foods- for example by direct contact with SE contaminated meat or eggs- or via contact with poultry manure containing SE when it is used as a fertilizer. One challenging aspect of SE is its ability to contaminate the inside of eggs through vertical transmission. SE can infect a chicken flock and spread rapidly within the flock, without causing visible clinical signs.

Salmonella Enteritidis in British Columbia

In B.C., the incidence of human cases of SE has increased nearly five-fold between 2006 and 2016, and at a faster pace than in the rest of Canada (Figure 1). The overall salmonellosis rate has also increased. This increase has been driven by SE, which currently accounts for more than half of all salmonellosis cases, while the number of cases caused by other serotypes has remained stable over the same period (Figure 2).

This increase in SE cases means that the performance target set for the salmonellosis rate (19 cases per 100,000 population in 2023) in the B.C. Guiding Framework for Public Health³ is becoming unachievable, unless additional effective mitigation measures are introduced (Figure 2). In the 10 years since the outbreak began, 4984 SE cases have been reported in B.C.⁴ Since only a small fraction of cases (1 in 25 with a range of 1 in 13 to 37)⁵ are reported, it is believed that 124,600 SE infections actually occurred between 2007 and 2016 in B.C. (range of 64,324-183,076). This equates to an estimated 34 cases of SE each day during that 10 year span. If the incidence had remained at pre-outbreak levels (2006), there would have been an estimated 1270 SE cases reported during the last decade (3678 cases less than were reported).

³ British Columbia Ministry of Health. BC's Guiding Framework for Public Health. 2013. www.health.gov.bc.ca/library/publications/year/2013/BC-guiding-framework-for-public-health.pdf. Accessed 2017-06-11.

⁴ Panorama and the British Columbia Centre for Disease Control Public Health Lab. 2017.

⁵ Thomas MK, Majowicz SE, Pollari F, Socket PN. 2008. Burden of acute gastrointestinal illness in Canada, 1999-2007: Interim summary of NSAGI activities. *Can Commun Dis Rep.* 34(5):8-15.

Regarding the costs of this 10 year outbreak, the mean annual cost per case of foodborne illness was estimated at \$113.70^{6,7} in 2004. Using this estimate, the mean annual cost per case of foodborne illness can be estimated to be \$135.62⁸ in 2017. Based on the 2017 estimate, the total cost of the SE infections during this time span ranges from \$8,723,620 to \$24,828,767 with a mean value of \$16,898,252. These costs do not include the costs incurred by producers, processors, retailers and food service operators.

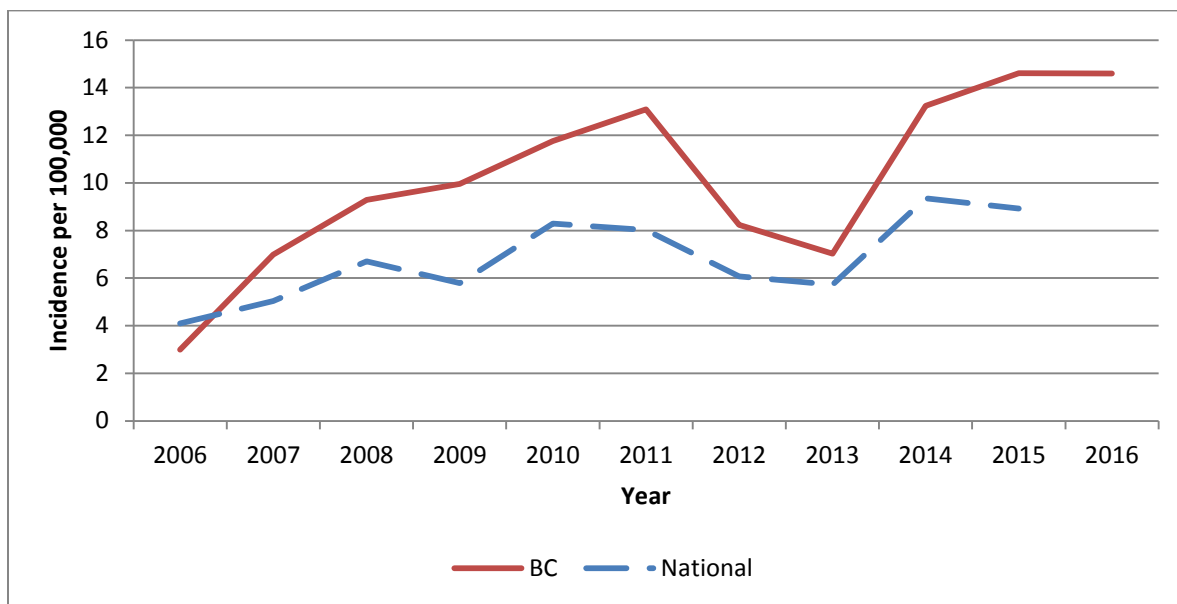


Figure 1. *Salmonella* Enteritidis incidence per 100,000 population in British Columbia and Canada (including B.C.), 2006 – 2016. Source: British Columbia Centre for Disease Control Public Health Laboratory (BCCDC PHL) and Public Health Agency of Canada (PHAC)

⁶ Henson SJ, Majowicz SE, Masakure O, Sockett PN, MacDougall L, Edge VL, Thomas MK, Fyfe M, Kovacs SJ, Jones AQ. Estimation of the costs of acute gastrointestinal illness in British Columbia, Canada. *Int J Food Microbiol.* 2008 Sep 30; 127(1-2):43-52.

⁷ Henson SJ, Majowicz SE, Masakure O, Sockett PN, MacDougall L, Edge VL, Thomas MK, Fyfe M, Kovacs SJ, Jones AQ. Corrigendum to “Estimation of the costs of acute gastrointestinal illness in British Columbia, Canada”. *Int J Food Microbiol.* 2008 Sep 30; 127(1-2):43-52.

⁸ Calculated by multiplying \$113.70 (2004 estimate) by the monthly B.C. Consumer Price Index changes from Dec 2014 to May 2017, found at: <http://www5.statcan.gc.ca/cansim/a01?lang=eng> (CANSIM table 326-0020, B.C. monthly CPI data).

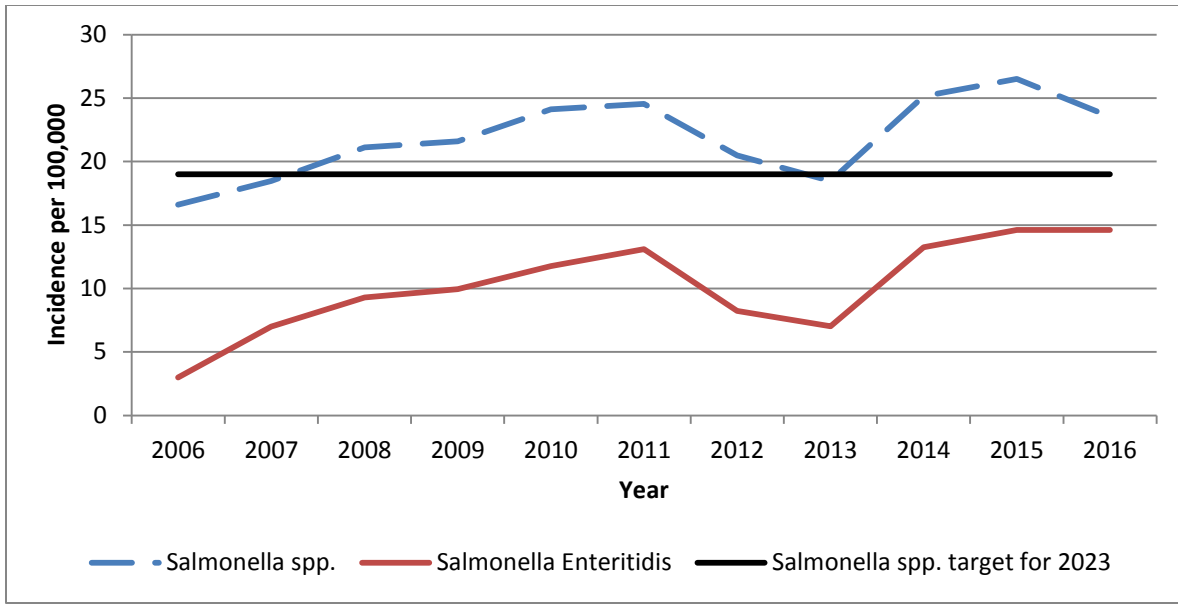


Figure 2. *Salmonella* spp. and *Salmonella* Enteritidis incidence per 100,000 population in British Columbia, 2006 – 2016. Source: BCCDC PHL

The link with poultry products is supported by surveillance data from case interviews and epidemiological analyses. That data indicate that SE cases in B.C. in 2014-2016 were more likely to consume chicken meat than the healthy population (76% of cases vs 69% of controls, $p < 0.001$) and more likely to consume eggs than the healthy population (69% of cases vs 54% of controls, $p < 0.001$). SE cases were also more likely to have had contact with live poultry than the healthy population (11% of cases vs 3% of controls, $p < 0.001$)⁹

The link with poultry is further supported by surveillance data gathered along the food chain. SE levels in food in B.C. are routinely measured by two federal programs¹⁰, both led by the Public Health Agency of Canada. In the last three years (2014-2016), an average of 21% of chicken samples purchased at retail in B.C. were positive for SE. This is higher than the national average of approximately 9%¹¹. The trend in proportion of contaminated chicken mirrors the increase in human cases almost perfectly (Figure 3). The most common phage types (PT's) isolated (PT13, PT13a and PT8) in chicken samples are the same as those isolated from human cases.

Further evidence that both poultry meat and eggs are responsible for the majority of SE cases in B.C. is supported by recent multivariate modelling analysis of the information collected through the enhanced *Salmonella* surveillance system carried out at the British Columbia Centre for Disease Control (BCCDC).

⁹ BC Centre for Disease Control. 2017. BC Integrated Surveillance of Foodborne Pathogens (BCISFP) Annual Summary, Salmonella Findings 2016. <http://www.bccdc.ca/resource-gallery/Documents/Statistics%20and%20Research/Statistics%20and%20Reports/Epid/Enterics/2016%20BCISFP%20Annual%20Report.pdf>. Accessed 2018-06-14

¹⁰ Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) and FoodNet Canada (B.C. Site)

¹¹ Data preliminary for 2016

That analysis showed that both chicken meat (OR=1.8, 95%CI=1.2-2.7) and eggs (OR=1.9, 95%CI=1.2-3.1) are independently associated with human disease caused by SE.

The association of illnesses with the consumption of chicken meat becomes more compelling when one observes the strong correlations shown in Figure 3 between the human SE incidence rate and the SE recovery rate from chicken meat during different periods of time. In 2011-13, as the SE recovery rate from chicken meat decreased, so too did the human SE incidence rate. A decrease of almost 50% in the SE recovery rate (from 19.7% to 10.1%) resulted in a similar percent decrease in the human SE incidence rate (from 7.9% to 4.0%). Similarly, in 2013-15, a large increase (182%) in the SE recovery rate (from 10.1% to 28.5%) also resulted in a large increase (133%) in the human SE incidence rate (from 4.0% to 9.3%). Based on the correlations in Figure 3, a 50% reduction in the SE recovery rate in chicken meat could be expected to result in a similar decrease in the human SE incidence rate.

Data on SE levels in eggs is not easily or directly available. Direct sampling of eggs is not considered to be effective as a means to measure SE in eggs and/or control SE on layer farms because the SE positivity rate of individually contaminated eggs is generally quite low at 1.7 per million Grade A eggs¹², or 0.00017%. Rather, environmental sampling and testing for SE on layer farms is recognized as being a more effective means of measuring whether or not a layer flock is infected with SE. Layer flocks that are not infected with SE will produce SE-free eggs. However, SE-infected layer flocks are known to produce SE-contaminated eggs. SE infected layer flocks continue to be found in B.C.¹³ Even relatively low positivity rates of SE in eggs still contribute to the overall risk of humans contracting an SE infection from a population health viewpoint as evidenced in the surveillance data. Egg-borne SE infections are known to be responsible for many cases of human illness caused by SE in other parts of the world. It is also important to note that some SE outbreaks confirmed in B.C. have been linked to the consumption of improperly cooked table and broiler breeder eggs or egg products.

¹² Leanne M. DeWinter, William H. Ross, Helene Couture and Jeff F. Farber. 2011. Risk Assessment of Shell Eggs Internally Contaminated with *Salmonella* Enteritidis. Agricultural and Biological Sciences "International Food Risk Analysis Journal", ISSN 1848-2368, Published: September 1, 2011 under CC BY 3.0 license. © The Authors. <https://docs.google.com/viewerng/viewer?url=https://cdn.intechopen.com/pdfs/20837.pdf&time=c15854a17013f7a67e4b966f09ce4246>. Accessed 2017-05-30

¹³ European Food Safety Authority, European Centre for Disease Control. 2016. European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2015. <http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2016.4634/full>. Accessed 2018-06-14.

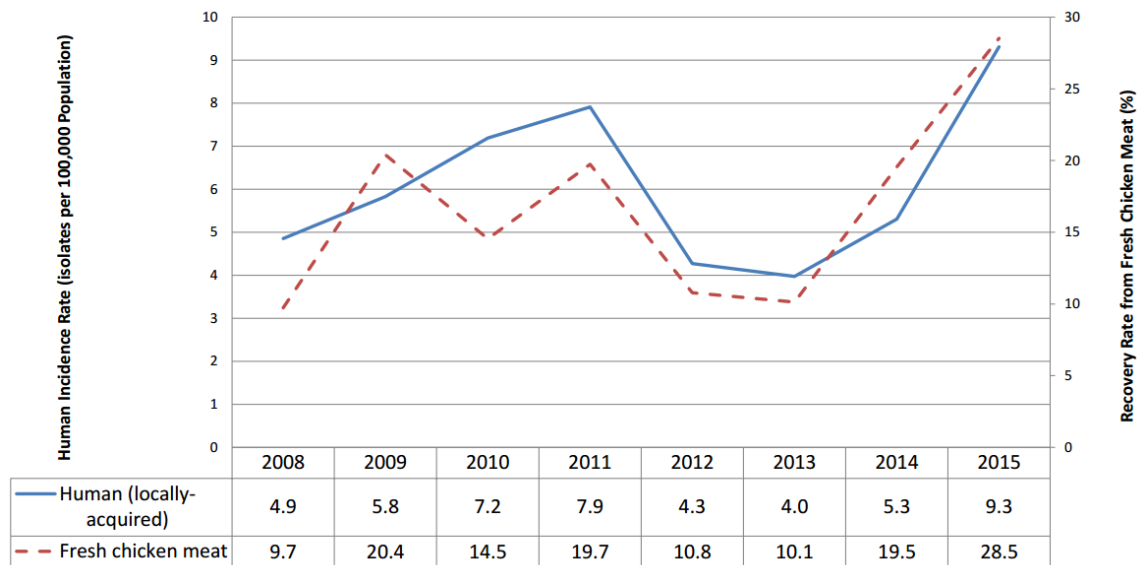


Figure 3. *Salmonella* Enteritidis human incidence (locally-acquired in B.C.) and recovery rate from fresh chicken meat, BC, 2015.¹⁴

In B.C., all commercial layer farms are tested for SE three times during the flock’s life. When a layer farm is found to be SE positive, the eggs are diverted to the processing plant for pasteurization. Because of the time period between tests and the time required to obtain test results, it is likely that eggs from SE-positive farms are distributed to the public for some time before diversion. **In summary, in the most current phase of the outbreak, there is strong evidence for poultry meat and some evidence for eggs as the foods being responsible for the majority of locally acquired SE cases in B.C.**

Salmonella Enteritidis response to-date

British Columbia

Since the incidence of SE started rising above historical levels in 2007, public health authorities in B.C. have undertaken a number of surveillance and control initiatives including:

- Enhanced data analysis and information exchange
 - There has been a quarterly meeting to update and exchange information with regional Health Authorities (RHAs), BCCDC and Ministry of Agriculture (AGRI) stakeholders regarding human illness caused by SE.

¹⁴ BC Centre for Disease Control. 2016. BC Integrated Surveillance of Foodborne Pathogens (BCISFP) Annual Summary. *Salmonella* findings 2015. <http://www.bccdc.ca/resource-gallery/Documents/Statistics%20and%20Research/Statistics%20and%20Reports/Epid/Enterics/2015%20BCISFP%20Annual%20Report.pdf>. Accessed 2018-06-14.

- BCCDC representatives have participated in regular meetings hosted by AGRI to inform the poultry industry about SE and facilitate coordination of the response.
- A standardized surveillance form is used to collect detailed history of foods eaten and other exposures from all human *Salmonella* cases. This form was enhanced with more chicken and egg related questions in 2015.
- Thorough investigation of all identified clusters
 - In the first phase of the outbreak (2008-11), several clusters of human cases were associated with both ungraded and graded table eggs as well as broiler breeder eggs being sold at food service establishments (FSEs). Because the proportion of ungraded eggs and broiler breeder eggs versus graded eggs used and consumed in FSEs is considered to be very small, ungraded eggs and broiler breeder eggs were considered more significant from a disease attribution perspective.
 - The egg-producing poultry industries in B.C. have taken a number of steps to reduce the likelihood of SE entering the food chain. In 2010, the B.C. Broiler Hatching Egg Commission implemented a regulation preventing the farm gate sale of hatching eggs to the public. Eggs can continue to be sold to egg breakers for pasteurized egg products through the BCBHEC Cull Egg program. The industry also introduced a mandatory SE vaccination program. Table egg flocks are routinely monitored for the presence of SE. If SE is detected, eggs from that flock are immediately redirected to breaking stations, in accordance with **Start Clean-Stay Clean™**, a national initiative.
 - A cluster of cases in 2015 was associated with the sale of live chicks from a contaminated hatchery in Alberta. This outbreak affected multiple provinces and territories (Alberta, British Columbia, Saskatchewan, Manitoba and Nunavut).
- A retrospective case control study was conducted in the winter of 2009 to assess the association of illness of SE with eggs. The rates of egg consumption were over twice as high for cases compared to controls. Other common risk factors for *Salmonella* were assessed along with chicken and none were significant at the time.
- Enhanced education for FSEs
 - The existing B.C. food safety training program for food premises (FOODSAFE) was enhanced to highlight the risk of *Salmonella* in poultry products (meat and eggs) including the connection to human disease and the subsequent importance of ensuring proper food handling steps are followed in order to reduce the risk of foodborne illness. The enhanced version of FOODSAFE was released in January 2017.
 - A guideline related to safe and recommended use of pooled eggs in FSEs was developed and implemented on March 1, 2016. Environmental Health Officers distribute and communicate the policy during routine inspections. The printable guideline is available in six languages.
- Progressive enforcement (e.g. ticketing, fines) with individuals distributing poor quality eggs to FSEs.
- Enhanced sampling for SE in food has been implemented using the Food Quality Check program led by the BCCDC.

Monitoring of SE in poultry farms and hatcheries is largely the responsibility of the poultry industry. AGRI has been working closely with the poultry industry to raise awareness of the problem and encourage them to take measures to reduce the prevalence of SE in poultry.

Diagnostic and monitoring samples from poultry in B.C. are tested at the Animal Health Centre laboratory and the results of this monitoring are compared with data from human and food sources in the B.C. Integrated Surveillance for Foodborne Pathogens (BCISFP).

Federal Government-led initiatives related to SE

At the federal level, a joint government/industry *Salmonella* Enteritidis working group (National SE WG) was established by the Federal/Provincial/Territorial Food Safety Committee (FPT FSC) in September 2011 of which B.C. was an active participant. The establishment of the National SE WG was as a result of outbreak investigations and targeted studies that implicated chicken and eggs as the source of infection in an increasing number of SE cases between 2005 and 2010. The mandate of the National SE WG was to identify and prioritize coordinated, national strategies to control SE in poultry in order to reduce the risk and burden of SE in humans. The National SE WG's primary deliverable was the "National Strategy for the Control of Poultry-Related Human *Salmonella* Enteritidis Illness in Canada" (SE Strategy), which was [published](#) on Health Canada's website in March 2015.

Due to the common drivers and mandates of the National SE WG and the Pathogen Reduction Initiative, the Federal Government partners and the FPT FSC agreed to link the implementation of the SE Strategy with the development of a risk management strategy for *Salmonella* and *Campylobacter* in live poultry and poultry food products. This resulted in the launching of the Joint Government-Industry Working Group (Joint WG) on the Control of *Salmonella* and *Campylobacter* in Poultry in the fall of 2015, reporting to the FPT FSC. B.C. is also an active participant in the Joint WG. The Joint WG is focusing its efforts on developing and implementing action plans from farm-to-fork to reduce *Salmonella* and *Campylobacter* in live poultry and poultry food products to strengthen the Canadian food safety system. The timelines for delivery of these action plans are not known at this time.

Strategy

Authority

In September 2015, the Assistant Deputy Ministers (ADMs) of Agriculture (AGRI) and Health (MoH) requested that staff work with partner organizations to define the scope of the policy and develop a provincial strategy to address SE in food. The two ministries formed a short term working group, co-chaired by AGRI and MoH, called the SE Working Group (SEWG) composed of members from the MoH, AGRI, the Regional Directors of Health Protection, the Office of the Provincial Health Officer, the First Nations Health Authority and BCCDC.

Strategy Objective

The primary objective of the strategy is the sustained reduction of human illness due to SE from poultry sources acquired in B.C. to pre-outbreak (2006) levels. To achieve the primary objective, much of the focus will be on the reduction of SE in provincial poultry and poultry products to pre-outbreak (2006) levels.

Areas of Focus and Activities

The section below describes six distinct areas of focus in order to reduce human illness caused by SE in British Columbia. These areas of focus are:

1. Control SE already circulating in the B.C. poultry supply chain (egg and meat)
2. Prevent new SE from entering the B.C. poultry supply chain (egg and meat)
3. Monitor the effectiveness of the control measures in poultry
4. Minimise SE contamination of food
5. Manage foods where SE may be found through education and preventive actions
6. Address knowledge and information gaps

Achieving gains in any one area of focus by itself will not achieve the primary objective of the strategy. There is no magic bullet or easy way forward. As noted in the process maps found in Appendices B, C and D, the poultry products industries are complex with many interconnecting and moving systems. The recommended actions in each of the six areas of focus are designed to be embedded into these systems and as such, and in many cases, will also be dependent on and interconnected with one another. In summary, implementing the recommended actions in the areas of focus will be important in achieving the ultimate goal of sustainably reducing human illness caused by SE to pre-outbreak levels.

Within each area of focus, a number of specific actions are outlined. The feasibility of, and how to implement each action will need to be explored in consultation with stakeholders— both government and industry. Priorities will need to be identified as well as a work plan for implementing each action. Specific implementation plans should include roles, responsibilities, timelines, costs, as well as a means to measure whether or not the expected outcome was achieved. All possible avenues for resourcing will continue to be explored. Some of the actions, such as whole genome sequencing, will require significant additional resources and capacity to implement. Others, however, such as enhancing transparency about the reporting of SE positive flocks, have the potential to improve the disease situation considerably with little

or no direct cost to the public or industry stakeholders. For several of the actions to be implemented, rather than resources, it will be the conscious decision to move forward that will be needed.

1. Control SE already circulating in B.C. poultry supply chain (eggs and meat)

In other countries, reducing the level of SE in poultry has been proven to lower the number of human cases. In the European Union, cases of SE have decreased significantly following the introduction of targets for reduction of SE and other serotypes of public health significance in the different poultry populations¹⁵. A specific example is in the UK where SE testing and vaccination programs were mandated- the number of annual reported SE human cases dropped from 23,231 in 1997 to 2,566 in 2011¹⁶

SE is not a federally reportable disease in poultry. Therefore the Canadian Food Inspection Agency (CFIA) currently lacks a clear mandate for SE control in poultry. Ideally, SE control, including improved monitoring and surveillance on farm, should be implemented and harmonized at the national level. However, given the continuing increase in the incidence of SE cases in B.C. and the associated health care, human and industry costs, control measures at the provincial level should be implemented.

SE control in poultry is most effective and efficient when implemented sequentially from the beginning of the poultry product system (i.e. breeding flocks) through to the end (i.e. retail, FSEs and consumer) - see Appendices B, C, and D for process flow maps. SE control should be implemented in this sequence because of the risk of amplification of contamination as product moves along the system. To illustrate an example of this, refer to Appendix B- the commercial broilers process map. In this example, one contaminated breeding flock can contaminate several broiler flocks. Each of these now contaminated broiler flocks can then contaminate other broiler flocks at the slaughter establishment as they are converted to various poultry products (food). These now contaminated poultry products can then contaminate previously uncontaminated poultry products, as well as other food types through cross-contamination at the retail, FSE and consumer levels. As this example shows, it is critical that both broiler and laying hen breeding flocks be free from SE, given that these flocks are positioned near the beginning of the poultry product system and that SE is vertically transmitted and that the scope of contamination expands as one moves through the poultry product system.

The different levels of the commercial poultry production industry are not well integrated, with different industry boards and companies having responsibilities at the breeding, hatching, and flock levels. This makes communication and implementation of control and surveillance more difficult. This has led to a perceived disincentive to detect and report SE due to concern about product acceptance at the next level. However, with transparency about flock SE status, the receiving farm could implement measures to control the disease, such as enhanced biosecurity and/or acidification of water. Increased transparency may also create a greater incentive to control the disease throughout the industry.

¹⁵ European Food Safety Authority, European Centre for Disease Prevention and Control. 2016. The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2015. Available at <http://onlinelibrary.wiley.com/doi/10.2903/j.efsa.2016.4634/full>

¹⁶ Lane, C., LeBaigue, S., Oluwasen, B., Esan Awofioso, A.A., Adams, N.L., Fisher, I.S.T., Grant, K.A., Peters, T.M., Larkin, L., Davies, R.H., Adak, G.K. 2014. *Salmonella enterica* Serovar Enteritidis, England and Wales, 1945-2011. *Emerging Infectious Diseases* 20 (7), 1097-1104.

- 1.1 Engage with the Federal Government to make SE a federally reportable disease in poultry. Currently, 'avian salmonellosis' is annually notifiable federally, and SE is notifiable provincially. Alternatively, consider making SE an immediately notifiable disease federally, as recommended in the National Strategy¹⁷.
- 1.2 Develop a comprehensive surveillance and control program for breeding flocks. Measures may include: importation of live chicks placed directly on farm (instead of hatching eggs); complete separation of space within the hatchery for hatching parent stock; evaluation and upgrading of pest control on all farms; vaccination of high-risk flocks; development and implementation of an SE monitoring program.
- 1.3 For all poultry farms and hatcheries to implement compulsory reporting of positive flocks to the recipient farm (or slaughter establishment, see 4.4 for additional detail) in order to enhance biosecurity and control measures.
- 1.4 Ensure transporters (including catching crews) are informed before transporting SE infected birds, and that appropriate biosecurity and thorough cleaning and disinfection procedures are undertaken following transportation and before transporting any other birds.
- 1.5 Develop a program for poultry farms to oversee farm biosecurity (e.g., disinfection between flocks, cleaning and disinfection procedures for staff prior to entering the barn, and pestcontrol) on all poultry farms. Full cleaning and disinfection of barns following an SE positive flock, rather than dry cleaning only, is essential to avoid horizontal transmission of SE to the subsequent flock.
- 1.6 Enhance the testing program for layer flocks, based on an evaluation of the current testing protocol (see 6.2 for additional detail).
- 1.7 Enhance awareness about SE and mitigation options, including vaccination, for both commercial and small flock owners.
- 1.8 Ensure that sources supplying day-old chicks to small flocks are subject to the same rules as those supplying commercial flocks.
- 1.9 Work with the CFIA to establish and licence additional egg grading stations in rural and remote B.C.

¹⁷ Health Canada. 2015. National Strategy for the Control of Poultry-Related Human *Salmonella* Enteritidis Illness in Canada. Bureau of Microbial Hazards, Food Directorate, Health Products and Food Branch.

2. Prevent new SE from entering B.C. poultry supply chain (eggs and meat)

As well as controlling SE circulating in B.C. poultry flocks, it is critical to reduce the risk of new infections being introduced through importation of infected eggs, birds or feed. Under trade agreements, twenty percent of hatching eggs may be imported into B.C. from the United States (US).

- 2.1 Work with the CFIA to only allow importation of certified SE-free day-old chicks or hatching eggs from certified SE-free flocks. However, for this standard to become an import requirement, the Federal Government would first need to make SE a federally reportable disease in poultry (see 1.1 for additional detail).
- 2.2 Ensure that poultry feed is free of SE. Measures to mitigate this risk include ensuring that the feed is stored under good biosecurity conditions (e.g. restricting pest access), heat treatment of the feed and an effective SE monitoring program for feed. The CFIA has full oversight of this under the Feeds Act and Feeds Regulations.

3. Monitor effectiveness of control measures in the B.C. poultry industry

Currently, surveillance by industry of SE in poultry does not allow for unbiased calculations of the disease incidence, and not all the information that is available is routinely or freely shared with government agencies. A system to monitor SE levels is necessary to ensure that the control measures are being implemented and are effective.

- 3.1 Develop a system of reporting SE monitoring results and trends in poultry flocks as well as hatcheries to stakeholders, including government agencies (e.g. quarterly reports).

4. Minimise SE contamination of food

There are measures that slaughter establishments, further processors and others could take to reduce the likelihood of cross-contamination if they were informed that they were receiving SE-contaminated product.

- 4.1 Set performance standards for SE in poultry products (e.g., limits to the amount or frequency of SE that can be present in these products in order to be marketed). This approach is being considered at the national level as part of the National Strategy implementation. This approach has been in place in Europe for the past several years. The USDA Food Safety and Inspection Service has recently (2016) enacted *Salmonella* and *Campylobacter* standards in poultry products.
- 4.2 Review the current implementation of the Hazard Analysis and Critical Control Points (HACCP) approach in B.C. slaughter establishments and further processors to identify further SE-specific mitigation strategies for implementation.
- 4.3 Implement testing of broiler flocks for SE close to slaughter. Until very recently, there was no routine sampling for SE in broiler flocks. The industry has initiated a pilot testing program in these flocks in January 2017.
- 4.4 Inform slaughter establishments and further processors if they will be receiving SE positive flocks and ensure that mitigating measures (e.g., slaughter SE positive flocks at the end of the day or week, prior to a cleaning break) are implemented.
- 4.5 Enhance education and awareness for slaughter and further processing establishment workers about SE and measures to minimise food contamination (e.g., ProcessSafe- under development).

- 4.6 Develop mechanisms to provide a competitive advantage to poultry products from SE-free farms. For example, labelling can be used as a tool: *Salmonella*-free or *Salmonella*-monitored products are already being marketed in other countries (e.g., Lion code type labels for eggs¹⁸, *Salmonella*-free poultry meat in Scandinavian countries).
- 4.7 Make leak-proof packaging compulsory at retail for poultry meat: cross-contamination of ready to eat foods with poultry juices has been reported at retail and in the household.
- 4.8 Improve traceability of poultry products- including both meat and eggs.

5. Manage foods where SE may be found through education and preventive actions

It is unrealistic to expect that all raw ingredients will be completely free from SE. Saying that, there are steps that people handling raw ingredients can take to minimise the risk that SE in an ingredient will still be present after the food has been cooked and is about to be consumed. Food handlers in food premises (further processors, food service establishments (FSEs) as well as food retail establishments) must be aware of the correct handling and cooking procedures for poultry meat and eggs. The Province has developed guidelines and educational materials in response to the risk posed by SE in poultry products (e.g., the pooled egg guideline, enhanced FOODSAFE training for poultry products). This information must be made available to the people who need to know- those people making day to day decisions that can affect the final safety of the food they are preparing.

- 5.1 Ensure food premises are aware of and are following the pooled egg guideline.
- 5.2 Ensure that food premises only use clean, uncracked, refrigerated and graded eggs.
- 5.3 Ensure food premises handle poultry products according to their food safety plans, with special attention placed on egg pooling, minimizing cross contamination, and cooking requirements.
- 5.4 Implement a public education campaign to enhance consumer education and awareness regarding SE and poultry products. This could include a sustainable media campaign and/or improved consumer education labelling.
- 5.5 Encourage retail establishments to make pasteurized egg products available for consumers.
- 5.6 Expand existing food safety training requirements for FSEs to include all food handlers. Currently only the FSE operator and one person in his/her absence is required to complete FOODSAFE training.
- 5.7 Further publicize and expand the uptake of existing food safety training programs (e.g., FOODSAFE) in order to attract broader audiences including the general public and/or younger audiences (e.g. high schools).
- 5.8 Implement mandatory food safety training for the food retail industry (e.g., FOODSAFE or ProcessSafe—currently under development), which would include specific information on how to handle poultry products safely.

¹⁸ The British Egg Industry Council. 2013. Code of Practice for Lion eggs.
<http://www.britisheggindustryCouncil.co.uk/download/LCoPV7.pdf>. Accessed 2018-06-14.

6. Address knowledge and information gaps

Currently available SE human illness and poultry/poultry products surveillance data do not allow the discernment between the relative contributions of egg and chicken meat consumption to the burden of human illness caused by SE. This is in part because SE is a clonal organism. What this means, from an organism “fingerprinting” viewpoint, is that there is generally very little variation between different isolates when using traditional laboratory methods such as Pulsed-Field Gel Electrophoresis (PFGE) and phage-typing. This lack of variation detected in isolates using traditional laboratory methods gives the appearance that most isolates have similar or identical fingerprints. As such, it has been difficult to identify clusters of human illness and to definitively link specific sources of food to the human illness cases.

However, whole genome sequencing (WGS), a relatively new laboratory method, is a much more sensitive and specific method that can be used to generate high resolution “fingerprints” for SE. An integrated surveillance system that includes WGS of SE isolates from animals, their environment, food and humans will be extremely useful to compare findings and assess where SE is being introduced along the farm to fork continuum. This will result in a better understanding of the source(s) and inform more effective interventions to prevent human infections.

WGS may also help in better understanding the dynamics of SE within the poultry industry. For example, WGS results could establish whether an SE positive flock was infected with strains originating in breeding flocks, previous positive flocks in the same barn or from the environment of the barn. This information would facilitate the identification and implementation of more effective SE control measures for poultry.

In addition, outstanding questions need to be addressed about the structure of the poultry industry in B.C., particularly regarding small flocks, and the details regarding the origin of fresh and processed poultry products sold in B.C.

- 6.1 Implement routine WGS of animal, food and human SE isolates, supporting the development of laboratory and analytical capacity, with an end goal of systematically integrating WGS data from multiple sources.
- 6.2 Build on existing SE surveillance to produce a robust, comprehensive and integrated farm to fork surveillance system (see process maps in Appendices B, C and D).
- 6.3 Determine the sensitivity of the sampling methods in hatcheries and laying flocks. Ideally, the minimum prevalence that can be detected should be known. This information could be used to calculate the potential number of contaminated (hatching or table) eggs that would be distributed prior to detection during routine surveillance. This activity is related to one of the high priority objectives of the National Strategy: to establish consistent, validated sampling and testing methods for SE in poultry products and poultry flock environments.
- 6.4 Determine the proportion of hatching eggs, day-old chicks, poultry meat (fresh and processed, e.g., chicken nuggets) and eggs imported into B.C. from outside of: 1) B.C. and 2) Canada. The greater the proportion imported and consumed by B.C. residents, the less effective B.C.-specific control measures will be, assuming a similar level of SE contamination between local and imported product.

- 6.5 Building on 6.3, recommend to the federal government that they provide dedicated resources to accelerate the implementation of the National Strategy including the sharing of SE data through national food and animal safety surveillance initiatives, both developed and in development. These include PulseNet Canada, the Canadian Animal Health Surveillance Network (CAHSN) and the Canadian Food Safety Information Network. These networks will ultimately form a Network of Networks to allow the seamless exchange of clinical, animal and food data across Canada.
- 6.6 Collate the existing baseline information on the poultry slaughter and processing industry sectors in B.C.: who they are, where they are located, what they process, how much they produce and distribute, and what are their current SE testing protocols and results.
- 6.7 Determine the size of the permitted small flock sector (both meat and eggs) in relation to the overall size of the poultry industry in B.C. Given the difficulty in implementing control measures in this largely unregulated sector, it would be useful, as a first step, to know the relative size of this sector in order to inform risk assessment efforts.¹⁹

¹⁹ Note: Consideration was given to determining the size of the non-permitted small flock sector. The Working Group concluded that the resources necessary to accurately determine this would not be justified from a cost/benefit perspective.

Appendix A: Overview of poultry sectors - Process maps

Process maps were developed to describe the broiler (meat), table egg and small flock industries in B.C. (see appendices B, C and D) to better understand:

- the flow of poultry products from farm to fork in B.C.;
- potential avenues for introduction of SE into these products;
- the current monitoring and control procedures for SE; and
- where SE surveillance or controls exist.

A summary of the information gathered for each sector is shown below.

1. Commercial Broilers (Chicken meat) (Appendix B)

The commercial broiler sector produces the majority of chickens consumed as meat in B.C. There are no significant exports of live broilers from B.C. The sector has three main components:

1. Grandparent stock: Grandparent stock is produced outside of Canada. They produce hatching eggs, which are then transported to hatcheries in Canada and the US. The resulting chicks go on to become broiler breeders.
2. Broiler breeders: There are approximately 60 producers in B.C., regulated by the BC Broiler Hatching Egg Commission. These birds produce broiler hatching eggs which then go to hatcheries to become broilers (meat birds which are consumed by people).
3. Broiler Farms: There are approximately 325 producers that raise broilers. These producers are regulated by the BC Chicken Marketing Board.

Hatching eggs are delivered to a hatchery, where the eggs are incubated for approximately three weeks before hatching day old chicks (DOC), which are then transported to a broiler breeder farm or a broiler farm (depending on the type of egg being hatched). Twenty percent of hatching eggs may be imported into B.C. from the US. In B.C., there are three large hatcheries, producing about 80% of the broiler chickens, and eight smaller hatcheries. Hatcheries may hatch both broiler breeder and broiler chicks in the same facility. The smaller hatcheries may also hatch layers, birds for small flocks or other species.

Routine surveillance for *Salmonella* is done through testing hatchery fluff, under a CFIA program designed for *Salmonella Pullorum* and *Salmonella Gallinarum*. *Salmonella Pullorum* and *Salmonella Gallinarum* are organisms related to animal/flock health- they are not a concern from a human health viewpoint. Each hatchery is sampled every six weeks. In the event of a positive sample, the hatchery is retested after two weeks and environmental sampling is done at the potentially implicated broiler breeder flock(s) of origin.

Possible additional control measures for SE in broilers include ensuring broiler breeder flocks are SE-free through compulsory vaccination of broiler breeders, acidification of water and increased biosecurity (e.g. cleaning and disinfection between flocks, adequate cleaning and disinfection procedures for staff prior to entering the barn, and pest control). Transitioning multi-age broiler farms into an all-in, all-out management system to allow for synchronized cleaning and disinfection, and down-time may also provide some benefit.

Slaughter establishments in B.C. are either federally registered by the CFIA or are provincially licensed. Slaughter establishments that are provincially licensed are only permitted to sell their product within B.C. There are currently 33 provincially licensed slaughter establishments (23 Class A and 10 Class B) that accept poultry in B.C.²⁰. There are 10 federally registered slaughter establishments in B.C., which are permitted to export their product outside the province. Federal slaughter establishments process the vast majority of chickens in B.C., with provincially licenced slaughter establishments slaughtering less than 4% of broiler chickens.

Most of the federally inspected slaughter establishments are working to meet new US performance standards for *Salmonella* and *Campylobacter* levels^{21,22}. These standards include regularly taking and testing samples for these pathogens to determine whether they meet the pre-established standards (US performance standard for *Salmonella* in broilers- fewer than five *Salmonella* spp. positive results in a set of 51 samples). The CFIA is planning to extend this requirement to all federally inspected plants in 2017. Provincially inspected processors are not currently required to follow these performance standards. Limited non-regulatory surveillance for *Salmonella* at provincially licensed slaughter establishments is performed through the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS).

SE levels in meat at retail stores are monitored by two federal programs: CIPARS and FoodNet Canada (B.C. Site). This information is complemented by the results of food sampling in B.C. FSEs and retail stores through the Food Quality Check Program, led by the BCCDC in collaboration with the RHAs.

²⁰ In addition to the Class A and B provincially licenced slaughter establishments, there are currently 24 Class D and 12 Class E facilities licensed by the Regional Health Authorities to process poultry. Class D facilities can slaughter and sell up to an equivalent of 5,000 birds per year to consumers at the farm gate, farmers markets and restaurants within their regional district. Class E facilities can slaughter and sell up to an equivalent of 2,000 birds per year to consumers at the farm gate and at farmers markets within their regional district.

²¹ Canadian Food Inspection Agency. 2017. Meat and Poultry Products, Manual of Procedures, Chapter 11, United States of America. Annex U: USDA Performance Standards for *Salmonella*. www.inspection.gc.ca/food/meat-and-poultry-products/manual-of-procedures/chapter-11/united-states-of-america/annex-u/eng/1371663720505/1371663913885 Accessed 2018-06-14.

²² Canadian Food Inspection Agency. 2017. Meat and Poultry Products, Manual of Procedures, Chapter 11, United States of America. Annex U-1: USDA Performance Standard for *Campylobacter* on Chilled Carcasses of Young Chickens and Turkeys. www.inspection.gc.ca/food/meat-and-poultry-products/manual-of-procedures/chapter-11/united-states-of-america/annex-u-1/eng/1396275708818/1396291666107

2. Table Eggs (Appendix C)

The commercial layer sector produces the majority of eggs consumed in B.C. The sector is also pyramidal with four levels:

1. Grandparent stock: All are located outside of Canada. They produce fertile eggs, which are then transported to hatcheries to become multiplier breeders.
2. Multiplier breeders: The multiplier breeder flocks in B.C. are all owned by a single company. They produce hatching eggs that are hatched at the single multiplier hatchery in B.C. Hatching eggs for the multiplier hatchery are also imported from other provinces and from some US states (Washington and Oregon). This sector is not regulated at the moment. Many of our pullet chicks are also imported from outside of British Columbia.
3. Pullet Grower Farms: These farms receive day old chicks from the multiplier hatchery and raise them to 17 weeks of age at which point they are then placed in egg layer farms. These operations are regulated by the BC Egg Marketing Board.
4. Regulated Egg Flocks: In B.C., about 136 registered producers raise almost 2.4 million layer hens annually, which in turn produce over 64 million dozen eggs per year²³. Each flock typically produces eggs for just less than one year at which point the flock is depopulated and replaced with a replacement flock. These producers are regulated by the BC Egg Marketing Board.

B.C. also imports table eggs from other provinces, including Manitoba, Saskatchewan and Alberta. In 2015, over 8.7 million dozen eggs were imported²⁴, compared with a B.C. table egg production of 64 million dozen eggs. In contrast, exports of table eggs are very limited, (68,550 dozen to Alberta in 2015)²⁵.

The **Start Clean-Stay Clean™** program is a certification program designed by the Egg Farmers of Canada and operationalized by the respective provincial egg marketing boards. The program entails monitoring critical control points, implementing best management practices and an annual inspection of all regulated egg farmers. There is a dedicated SE testing program which includes environmental testing of flocks at the pullet barn before placement at the layer farm, and then halfway through and at the end of life of the laying flock. Eggs from SE positive flocks are sent to the breaking station immediately on detection, where they will be used in processed products until the end of the SE positive flock's life. This program also ensures egg producers are compensated for the economic loss of the SE positive flock, which provides compliance and participation from the entire sector.

²³ BC Egg Farmers. Undated. BC Egg Farmers Care. <http://www.bcegg.com/farm-to-table/bc-egg-producers>. Accessed 2018-06-14.

²⁴ Egg Farmers of Canada. 2018. Interprovincial and territorial movement of eggs. Tableau 5. <http://www.eggfarmers.ca/market-information-tables/#tableau-5>. Accessed 2018-06-14.

²⁵ Ibid.

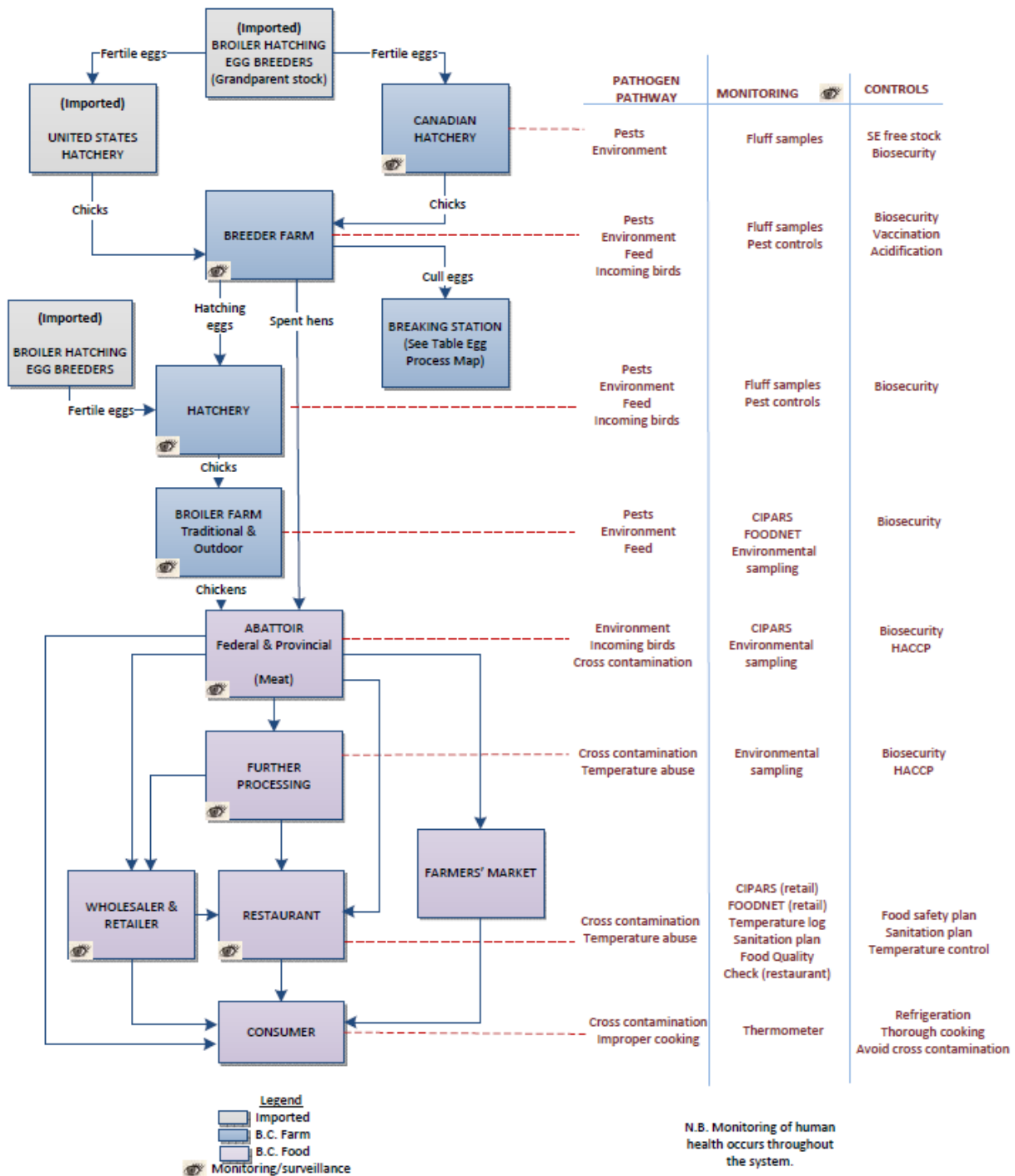
3. Small Flocks (Appendix D)

A small flock is considered to be less than 100 layer hens or fewer than 200 broilers. It is estimated that there are approximately 10,000 small flocks in B.C., but the actual number is unknown. These flocks may be dedicated to egg or meat production or both. Small flock producers typically purchase chicks from feed stores, owners of other small flocks or hatcheries. It is not known how many hatcheries in B.C. serve small flocks. Some hatcheries do 'mail order' delivery of the chicks. These hatcheries may be located outside of the province or the country. Some feed stores are also involved in receiving and distributing chicks to customers.

Both the B.C. Chicken Marketing Board and the BC Egg Marketing Board have introduced permitted production, allowing for farms to produce limited numbers of both products within the regulated system. These producers are required to use licenced slaughter facilities when processing product for sale, and they are encouraged to use egg grading stations wherever possible. The B.C. Egg Marketing Board also does a site visit and follows a biosecurity checklist with their permitted producers to create awareness. This includes discussions about the potential impact of SE on human health.

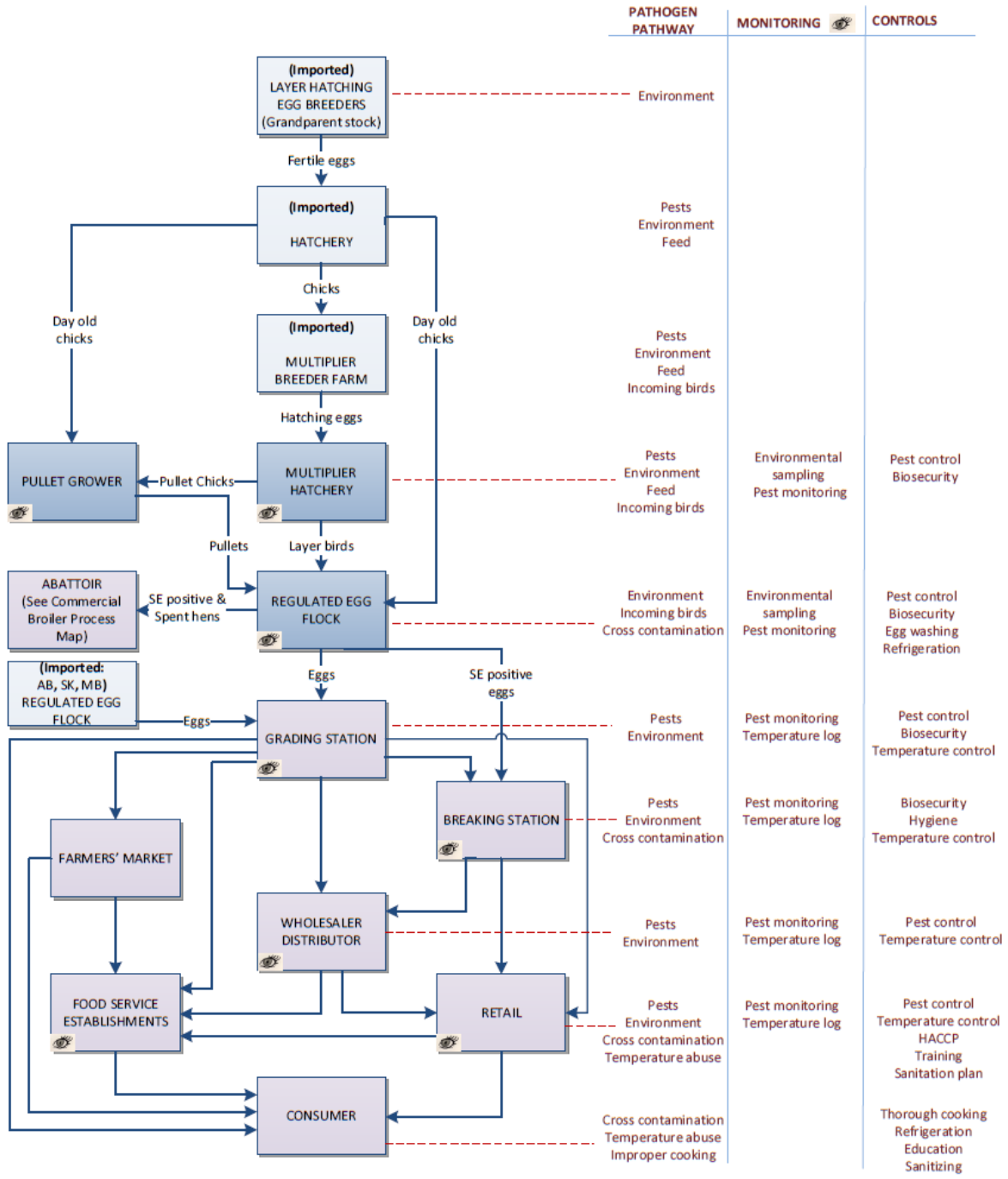
Appendix B: B.C. Commercial Broiler Process Map

B.C. Commercial Broiler Process Map



Appendix C: B.C. Table Egg Process Map

B.C. Table Egg Process Map



Legend
 Imported
 B.C. Farm
 B.C. Food
 Monitoring/surveillance
 * = 3 generations

N.B. Monitoring of human health occurs throughout the system.

Appendix D: B.C. Small Flock Process Maps

B.C. Small Flock Process Map

