May, 2017

Recommendations for Creating an Optimal Area Based Management Plan for the Hullcar Aquifer

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INTRODUCTION

Livestock-related nitrate contamination of groundwater is a serious problem across North America and British Columbia. Cow manure from dairy farms is recognized as a significant source of agricultural pollution and a primary source of excess nutrients in groundwater.[1] North American agricultural practices have increased the concentration of animals, increasing waste quantity and the risk of nutrient contamination. Nitrate is the most common groundwater contaminant, and agriculture the most significant source.[2] Cleaning up contaminated groundwater is very costly, if possible at all -- reducing nitrate inputs on fields may take years to improve groundwater quality.[3]

Effluent from dairy farms poses a risk of contamination to shallow aquifers in the Okanagan, Fraser, Comox, Cowichan and other watersheds throughout BC[4] – and has now reached a crisis level in the Hullcar Valley.[5] This report identifies causes and history of nitrate pollution in the

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1 Western Environmental Law Centre, "*Agricultural Pollution in Puget Sound: Inspiration to Change Washington's Reliance on Voluntary Incentive Programs to Save Salmon*", (2016) at page 9.

2 Loren Bekeris, *Field-Scale Evaluation of Enhanced Agricultural Management Practices Using a Novel Unsaturated Zone Nitrate Mass Load Approach*, 2007, Waterloo.

3 Loren Bekeris, *Field-Scale Evaluation of Enhanced Agricultural Management Practices Using a Novel Unsaturated Zone Nitrate Mass Load Approach*, 2007, Waterloo at page 2. On the high cost of groundwater cleanup, see: Western Environmental Law Centre, "*Agricultural Pollution in Puget Sound: Inspiration to Change Washington's Reliance on Voluntary Incentive Programs to Save Salmon*", (2016) at page 10 and Auditor General of British Columbia, *An Audit of the Management of Groundwater Resources in British Columbia* (Victoria, BC: Office of the Auditor General, 2010) at page 17.
http://www.bcauditor.com/sites/default/files/publications/2010/report_8/report/OAGBC_Groundwater_Final.pdf>

4 "Frequently Asked Questions and Answers, Hullcar Aquifer Water Quality", Online: Ministry of Environment, <http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/hullcar/2016-06-10_hullcar_faqs.pdf>

5 Drinking water in the Hullcar aquifer has been contaminated by dangerous levels of nitrates, which can cause "blue-baby syndrome" in infants, and pose other health risks. The largest dairy farm in the Okanagan, which disposed of its excess manure on fields above the aquifer, has been identified as a source of nitrate pollution. [See Pollution Abatement Order #108387, Armstrong BC (May 12, 2016)]. In 2014, the Ministry of the Environment placed a Compliance Order on the farm, and required them to complete a Nutrient Management Plan ("NMP"). However, the nitrate levels in drinking water continued to rise. [See "Hullcar Aquifer Inter-Ministry Working Group Updates" (November 18) Online: Ministry of Environment, http://www2.gov.bc.ca/assets/gov/environment/air-land-water/site-permitting-and-compliance/hullcar/2016_11_18_interministry_wg_update.pdf]. Last year SHAT and the ELC requested a Drinking Water Protection Order for the Hullcar Valley, which a Ministry of Health team is now investigating. Residents of the Hullcar Valley as well as other people in rural locations depend upon the drinking water quality of shallow groundwater aquifers. Non-point source contamination from intensive dairy operations can compromise the drinking water for all residents of the Hullcar Valley.

Hullcar Valley, and proposes solutions based on strategies employed in other jurisdictions, and tools available in the province of BC.

ROOT CAUSES OF NITRATE CONTAMINATION

A systemic cause of nitrogen pollution in the Hullcar Valley and other BC dairy farming areas is a lack of clear nutrient management regulations for the agricultural industry. Flawed laws have allowed improper agricultural waste management practices. The problem has been exacerbated by a lack of enforceable integrated watershed-based planning.

The need for BC to better regulate dairy farmers was spotlighted last year when Washington State farmers asked the Governor of Washington to demand that BC crack down on manure contamination flowing across the border and damaging streams and shellfish beds. The Washington farmers pointed out that since 1998 Washington has required farmers to develop and follow manure (nutrient) management plans. They objected to the fact that BC has yet to require BC farmers to do the same to protect the environment.[6]

The Hullcar situation again highlights just how weak regulation of agricultural nitrates in BC is, in comparison to other jurisdictions. The current BC approach to agriculture-based groundwater pollution prevention is not working because land management practices (such as the storage, transportation, and application of manure as fertilizer) are not regulated based on meeting drinking water quality standards. The regulation of agricultural waste discharges does not adequately address the important connection between land use and water quality.

Agricultural waste is regulated by the *Environmental Management Act* and the Agricultural Waste Control Regulation ("AWCR").[7] Section 13 and 14 of the AWCR state:

> *"S.13 Agricultural waste must not be applied to the land if, due to meteorological, topographical or soil conditions or the rate of application, runoff or the escape of agricultural waste causes pollution of a watercourse or groundwater."*
>
> *"S.14 Agricultural wastes must not be applied (e) at rates of application that exceed the amount required for crop growth, if runoff or escape of agricultural waste causes pollution of a watercourse or groundwater, or goes beyond the farm boundary."*[8]

On its face, the regulation is aimed at protecting groundwater sources such as the Hullcar Aquifer. However, it is inadequate because it is so vague – and is so reactive, instead of proactive. The regulation only becomes relevant once the pollution is already occurring. But there is nothing enforceable until the pollution has happened.

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6 Larry Pynn, *Vancouver Sun*, September 6, 2016, "Washington state farmers want B.C. to tackle cross-border waste flows" http://vancouversun.com/news/local-news/washington-state-farmers-want-bc-to-tackle-flow-of-sewage-south-in-border-streams

7 BC Reg. 5/2015

8 *Environmental Management Act, SBC 2003, c.53; Agricultural Waste Control Regulation*, BC Reg 5/2015 at s.13

Unlike many jurisdictions, BC does not require the farmer to actually calculate the amount of manure effluent that a particular field can safely absorb before it will threaten groundwater quality. BC farmers may not intend to apply manure at rates of application that exceed the amount required for crop growth in such a way that it pollutes aquifers. But a lack of regulations means that BC farmers – unlike farmers in Washington and Ontario – are not required to go through a science-based process to determine the amount of manure that can be applied to the field without putting aquifers at risk. This situation arises because the current *Environmental Management Act* and AWCR do not require the farmer to have such knowledge before spreading the potentially polluting material.

The Hullcar aquifer watershed does not have an enforceable integrated watershed-based plan for managing threats to its drinking water (such as a Drinking Water Protection Plan). And by itself the Agricultural Waste Control Regulation is inadequate for preventing pollution. First of all, the AWCR does not take a watershed or cumulative effects approach to preventing the threat of agricultural waste contaminating drinking water sources. Second, the AWCR is vague, allows too much room for uncertainty -- and its wording is not specific enough about allowable amounts of waste like manure effluent. It does not set a measurable nutrient concentration value that the farm must stay below in order to avoid polluting surface and groundwater. This encourages a trial-and-error approach to nutrient application that may lead directly to the very type of contamination that the Hullcar Valley is experiencing. The problem with such trial and error is that an error may poison someone's tap water. As in the Hullcar case, action is only taken when it is too late to ensure the drinking water is clean. To coin a phrase, this law only closes the barn door after the cow (poop) has escaped.

THE HULLCAR NITRATE CONTAMINATION SITUATION

In the Hullcar situation, it was only after drinking water had become almost undrinkable that Government issued a compliance order. And it was only when that Compliance Order was issued that the suspected farm was ordered to do what other Governments require **all** farms to do in the first place – to prepare a scientifically-sound Nutrient Management Plan.[9] The Compliance Order also finally required consideration of the drinking water quality in a way that the AWCR regulation did not. The MOE order finally declared that "the recommended application rate [of manure] must also consider nitrate levels in Steele Springs", and ordered Jansen Farms to retain a qualified professional to report recommendations relative to mitigating the nitrate levels in Steel Springs to less than 6 mg/L.[10]

The Compliance Order approach has its merits – it can address contraventions of the EMA which have occurred, and may order preventative measures to address future contraventions of the offender. However, because it is *retrospective* in nature, it can come too late, after the damage is done. And it may be ineffective in preventing similar occurrences from other potential drinking water threats.

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[9] See the discussion of jurisdictions that require Nutrient Management Plans below. The issuance of the Compliance order just before nitrate levels exceeded safe levels is discussed in our request for a Drinking Water Order, found at http://www.elc.uvic.ca/wordpress/wp-content/uploads/2016/02/Drinking-Water-Protection-Order-submission-2016Feb1.pdf, p.6.

[10] Compliance Order #76600-20, Armstrong, at pg. 5

The subsequent Pollution Abatement Order issued to Jansen Farm[11] recognized the importance of linking land use to groundwater contamination when it ordered the following requirements:

- Complete an Environmental Impact Assessment ("EIA") that assesses the impact of fields where manure are generated or stored, storage facilities, manure effluent lines, seasonal and confined feeding areas, drainage, and all fields where agricultural waste has been applied as nutrients.
- Retain a qualified professional to prepare and implement an Action Plan detailing measures to abate environmental impacts identified in the EIA, which must include:
    - Manure storage measures that ensure sufficient storage
    - Drainage management measures that ensure contaminated runoff doesn't enter groundwater
    - Remedial measures to ensure manure doesn't extend into a watercourse
    - Soil, surface, and groundwater monitoring to ensure effectiveness of action plan
    - Map of all farm operations including manure storage, feeding areas, water wells, and surface water
    - A nutrient management plan
    - A timeline for implementation of the action plan
- Prepare annual progress reports for 2 years[12]

After the Hullcar aquifer's undrinkable water became a major political and media story, Government issued this Pollution Abatement Order, which recognized effective measures for preventing contamination caused by dairy farms. However, other jurisdictions require similar measures as a matter of course – and don't wait for water to become undrinkable and subject to media and Legislative controversy before action is taken. Other jurisdictions have recognized such land management and other measures are effective in *preventing* contamination of drinking water sources. We can learn from the experiences of those jurisdictions as we:

- design an effective ABMP;
- apply that model ABMP in other BC agricultural areas; and
- create new remedial legislation.

STRATEGIES EMPLOYED IN OTHER JURISDICTIONS:

Other jurisdictions have designed systems of agricultural management to prevent nitrate contamination, mitigate existing contaminant, and make better use of the valuable byproducts of dairy farming. The ELC has researched initiatives in other jurisdictions, including legislated measures, best farm practices, encouragement of advanced technologies, voluntary measures, financial incentives and monitoring and enforcement measures,. Four key strategies -- and the jurisdictions that employ them – are displayed in Table 1. Each strategy and its implementation in each jurisdiction is further detailed below.

[11] This Pollution Abatement Order #108387, Armstrong BC, May 12, 2016 replaced Compliance Order #76600-20, and contained very similar specific requirements.
[12] Pollution Abatement Order #108387, Armstrong BC, May 12, 2016

We recommend that each of these strategies be considered for incorporation into the plan to resolve and prevent further nitrate contamination of the Hullcar Valley. Furthermore, we recommend that the strategies be considered for province-wide implementation, in the valleys facing similar agricultural waste problems. For example, these strategies could be used widely to create Dairy District Area Based Management Plans, wherever intensive dairy and livestock production threatens water quality.

Table 1: Strategies employed in other Jurisdictions				
Strategy for Animal-Sourced Nitrogen	Jurisdiction			
	Washington	Alberta	Ontario	EU
1. Place a cap on cow density for farms that spread manure onsite.		✓		✓
2. Require nutrient management plans that limit manure applications to non-polluting levels	✓	✓	✓	✓
3. Require adequate manure storage facilities	✓	✓	✓	✓
4. Support opportunities for alternative manure processing technologies	✓	✓	✓	✓

1. PLACE A CAP ON COW DENSITY FOR FARMS THAT SPREAD THEIR MANURE ON SITE

This strategy involves limiting the density of cows on a farm to match the nitrogen cycling capacity of the farm's fields (for farms which fertilize their fields with manure).

This is key, since a common cause of groundwater nitrate overloading is simply having too many cattle on too small a field. Each field has a nitrogen loading rate which it can sustainably absorb. When nitrogen loads on the land exceed the capacity of the soil to cycle the nutrient, the excess nitrogen can leach from the field and become a contaminant in surface and groundwater. The carrying capacity of a field varies with the soil type, with coarse soils being more susceptible to nutrient leaching, and therefore having a more limited carrying capacity.[13] Dairy cows (and other livestock) create a predictable amount of nitrogen.[14] Hence, where dairy cow (and other livestock) manure is the source of the nitrogen, the simple solution is to place no more animals on the field than the field can sustainably hold.

In practical terms, setting a nitrogen application limit on fields that get nitrogen from cow

[13] Telephone conversation, Hans Shreier – Professor Emeritus, Land and Water Systems UBC (October 14, 2016)

[14] Standards and Administration Regulation AR 267/2001 s. 24(1); Schedule 3 - Table 3. Dairy cows produce approximately 100 kg of Nitrogen in their manure annually - State of Washington Department of Ecology, "*Concentrated Animal Feeding Operation (CAFO) National Pollutant Discharge Elimination System (NPDES) And State Waste Discharge General Permit*", (Olympia, Washington 2006)

manure works out to be a "cap" on the number of cows that the field can sustainably hold. It works out to be a cap on cow density.

European Union

In the European Union, the Nitrate Directive specifies a maximum of 170 kilograms (kg) nitrogen per hectare per year, which practically translates to an animal density limit of 2 dairy cows per hectare for farms that spread all of their manure onsite.[15] Penalties are issued to farms which breach the nitrogen application limits. Exceptions to the 170 kg N/ha/yr rule are permitted, but must be justified on the basis of a greater abilty to absorb nitrogen (*e.g.*, due to longer growing seasons, high nitrogen uptake crops, high net precipitation, or exceptionally high denitrification capacity). In the UK, exceptions are granted for farmers with grassland derogation - the Nitrate limit is increased to 250 kg N/ha/year for eligible farm operations. To be eligible, farms must have 80% of the agricultural area of the farm as grass. Land management conditions are prescribed as well, and include: nutrient application plans, ploughing restrictions, crop restrictions, fertilizer application plans for phosphorus and nitrogen, and additional record keeping.[16]

It is encouraging to note a key point -- the introduction of nitrogen limits works. In the European Union between 2004 and 2007, nitrate concentrations in both surface and groundwater remained stable or improved in the majority of sites tested.[17]

Alberta

Alberta has a limit on nitrogen application to land -- which roughly translates into a cap on cow density. Alberta requires that a person have access to sufficient land for the application of manure so that the application limits for nitrogen are not exceeded; the nitrogen limits are set according to soil type and range from 80 kg/ha to 270 kg/ha (or functionally approximately 1 to 3 cows per hectare). [18] To protect soil, a person must not apply manure to soil unless the soil has been tested within 3 years, and a person may not apply manure if the nitrogen in the soil will exceed the limits in the regulation.[19] If the cap is exceeded, a Nutrient Management Plan is required.

(On a related note, concentrated/confined animal feeding operations ("CAFO") routinely exceed the carrying capacity of the land they are on. These operations create an increased risk of pollution compared to other farming operations because they generate waste that must be managed, stored and disposed of away from the area where the animals are contained. Many jurisdictions including Alberta and Washington State recognize the increased risk of CAFOs and

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[15] "*Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC)"* (Official Journal of the European Communities No L 375/1.

[16] Department for Environment Food & Rural Affairs, "*Guidance on complying with the rules for Nitrate Vulnerable Zones in England for 2013-2016*", (UK: Department for Environment Food & Rural Affairs, 2013)

[17] European Commission, "The EU Nitrates directive"(2010) at page 1. online: http://ec.europa.eu/environment/pubs/pdf/factsheets/nitrates.pdf

[18] Standards and Administration Regulation AR 267/2001 s. 24(1); Schedule 3 - Table 3. Dairy cows produce approximately 100 kg of Nitrogen in their manure annually - State of Washington Department of Ecology, "*Concentrated Animal Feeding Operation (CAFO) National Pollutant Discharge Elimination System (NPDES) And State Waste Discharge General Permit*", (Olympia, Washington 2006)

[19] Standards and Administration Regulation AR 267/2001 25(5) and (6).

require permitting or approval of these operations.[20])

2. REQUIRE NUTRIENT MANAGEMENT PLANS THAT LIMIT MANURE APPLICATIONS TO NON-POLLUTING LEVELS

Nutrient Management Plans (NMPs) allow farmers to calculate how much manure they can apply to their land before it may harm the environment. They are science-based plans that are designed to avoid over-application of manure that may threaten water and other environmental values.[21] NMPs require testing of soil to see how much nitrate is in the soil, testing of manure effluent to determine nitrate levels, consideration of the amount of nitrate particular crops may either fix into or remove from the soil, mapping of soil types to determine porosity of soil to groundwater, identification of areas of the farm that may be sensitive to nutrient overload, and determination of optimal rates, timing and method of nutrient application to the farm (See Appendix H, which describes the key components of a Nutrient Management Plan.)

Dairy farms in many US states, Ontario and across the European Union are required to have nutrient management plans.[22]

Washington and other US States
Dairy farmers in Washington and in a number of other US states must meet a general requirement to have Nutrient Management Plans.[23] For example, all dairy producers in Washington state licensed to produce milk for sale, regardless of size, must prepare a dairy nutrient management plan.[24] Dairy producers are also required to register with the Washington State Department of Agriculture, and participate in a program of regular inspections and compliance. Additional permits are required for Concentrated Animal Feeding Operations (CAFOs).[25]

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[20] Agricultural Operation Practices Act, RSA 2000, C.A-7, s.13.

[21] For a further explanation of the key components of Nutrient Management Plans, see Appendix H. Also, see the US Department of Agriculture's extensive information on "Comprehensive Nutrient Management Plans" at: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/pa/technical/ecoscience/nutrient/?cid=nrcs142p2_018164

[22] Ontario's *Nutrient Management Act, S.O. 2002, c.4; O. Reg 267/03 s.11 (3), s.13. Washington State's Dairy Nutrient Management Act, RCW c.90.64.026. The European Union's* "*Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC)"* (Official Journal of the European Communities No L 375/1., Article 5, Annex III. See footnote below for examples of other US states that require nutrient management plans.

[23] Maryland requires nutrient management plans for all farms that spread animal manure, unless the farm has fewer than eight animal units or a gross income of less than $2,500 USD. Online: http://mda.maryland.gov/resource_conservation/Documents/NM_Law.pdf. Minnesota requires manure management plans (similar to NMPs) for livestock operations of a certain size. Online: <https://www.revisor.leg.state.mn.us/rules/?id=7020.2225> . Vermont requires NMPs for all medium and large farm operations. Online: < http://agriculture.vermont.gov/water-quality/farmer-assistance/nmp-ltp>. CAFO in Oregon which require permitting are also required to produce an animal waste management plan. Online: http://www.oregon.gov/ODA/shared/Documents/Publications/NaturalResources/NPDESGeneralPermit.pdf.

[24] *Dairy Nutrient Management Act, RCW c.90.64.026,* s.1

[25] Washington State Department of Agriculture, "Nutrient Management Plans", Online: <http://agr.wa.gov/foodanimal/livestock-nutrient/nutrientmgmtplans.aspx>

Ontario
Dairy farmers in Ontario are required to have a NMP when livestock numbers are greater than 300 Nutrient Units (300 Nutrient Units = 300 small-framed cows), or located within 100 m of a municipal well.[26] The Ontario government passed the *Nutrient Management Act* in 2002, and a regulation under the Act sets requirements for nutrient management plans.[27]

As in other jurisdictions, the NMP outlines cropping practices, field management and land application of manure and other nutrients according to accepted agronomic practices. It can help the farmer optimize the value of the manure and other nutrients in the cropping program while minimizing the risks to surface and ground water resources. The Ontario Government points out that even where the Regulation does not require a smaller farm to have a NMP, by undergoing the NMP process a farmer can better utilize the nutrients from manure and save money on fertilizer purchases.[28]

Alberta
Farmers in Alberta are not generally required to have nutrient management plans. However, they are subject to manure management regulations that include setbacks, soil testing, record keeping, and application of manure in accordance with *Agriculture Operation Practices Act* (AOPA).[29] In addition, Alberta farmers who do not meet the land base requirements and nitrogen limits (as per Strategy #1 above) must have a Nutrient Management Plan to address their manure application.

European Union
The EU has comprehensive NMP requirements. The EU Nitrogen directive requires that member states implement action programs to address nitrate contamination.[30] The states must either identify nitrate vulnerable zones (NVZ) or apply their action programs to the entire state. The action plans must include the following measures related to nutrient management planning:

> *…limitation of the land application of fertilizers, consistent with good agricultural practice and taking into account the characteristics of the vulnerable zone concerned, in particular:*
> *(a) soil conditions, soil type and slope;*
> *(b) climatic conditions, rainfall and irrigation;*
> *(c) land use and agricultural practices, including crop rotation systems; and to be based on a balance between:*
> *i. the foreseeable nitrogen requirements of the crops, and*
> *ii. the nitrogen supply to the crops from the soil and from fertilization corresponding to:*

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[26] *Nutrient Management Act, S.O. 2002, c.4; O. Reg 267/03, s. 7, s.11 (3) and s.13 And see: http://www.omafra.gov.on.ca/english/nm/regs/nmpro/nmpro03-jun03.htm at Table 3.2.1.*
[27] *Nutrient Management Act, S.O. 2002, c.4*
[28] http://www.omafra.gov.on.ca/english/engineer/facts/10-035.htm (accessed November 15, 2016)
[29] See Standards and Administration Regulation AR 267/2001 s. 24(1) and Alberta Agriculture and Forestry, "Manure Management Planning: The Essentials: Online: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/epw9856
[30] "*Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC)"* (Official Journal of the European Communities No L 375/1.

- *the amount of nitrogen present in the soil at the moment when the crop starts to use it to a significant degree (outstanding amounts at the end of winter),*
- *the supply of nitrogen through the net mineralization of the reserves of organic nitrogen in the soil,*
- *additions of nitrogen compounds from livestock manure,*
- *additions of nitrogen compounds from chemical and other fertilizers.*[31]

The UK offers an example of a comprehensive Nutrient Management Plan regime. The UK regulates the amount of nitrogen that can be applied to specific crops.[32] The amount of nitrogen available for crop uptake from application of livestock manure is calculated based upon the total amount of nitrogen in the manure (established by using standard values, or by sampling and analysis) and the amount of crop-available nitrogen (from a standard value). The UK has implemented reporting and record keeping requirements, although record keeping requirements are relaxed for low-intensity farming operations. [33] Records must be kept of the actual application of manure and crop grown.

The UK has special regulations for the application of nitrates in liquid form – like the manure effluent sprayed in the Hullcar Valley. This is because slurry (manure produced by livestock in a yard or building that has a consistency allowing it to be pumped or discharged by gravity) presents a significant risk of polluting water because of its high readily available nitrogen.[34] Therefore, the UK has specific regulations for application of slurry:

> *Spreading is prohibited during closed periods, which vary depending on soil type and crop type.*
>
> *Restrictions for the rate of spreading outside of the closed period, from the end of the closed period until the end of February, no more than 30 m^3/ha of slurry may be spread in a single application.*
>
> *Three weeks must be allowed between individual applications.*
>
> *May only be spread with equipment that has a low spreading trajectory (below 4 metres from the ground), unless its rate of supplication is less than 0.2mm per hour.*
>
> *Slurry and liquid digested sludge must be incorporated into the soil as soon as practicable, and within 24 hours at the latest unless it is applied by a trailing hose band spreader or a trailing shoe band spreader, or injected into the soil.* [35]

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[31] "*Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC)"* (Official Journal of the European Communities No L 375/1., Article 5, Annex III

[32] *supra note 2*

[33] Department for Environment Food & Rural Affairs, "*Guidance on complying with the rules for Nitrate Vulnerable Zones in England for 2013-2016*", (UK: Department for Environment Food & Rural Affairs, 2013)

[34] Department for Environment Food & Rural Affairs, "*Guidance on complying with the rules for Nitrate Vulnerable Zones in England for 2013-2016*", (UK: Department for Environment Food & Rural Affairs, 2013)

[35] Department for Environment Food & Rural Affairs, "*Guidance on complying with the rules for Nitrate Vulnerable Zones in England for 2013-2016*", (UK: Department for Environment Food & Rural Affairs, 2013)

Unfortunately, in BC – unlike so many jurisdictions -- we do not have a general requirement for Nutrient Management Plans. Thus, in the Hullcar situation, Government eventually ordered farms to develop Nutrient Management Plans – but it was too late, because the water was already seriously polluted.

We should carefully consider jurisdictions that take the much more careful and proactive approach – and require Nutrient Management Plans before water becomes undrinkable. All Nutrient Management Plans should require farms to follow stringent Best Management Practices. And is important to note that in areas where soil and water nitrate levels are already excessive, absolutely no nitrogen application should be allowed.

Note that a useful summary and discussion of best management practices for field management of manure in Washington state is found at Appendix C of this report (The document by Dr. Byron Shaw).[36] In addition, the State of Washington and Ontario's Grand River Water Management Plan have set out useful Best Management Practices documents.[37] These best practices should be reflected in BC Nutrient Management Plans.

All of this planning ahead is simply a recognition that clean up will be exponentially more expensive than prevention.

3. REQUIRE ADEQUATE MANURE STORAGE FACILITIES TO PREVENT LEACHING OF NITRATE

The recent failure of the manure lagoon at Grace-Mar Farms in Spallumcheen highlights the need for proper regulation of manure lagoon facilities. Aside from such catastrophic failures, unlined manure lagoons present a serious ongoing risk of nutrient leaching. Research has shown that all unlined manure lagoons end up discharging to either groundwater or hydrologically connected surface water. [38] Such storage facilities need to be brought up to standard with proper lining. In addition, the risk posed by such lagoons can be reduced by other infrastructure, including roofs to reduce the overfilling of lagoons with precipitation.

A number of jurisdictions regulate these matters. For example, Washington State, Alberta, Ontario, and the EU have legislation requiring adequate manure storage facilities to prevent leaching of nutrients from stored manure into groundwater.

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36 Western Environmental Law Centre, "*Agricultural Pollution in Puget Sound: Inspiration to Change Washington's Reliance on Voluntary Incentive Programs to Save Salmon*", (2016) at page 122-133. See Appendix C of this report.

37 See: *Manure and Groundwater Quality: Literature Review*.Washington State Department of Ecology, June 2016 https://fortress.wa.gov/ecy/publications/documents/1603026.pdf . The Grand River Conservation Authority's Best Management Plan Toolkit Review is found at Appendix E of this paper and online at: https://www.grandriver.ca/en/our-watershed/resources/Documents/WMP/Water_WMP_Report_NutrientBMP.pdf . https://www.grandriver.ca/en/our-watershed/Water-management-plan.aspx

38 Andrea K. Rogers, Attorney and Charles M. Tebbutt, Attorney. "*Re: Conservation Organization Comments on Draft WA CAFO Permit*", Letter to Jon Jennings, WA State Department of Ecology. August 29, 2016. Western Environmental Law Centre, Oregon.

Washington

Washington State requires permits for CAFOs that regulate the storage of manure to prevent leakage. [39] Washington State is in the process of developing a draft CAFO general discharge permit, replacing one that expired in 2011.[40] The recent Cow Palace lawsuit held that where a farm's manure storage permitted leakage of nutrients into water bodies, that the farm violated the *Resource Conservation and Recovery Act* which prohibits dumping of solid waste that poses an imminent and substantial danger to the public.[41] It is important to note that Washington State has created subsidies for lagoon liners under the *Livestock Nutrient Management Equipment And Facilities Tax Exemption*.[42]

Alberta

Alberta requires approval of manure storage facilities or manure collection areas for confined feeding operations.[43] The regulation has explicit groundwater resource protection measures.[44] Concentrated Animal Feedlot Operations (CAFOs), manure storage facilities and manure collection areas must have permits. [45]

Ontario

Ontario requires manure storage facilities to meet construction specifications that reduce the threat to groundwater for solid and liquid permanent nutrient storage facilities (for any farm that requires a nutrient management strategy or nutrient management plan). [46] Simultaneously, Ontario has offered financial assistance for upgrading such structures. [47]

European Union

Among other things, the European Union Nitrogen Directive requires the following measure related to manure storage:

> *The capacity of storage vessels for livestock manure: this capacity must exceed that required for storage throughout the longest period during which land application in the vulnerable zone is prohibited, except where it can be demonstrated to the competent authority that any quantity of manure in excess of the actual storage capacity will be disposed of in a manner which will not cause harm to the environment…*[48]

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[39] State of Washington Department of Ecology, "*Concentrated Animal Feeding Operation (CAFO) National Pollutant Discharge Elimination System (NPDES) And State Waste Discharge General Permit Fact Sheet*", (Olympia, Washington 2006).

[40] Department of Ecology State of Washington, "Concentrated Animal Feeding Operation General Permit", Online: <http://www.ecy.wa.gov/programs/wq/permits/cafo/index.html

[41] CARE and Center for Food Safety v. Cow Palace, et al., 2015 WL 403178 (E.D. Wash. Jan. 28, 2015)

[42] Washington State Legislature, RCW 82.08.890 .

[43] Agricultural Operation Practices Act, RSA 2000, C.A-7, s.14.

[44] Standards and Administration Regulation AR 267/2001 s. 24(1) s.9(1): "A manure storage facility and a manure collection area must have either a protective layer or a liner that meets the requirements of this section, between the facility or area and the uppermost groundwater resource below the site."

[45] Standards and Administration Regulation AR 267/2001 s. 24(1) s.9-11.

[46] *O. Reg 267/03 s.65, 66*

[47] Ontario Ministry of Agriculture, Food and Rural Affairs, "Growing Forward 2 Program" , Online: <http://www.omafra.gov.on.ca/english/about/growingforward/gf2-processor.htm>

[48] "*Council Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC)"* (Official Journal of the European Communities No L 375/1.

The lack of a speedy response to the Grace-Mar Farms lagoon failure highlights the need for a law requiring all farms with sewage lagoons to prepare comprehensive emergency response plans. Ontario has such a law, which should be emulated.[49]

Note that a useful summary and discussion of best management practices for manure storage lagoons specifically is found at Appendix C of this report (The document by Dr. Byron Shaw). [50]

4. SUPPORT OPPORTUNITIES FOR CLEANER OPERATIONS AND ALTERNATIVE MANURE PROCESSING TECHNOLOGIES

Modern Best Management Practices utilizing optimal agricultural methods, optimal manure storage, control of feed inputs to reduce manure production, high-tech methods, etc. can reduce water contamination. For example, sensor technology that allows farmers to only fertilize plants "a spoonful at a time, when needed" could reduce over-fertilization problems.[51] In addition, a number of alternative manure processing technologies have been developed that can create a win-win – by turning a problematic manure waste into a commercially attractive, saleable or usable product. Technologies that remove nutrients and create a valuable byproduct have come a long way. Manure processing technologies such as anaerobic digesters, biogas, liquid-solid separators, and composting equipment can create stable solid fertilizer, fuel, and electricity. Such technologies can replace harmful direct effluent spreading – and can reduce environmental liability, decrease odour, produce useful products, and even increase food security by reducing dependence on imported fertilizer.

Governments in places like Ontario, Alberta, Washington State, and the EU are supporting cleaner farming and things like alternative manure processing technologies. The new Hullcar Area Based Management Plan should recognize the opportunity that these technologies represent, and strive to develop sustainable agriculture systems within the ABMP designated area. Hullcar is an ideal area to "pilot" such innovative technologies.[52]

Upfront capital costs for installing these technologies can be high. The short term returns and financial incentives can be relatively low for farmers who otherwise dispose of their excess nutrient-rich manure on nearby fields at little to no cost to their operation. The costs to the drinking water quality however are not tenable.[53] Therefore, a number of jurisdictions are incentivizing such green technology.

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49 Ontario Regulation 267/03 under the *Nutrient Management Act, 2002*, s. 17(1)(b.1) and s. 24(1)(b.1) requires that contingency plans be included in Nutrient Management Plans.

50 Western Environmental Law Centre, "*Agricultural Pollution in Puget Sound: Inspiration to Change Washington's Reliance on Voluntary Incentive Programs to Save Salmon*", (2016) at page 130-133 See Appendix C.

51 See a discussion of this sensor technology at: http://www.pbs.org/newshour/bb/using-sensors-spoon-feed-crops-extreme-precision/ .

52 "NMPF Endorses New Legislation Creating Tax Incentive for Investments in Biogas and Nutrient Recovery"", National Milk Producers Federation (June 16, 2016).

53 Indeed, recent litigation in Washington state suggests that spreading excessive manure may be characterized as dumping of solid waste. *CARE and Center for Food Safety v. Cow Palace, et al.*, 2015 WL 403178 (E.D. Wash. Jan. 28, 2015).

Washington and other States

Washington State already has subsidies for aerators, agitators, augurs, manure composting devices and others under the Livestock nutrient management equipment and facilities tax exemption. [54] And new federal legislation has been proposed which would provide for a 30% tax credit for biogas systems on livestock and dairy operations.[55] Significant climate change benefits could be achievable. The Environment and Energy Study Institute newletter states: "The EPA's Biogas Roadmap estimates that 11,000 biogas systems could be added to farms and dairies in the United States, producing enough power for 3 million homes and reducing methane emissions by 4 to 54 million metric tons by 2030".[56]

Alberta

In Alberta, the On-Farm Stewardship Program and Confined Feeding Operation Stewardship programs funds projects that "have a direct and positive impact on water quality, while also improving the management of inorganic agricultural wastes" and "make improvements to minimize risks to water quality, benefitting their business and the environment". Projects are funded up to 70% of their costs.[57]

Ontario

The Ontario Conservation Authorities Rural Water Quality program reaches out to farmers to provide financial assistance to farmers who undertake projects to protect water quality with respect to their operations.[58] Available funding varies per county, and is subject to approval by the conservation authorities that manage the funds; projects such as manure storage, nutrient management plans, and milkhouse waste are eligible.

European Union

In the EU, legislative instruments such as Directive 2009/28/EC on the promotion of the use of energy from renewable sources, promote the use of biomass from livestock manure as a biogas feedstock.[59] Biogas from livestock manure is recognized as one of the most efficient greenhouse gas reducing biofuels. [60] The UK incentivises farmers to compost their manure by relaxing the

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[54] Washington State Legislature, RCW 82.08.890

[55] In the US, this proposed bill advocates for a 30% tax credit for biogas systems on livestock and dairy operations. House Bill Could Help Small and Mid-Size Dairies Deal with Excess Nutrients, (June 17, 2016) Online: < http://www.eesi.org/articles/view/house-bill-could-help-small-and-mid-size-dairies-deal-with-excess-nutrients>

[56] Environment and Energy Study Institute, "House Bill Could Help Small and Mid-Size Dairies Deal with Excess Nutrients", (June 17, 2016) Online: < http://www.eesi.org/articles/view/house-bill-could-help-small-and-mid-size-dairies-deal-with-excess-nutrients>

[57] Alberta Ministry of Agriculture and Forestry, Growing Forward 2 website, Online: http://www.growingforward.alberta.ca/Programs/index.htm?contentId=ON_FARM_STEWD_PRG&useSecondary=true and Alberta Ministry of Agriculture and Forestry, Growing Forward 2 website, Online: < http://www.growingforward.alberta.ca/Programs/index.htm?contentId=CONFINED_OPR_PRG&useSecondary=true&active=yes >

[58] See the details of this Rural Water Quality Program, online: < https://www.grandriver.ca/en/our-watershed/Rural-Water-Quality-Program.aspx> .

[59] Foged, Henning Lyngsø, Xavier Flotats & August Bonmati Blasi. 2011. *Future trends on manure processing activities in Europe. Technical Report No. V concerning "Manure Processing Activities in Europe"* to the European Commission, Directorate-General Environment. 34 pp.

[60] Foged, Henning Lyngsø, Xavier Flotats & August Bonmati Blasi. 2011. *Future trends on manure processing activities in Europe. Technical Report No. V concerning "Manure Processing Activities in Europe"* to the European Commission, Directorate-General Environment. 34 pp.

nitrogen restriction from170 kg N/ha/year for composted agricultural manure to a limit of 500 kg N/ha every 2 years.[61] The Netherlands provides financial incentives for converting dairy manure into biogas.[62]

Such technical innovation solutions as those above should be carefully considered and encouraged in the Hullcar Valley.

GOVERNANCE

SHAT is committed to a cooperative governance structure to achieve the best results for the Hullcar Aquifer and the community. To achieve its critical purpose, the Area Based Management Plan needs an effective governance model – allowing each Party to play an effective role in ABMP decision making.

Effective governance requires that the ABMP process should:

- prioritize protecting public drinking water sources;
- offer objective science to inform decisions about best management practices and necessary nitrate thresholds;
- be sufficiently resourced;
- be transparent (including ongoing monitoring and public reporting);
- clearly outline roles and responsibilities; and
- offer local parties (and those impacted) a say.

Each Party must know its role and responsibilities, and should be leveraged for its unique abilities – and perspectives -- to contribute to a solution for the Hullcar nitrate problem.

Good governance allows flexibility to adapt to change. Sometimes inaction occurs when capable groups don't have the right level of authority to accomplish their mandates, or don't have a clear understanding of who holds what role and responsibility. Good governance makes that clear. Good governance also creates a method for communication between levels of decision makers which have different priorities and expertise.

In recognition of these principles of governance, and the concerns identified by SHAT in the attached letter, we propose the following recommendations for an effective governance structure:

A. Designate the Township of Spallumcheen and the Splatsin First Nation as co-chairs of the ABMP development team, responsible for coordinating and overseeing the Hullcar

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61 Department for Environment Food & Rural Affairs, "*Guidance on complying with the rules for Nitrate Vulnerable Zones in England for 2013-2016*", (UK: Department for Environment Food & Rural Affairs, 2013)

62 *The Guardian*, "Poo Power: Dutch Dairy Industry Launches L150 Million Biogas Project", November 2, 2016 at:https://www.theguardian.com/sustainable-business/2016/nov/02/netherlands-europe-dairy-industry-agriculture-biogas-cows-manure-poo-power?CMP=share_btn_link

Valley ABMP development and implementation. The township of Spallumcheen and Splatsin First Nation governments have the appropriate experience and connection to the local interests to lead the initiative.[63] Note that at the successful Cowichan Watershed Board, the Cowichan Valley Regional District and Cowichan Tribes are co-chairs of the Watershed Board, and their partnership has been recognized as lending legitimacy critical to the success of the initiative.

B. Designate Steele Springs Water District, H.S. Jansen and Sons Farm Ltd., Kenneth Regehr Holdings Ltd., George E Curtis and Kevin F Curtis, Grace-Mar Farms Ltd., and SHAT as Parties with an advisory role in the Hullcar Valley ABMP development team. Each of these parties contributes unique knowledge of the watershed – on water quality and quantity, land use, economic and community knowledge.

C. Allocate substantial provincial funding to the township of Spallumcheen and Splatsin First Nation to develop the Hullcar Valley ABMP, with collaborative input from all the other Parties.[64] Adequate funding must be provided to Steele Springs Water District, SHAT, and other public interest voices in the process.

   It is troubling that the draft ABMP order states: "Each party will bear the costs of participation in ABMP development." This immediately creates a profoundly uneven playing field. Dairy businesses that contribute to the pollution problem have a powerful and direct economic incentive to participate and influence ABMP decisions. Government participants have full salaries and ample resources. It is unacceptable that the citizens impacted by tainted drinking water will be the ones who lack the resources to hire expertise and afford to dedicate hours of time. This must be remedied.

D. Identify clear, specific and progressive water quality objectives as part of the terms of reference of the ABMP – including a target nitrate concentration of 3 mg/L.[65]

E. Establish a Technical Advisory Committee to support development of the ABMP under s. 89(2)(c) of the *Environmental Management Act*. [66]

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63 Local control over the watershed in the Cowichan was recognized as essential for dealing with local crises such as drought and source water protection. Decisions are made on a consensus basis, with a default to *Roberts Rules of Order* in the event that consensus cannot be reached. Actions and decisions of the CWB are transparent and publicly available. See: http://poliswaterproject.org/publication/761

64 Lack of adequate funding and regulatory authority are main factors negatively affecting the CWB's success. The CWB has primarily been a stewardship organization; with the implementation of the Water Sustainability Act in 2016, the CWB will consider the option of increasing its decision making authority thereby bringing watershed based decisions to a local level. *The Cowichan Watershed Board: an Evolution of Collaborative Watershed Governance,* August 2014, Rodger Hunter, Polis Project on Ecological Governance, Centre for Global Studies, University of Victoria at page 17. Online: http://poliswaterproject.org/publication/761

65 The technical advisory committee should be required to consider meeting these water objectives as the main goal of the ABMP. Water objectives should be clear and simple – such as a target nitrate concentration of 3mg/L, having the water advisory notice lifted by a certain date, and implementing best management practices for agriculture operations that present a threat to drinking water in the watershed. The CWB attributes part of its success to having clear, attainable targets that are easily understandable and resonate with the community. See the attached letter to the Minister of Environment for more on the rationale of a 3 mg/L target in the Hullcar Valley.

a. The Technical Advisory Committee should consist of at a minimum:
    i. An independent scientist nominated by Splatsin Nation
    ii. An independent scientist nominated by the Township, Steele Springs Waterworks District and SHAT
    iii. Ministry of Agriculture and Lands
    iv. Ministry of Environment
    v. Ministry of Healthy Living and Sport
    vi. An independent drinking water officer
    vii. Other technical experts as determined

F. Eventually, a parallel local committee (Hullcar Aquifer Water Board) could be designated by the province as an advisory body or "watershed entity" under *WSA* s.115.[67] This board would have the present role of developing locally appropriate water objectives and providing oversight and direction to the ABMP. It could also have an ongoing role of addressing broader local challenges with water quality, quantity, enforcement, riparian development and other future development in the region. The Hullcar Valley Watershed Board would be a watershed-scale collaborative decision-making advisory entity, modelled after the Cowichan Watershed Board. The Cowichan Watershed Board (CWB) is an example of a watershed governance initiative in a small valley which faces similar land and water use challenges as those in the Hullcar Valley.[68]

For further information, the ABMP development team should consider the watershed governance model described in the *Blueprint for Watershed Governance in British Columbia* published by Polis Project.[69] The Grand River Watershed Water Management Plan prepared by the Grand River Conservation Authority offers a successful Canadian example of an integrated Action Plan developed through voluntary efforts of local stakeholders.[70]

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[66] *Environmental Management Act,* SBC 2003, c.53, s. 89(2)(c). The TAC should consist of technical experts who can advise on the terms of reference of the ABMP. The goal of the TAC is to provide legitimacy and informed scientific and expert guidance to the ABMP development and implementation process.

[67] A watershed entity is an organization that operates at the scale of a watershed for analysis and management purposes; it considers decisions that affect water within its boundaries. The approach draws on scientific, social, traditional, and economic knowledge from government and non-government sources. See: *The Cowichan Watershed Board: an Evolution of Collaborative Watershed Governance,* August 2014, Rodger Hunter, Polis Project on Ecological Governance, Centre for Global Studies, University of Victoria at Appendix F and online: http://poliswaterproject.org/publication/761

[68] The Cowichan model of governance was designed based on studies of models in other jurisdictions, as well as an assessment of federal, provincial, and regional willingness and capacity. *The Cowichan Watershed Board: an Evolution of Collaborative Watershed Governance,* August 2014, Rodger Hunter, Polis Project on Ecological Governance, Centre for Global Studies, University of Victoria [See the Cowichan case study at Appendix F and online at: http://poliswaterproject.org/publication/761]. Watershed entities are advocated in *A Blueprint for Watershed Governance in British Columbia,*. Jon O'Riordan and Oliver Brandes, Polis Project, 2014, online at: http://poliswaterproject.org/sites/default/files/POLIS-Blueprint-web.pdf.

[69] *A Blueprint for Watershed Governance in British Columbia,*. Jon O'Riordan and Oliver Brandes, Polis Project, 2014, online at: http://poliswaterproject.org/sites/default/files/POLIS-Blueprint-web.pdf.

[70] The Grand River Watershed Water Management Plan is a voluntary joint plan by municipalities, First Nations, the GRCA, provincial and federal departments to address water issues, including agricultural problems. See: https://www.grandriver.ca/en/our-watershed/Water-management-plan.aspx.

It is important to note that the Grand River Plan runs parallel to a mandatory Source Protection Plan – and to a vibrant Rural Water Quality Program that offers farmers grants for implementation of Best Management Practices to improve watershed water quality.

LAND USE PLANNING

The Area Based Management Plan should consider the need for Hullcar Valley land use planning measures to address – in a proactive, long-term way -- the sources of potential nitrate contamination in the watershed. Long-term solutions to water contamination often require broad land use measures – for example, by using zoning to limit the concentration of intense livestock operations over sensitive aquifers. Progressive jurisdictions have land use planning measures that impose statutory requirements to consider groundwater. For example, Ontario Conservation Authorities can require that zoning and permitting decisions be consistent with protecting threatened local groundwater.[71]

Several new measures available in BC under the new *Water Sustainability Act* should be considered. These include Water Sustainability Plans and Water Objectives; tools that provide opportunities to manage potential threats to groundwater.[72] Water Objectives are a new tool that can be used to require land and resource use decision-makers in British Columbia to consider impacts on water when making their individual decisions. [73] Under this system, Water Objectives could be established for the Hullcar Valley, with a view to preventing further nitrate contamination.

Note that the objectives need to be set carefully to avoid pitfalls that have been identified with these types of tools used elsewhere. To avoid problems encountered elsewhere, a checklist for successful regulations on Water Objectives is provided in Polis Project's *Awash with Opportunity*. The checklist includes steps for developing and implementing robust regulations:

> *Step 1: Develop Strong and Meaningful Water Objectives*
>
> - *Identify the watersheds, streams, aquifers, or other specified environmental features that require protection to sustain water quality for specified water uses (such as drinking water)*
> - *Identify water quality parameters required to sustain specified water uses; pair these with specific, quantitative, acceptable condition thresholds, and establish the current status of the water in relation to these thresholds*
> - *Determine the appropriate, and ecologically meaningful, scale for a given objective.*

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[71] Clean Water Act, S.O. 2006, c.2, sections 37-39.
[72] *Water Sustainability Act*, SBC 2015, c.15
[73] See *Awash with Opportunity: Ensuring the sustainability of British Columbia's new water Law*, November 2015, Brandes, Carr-Wilson, Curran, Simms, Polis Project on Ecological Governance, Centre for Global Studies, Univeristy of Victoria Online at: http://poliswaterproject.org/sites/default/files/Awash-FINAL-WebVersion-compressed_UpdatedDec1.pdf

Step 2: Apply Water Objectives

1. Require all relevant decision-makers in a watershed to consider water objectives.

- *Require decision-makers to model how a given decision will affect acceptable condition thresholds; use this information when deciding whether to grant an approval (or permit, tenure, licence, etc.) or to impose permit conditions and mitigation measures.*

2. Conduct regular reviews of water objectives.

- *Review and amend water objectives every three to five years to ensure they continue to provide appropriate evaluative criteria and thresholds based on current science.*
- *Designate an independent third-party entity to periodically evaluate whether objectives are being met, conduct audits, investigate public complaints about compliance with water objectives, and issue special reports.*

3. Ensure water objectives are applied consistently.

- *Require water sustainability plans and area-based regulations to be consistent with established water objectives if these plans or regulations do not explicitly establish water objectives.*[74]

In the long term, this checklist should be considered for identifying water quality objectives for the Hullcar aquifer, and developing regulations capable of achieving the objectives.

CONCLUSION

The Save Hullcar Aquifer Team is committed to working with the province, and all local stakeholders to resolve the nitrate contamination in the Hullcar Valley. However, for the Area Based Management Plan solution to be successful, it must combine:

- innovative strategies to address the source of nitrate contamination the Hullcar valley;.
- the best regulatory measures used by governments elsewhere;
- the best policy measures elsewhere, including appropriate education, training, financial incentives, technology transfer, etc.
- progressive long-term land use and watershed protection measures;
- an inclusive and effective governance model for the Area Based Management Plan itself – one that empowers citizens and others to meaningfully participate in a process based on the best objective science and an unwavering commitment to public health..

The root cause of nitrate pollution is well understood, and sadly not a problem unique to the Hullcar aquifer. We can certainly learn from measures adopted elsewhere. Ultimately, the solutions developed in the Hullcar Valley should be considered for province-wide

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74 *Awash with Opportunity: Ensuring the sustainability of British Columbia's new water Law*, November 2015, Brandes, Carr-Wilson, Curran, Simms, Polis Project on Ecological Governance, Centre for Global Studies, University of Victoria at page 34 Online: http://poliswaterproject.org/sites/default/files/Awash-FINAL-WebVersion-compressed_UpdatedDec1.pdf

implementation. The development of a model Dairy District Area Based Management Plan in the Hullcar Valley will benefit the many other BC valleys that face similar nitrate problems.