

**Agrium Products Inc.  
Phosphogypsum Storage  
Expansion  
Redwater, Alberta**

Natural Resources Conservation Board  
Decision Report

August 2004

**Report of the Natural Resources Conservation Board  
Agrium Products Inc.  
Phosphogypsum Storage Extension  
NRCB Decision NR2004-01**

August 2004

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ISBN 0773219196

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The following table of contents reflects all of the issues presented to the Board during the course of the public hearing in February and March of 2004. This report has been arranged in such a way that the views of the applicant and of the interveners are summarized in the first part of the report (Sections 1 to 10), and the views of the Board on all topics comprise a second part of the report (Section 11). Where the Board felt that further discussion and analysis of the evidence was warranted, a section entitled “The Board’s Analysis” immediately follows the views of the applicant and interveners in the first part of the report. The Board’s Analysis sections strive mainly to clearly state the Board’s interpretation of the evidence presented. The Board’s final conclusions regarding all issues raised are reserved for Section 11, and the organization of topics in that section also follows the order presented in the table of contents below. The Board’s decision is provided in Section 12.

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## BOARD DECISION

Having regard for all of the submissions received by the Board in respect of this application, the Board concludes that it is prepared to issue a conditional approval. The following report contains the Board's reasons for decision as well as a form of approval. The Board's decision is described in Section 12. The Board thanks each of the parties to this review and Board staff for the considerable contribution each has made to the decision-making process.



## 1.0 BACKGROUND, INTRODUCTION, JURISDICTION

Operation of the fertilizer manufacturing plant commenced at the Redwater facility in 1969 under the ownership of Imperial Oil Limited. Agrium Products Inc. (Agrium) acquired this facility in December 1996 from Sherritt Inc. In order to continue production of phosphate fertilizer, Agrium identified the need to extend the storage area for the phosphogypsum byproduct.

An environmental screening conducted by Alberta Environment determined that an environmental impact assessment (EIA) would be required for Agrium's proposed extension. Final terms of reference for the EIA were issued by Alberta Environment on March 18, 2003. By Order in Council number 184/2003 dated April 13, 2003 the proposed activity of Agrium was designated as a "reviewable project" pursuant to section 4(f) of the *Natural Resources Conservation Board Act* (the "Act").

The Act provides that the Natural Resources Conservation Board ("Board or NRCB") was created "... to provide for an impartial process to review projects that will or may affect the natural resources of Alberta in order to determine whether, in the Board's opinion, the projects are in the public interest, having regard to the social and economic effects of the projects and the effect of the projects on the environment." The Act prohibits the commencement of a reviewable project unless the NRCB, on application, has granted an approval for the project.

Agrium Products Inc. ("Agrium") has applied for an approval of a northward extension of its existing phosphogypsum storage stack area at its fertilizer plant approximately 13 kilometres south of Redwater, Alberta at:

The North Side of the North Saskatchewan River in **Sections 17 and 20**  
Township 56 Range 21 West of the Fourth (4<sup>th</sup>) Meridian

The Board held a public Pre-Hearing Meeting in Fort Saskatchewan, Alberta on Wednesday, December 17, 2003 to hear representations on various matters that were preliminary to a public hearing, including issues to be examined at the hearing, the location and timing for a hearing, and advance intervener funding. The Board's report from that Pre-Hearing Meeting is available on the NRCB website or may be obtained through any of the NRCB offices.

The Board conducted a public hearing in Fort Saskatchewan on February 23<sup>rd</sup> through 28<sup>th</sup>, inclusive, and March 11<sup>th</sup> and 12<sup>th</sup>, 2004. At that hearing the Board received evidence from each of the participants, some of which is summarized in this report. The complete record of that

hearing including transcripts and exhibits is available for viewing by appointment at the NRCB's Edmonton office.

In conducting this review, the Board's ability to fully explore all relevant issues was greatly assisted by the applicant, participating area residents, the Capital Health Authority, Alberta Environment and Alberta Health and Wellness.



## 2.0 CONSTRUCTION

### 2.1 Views of Agrium

Agrium stated that it intends to integrate the existing phosphogypsum stack with the proposed extension. It noted that a synthetic liner will underlie the entire extension area and that the existing groundwater intercept system along the north boundary will be replaced by a slurry wall separating the old stack from the new. Agrium explained that a perimeter drainage system and containment dykes will surround the proposed extension. Agrium confirmed that a series of water monitoring wells would be installed outside of that perimeter, and proposed that the extension be constructed in four stages, with the first phase commencing in the southeast corner in the spring of 2004.

Agrium explained that the initial stage of construction would consist of 'topsoil' removal and then the preparation of the underlying clay for the installation of a synthetic liner. The proposed material for the liner is a 60-mil (1.5mm) high-density polyethylene. Agrium stated that the liner material was designed to specifications provided by its consultants, and emphasized that its consultants observe both the manufacture and testing of the liner material to ensure that it meets exacting requirements. Agrium noted that a gas-venting mechanism will be installed beneath the liner, and explained that the liner material is produced in rolls that are seven metres wide, joined using a process similar to welding. It observed that the integrity of the welds is tested both by non-destructive pressure analysis and by a destructive strength test. Agrium noted that a different welding method is utilized when there is only one edge of the liner exposed or when patching the liner. Agrium noted that the liner would be tied into the slurry wall and into the surrounding perimeter dykes.

Agrium explained that the installation and testing of the liner would be followed by the establishment of the perimeter underdrain system. The purpose of the underdrain system, Agrium noted, was to increase the overall stability of the gypsum dykes. A layer of gypsum would be placed upon the liner where the drains are to be located, and a trench dug into the gypsum. A geo-textile fabric would then be laid across the trench, followed by non-reactive aggregate and a slotted pipe (the underdrain). The pipe would then be completely covered by additional aggregate, the geotextile would be folded and sewn over the pipe and the aggregate, and finally this system would be covered with additional gypsum.

The final step in the construction of the new storage area, Agrium noted, was the construction of perimeter dykes. Agrium stated that it intended to use clay uncovered in the site preparation phase to construct the perimeter dykes.

Agrium stated that the construction of a slurry wall could be carried out coincidentally with the preparation of the first phase of the extension. The slurry wall would run east to west along the northern boundary of the existing stack with an additional extension running to the southeast at the eastern edge of the stack. The purpose of the slurry wall, Agrium explained, was to segregate the groundwater between the existing gypsum storage area and the proposed extension area. Agrium described the slurry wall as consisting of a bentonite mud that would extend from the

ground surface down to the underlying shale deposits. Agrium emphasized that it would not be a problem to install the slurry wall in spite of the presence of sandstone layers between the surface and the lower shale strata, and noted that the integrity of the slurry wall could be assessed by monitoring wells installed to the west and the east of the stack.

Agrium stated that the first phase of construction would take approximately five months, and proposed that it occur between June and October 2004. Agrium estimated that 20 pieces of heavy equipment would be used in the construction of the extension area. Agrium committed to limiting construction times from 7:00 am to 7:00 pm, using louder machines only between 9:00 am and 5:30 pm, in order to address some of the noise concerns expressed by nearby residents.

## 2.2 Views of the Interveners

### Mr. Smulski

Mr. Ken Smulski advised the Board that he was appearing on behalf of himself, J. Smulski estate, S.V. Farms of Gibbons, and company number 26754 Alberta Ltd., hereafter collectively referred to as 'Mr. Smulski'. This intervener expressed concerns relating to the integration of the proposed stack with the existing stack, as well as the proposed setback for the extension. Mr. Smulski argued that the two stacks should remain separate to avoid the integration of the old technology with the new. He noted that the integration of the stacks would allow for seepage from the new stack to drain through the old stack. He suggested that maintaining separation between the two stacks would allow Agrium to install monitoring wells for the purpose of assessing the integrity of the slurry wall. Mr. Smulski also added that separation of the stacks would allow access for any maintenance functions that are required. He proposed that the separation be maintained until the integrity of the slurry wall is confirmed.

Mr. Smulski questioned the effectiveness of the current interceptor system along the western boundary of the existing stack. While he acknowledged Agrium's stated intention to replace approximately 300 metres of that system in the northwest corner, he indicated that replacement along the entire western side was appropriate. He observed that the current intercept system utilized weeping tile wrapped in a 'sock' material and argued that this system was not optimum and could be improved. Specifically, he declared that the sock material tends to collect silt over time, leading to plugging of the pipe and eventual collapse. Mr. Smulski noted that the weeping tile would produce better results if encapsulated in a coarser, more granular material.

Mr. Smulski argued that the extension of the phosphogypsum stack was designed solely to enhance storage capacity and that it did not take into account secondary effects such as groundwater contamination, or groundwater flow. Mr. Smulski stated that it was important to maintain the proper moisture content and proctor density of the clay beneath the liner during installation to provide for liner integrity. He expressed concern that the current construction plans may not have appropriately addressed this issue.

Mr. Smulski's consultant observed that sandstone strata shown on Agrium's geologic cross-sections for the proposed extension are discontinuous. He submitted that the theoretical analysis

of the phosphogypsum stack should review the stability of a deep-seated shear zone through the clay shale stratum where the sandstone is not continuous.

Mr. Smulski stated that his consultant's review of the borehole logs identified some areas of concern with respect to the geo-technical stability of the stack. Specifically, he referred to logs that revealed the existence of bentonite in the area underlying the extension as well as 'slickenside' structures that could make the site unstable. Mr. Smulski commented that more information was required about the geological conditions underlying the proposed extension and along the slurry wall prior to the commencement of construction. He further indicated that these concerns could likely be addressed with additional borehole data.

Mr. Smulski stated that the proposed setback from the highway was insufficient and that it should be increased to 500 feet, arguing that this was the setback originally planned by Agrium's predecessor. Mr. Smulski also expressed concern about a gas pipeline that was installed in the right-of-way beside the western edge of the existing stack. Mr. Smulski argued that the larger right-of-way would allow for further remediation and make it possible to install an additional intercept system if such a step proved necessary.

Finally, Mr. Smulski suggested that Agrium would benefit from the advice of independent experts regarding the construction of the proposed extension. He noted that Agrium had been using the same engineering and hydrogeological consultants since the 1970's and 1980's.

#### **Alberta Justice representing Alberta Environment and Alberta Health and Wellness (Alberta)**

Alberta agreed with Agrium that the interceptor system along the northwest corner of the existing stack required replacement, as it had not been performing very well. In that regard, Alberta was considering including a requirement for better maintenance of the interceptor system as a potential *Environmental Protection and Enhancement Act (EPEA)* approval requirement. Alberta also indicated that it would be seeking a detailed design for Agrium's planned replacement of northern portions of the west interceptor.



## 3.0 NOISE

### 3.1 Views of Agrium

Agrium acknowledged that noise was the primary source of landowner complaint. However, Agrium emphasized that noise was a regional issue and that Agrium itself was not the only noise source in the area. Agrium emphasized that the Alberta Energy and Utilities Board (EUB) was the agency responsible for the regulation of the plant's noise by way of an EUB Industrial Development Permit. Agrium pointed out that the EUB has a comprehensive regulatory scheme with respect to noise and that it had worked extensively with the EUB to address noise concerns. Agrium requested the NRCB not include any conditions in its approval that would conflict with EUB regulatory requirements pursuant to its Industrial Development Permit.

Agrium stated that it had taken significant steps to address landowner noise concerns including the retention of an acoustical consultant and the implementation of a noise mitigation program. Agrium commented that it had spent in excess of one million dollars in the past few years on efforts to reduce the noise associated with its operations. Further, Agrium stated that it initiated the Strathcona Noise Advisory Panel (SNAP) committee in 2001 with the specific goal of addressing noise concerns. While it acknowledged that the effectiveness of the SNAP committee had declined with the loss of landowner participants, Agrium repeated its resolve to address noise complaints.

Agrium testified that it hired an acoustical consultant in 2001 to conduct noise studies, including modelling, to identify and eliminate noise sources from its facility. Agrium stated that its consultant proposed a number of modifications to its operation and that, to date, it had adopted approximately 80 percent of those recommendations. It emphasized its commitment to further improvements with respect to the noise issue, and said it would continue to implement its consultant's recommendations.

Agrium stated that it had been conducting random noise tests in the area, both in response to landowner complaints and when specific operations were occurring. It noted that it had never recorded noise levels in excess of guidelines during this monitoring program and that it had only two daytime readings over the 50 dBA level from a total of 269 measurements. Agrium also referred to two EUB noise studies conducted in 2002 and 2003. Agrium noted that its facility had generated no night time noise levels in excess of guidelines when the plant was operating under normal conditions.

Agrium stated that it planned to institute a number of management controls with respect to the construction of the project to ensure that the noise impact associated with those activities was limited. As noted in Appendix A of this decision, Agrium committed to specific construction times to minimize noise concerns. It also indicated that the use of engine retarder brakes would not be allowed on-site, and that the equipment used would have adequate mufflers and other appropriate noise attenuation controls. Agrium indicated that the project manager would be responsible for ensuring noise mitigation.

Agrium stated that construction of phase one would involve approximately 20 pieces of heavy machinery working at one time. It observed that a similar amount of heavy equipment was employed to resurface the highway immediately adjacent to the plant facility and noted that no noise complaints were received for that construction. It stated that it would be conducting random noise monitoring during construction to ensure that levels did not exceed the EUB's noise guidelines.

With respect to its ongoing operations, Agrium stated that it had been testing a new pond management technique called rim ditching. Agrium stated that this technique was successfully employed in a number of other operations, and that it substantially reduced the amount of heavy equipment necessary for day-to-day operations. Agrium noted that its use of rim ditching is currently a pilot project, but was confident that it would be implemented more broadly. If adopted, Agrium stated that the practice would reduce the number of machines working on the stack from between eight and twelve to about three or four, resulting in a significant decrease in operational noise.

Agrium stated that its studies had not addressed the issue of low frequency noise, but noted that the EUB is currently considering a policy related to that issue. It stated that it would monitor during construction for low frequency noise.

### 3.2 Views of the Interveners

#### Sturgeon County Residents (SCR)

While the Sturgeon County Residents stated that they sometimes hear noise from the plant, they agreed that noise was not currently a significant issue for them. However, these interveners emphasized that their position could change should the proposed extension occur.

#### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG stated that one of their greatest concerns with the Agrium facility over the past five years was the associated noise. It acknowledged that Agrium had taken a number of steps to decrease facility noise but maintained that these measures had not materially improved the noise environment in the plant's vicinity. These interveners stated that disruptive noise events occurred approximately 20 to 30 times a month and that noise from the Agrium site often interfered with their sleep. Members of this group remarked that they often retreated to their basement when the noise became loud enough to disrupt their sleep. The NSCRG stated that studies conducted in the year 2000 revealed that the EUB's night time permissible sound levels were frequently exceeded.

These interveners proposed that a noise monitoring station be established in the vicinity of their properties in order to get a more representative understanding of the noise levels they experience. The NSCRG also noted that to date, noise monitoring had only taken place during the summer months. It believed that additional monitoring during the winter months or during temperature

inversion conditions would provide Agrium and the EUB with more complete information about the local noise conditions.

The NSCRG believed that Agrium was not taking their noise concerns seriously. It observed that Agrium did not have a noise expert appear at the proceeding to give evidence, and it questioned Agrium's opposition to funding the residents' noise expert. The NSCRG argued that mere adherence to the EUB's noise guidelines did not satisfy their concerns. It stated that changes in noise levels, even if below the permissible sound levels, caused significant disruption in their lives. It also pointed out that Agrium had done nothing to address their concerns with respect to low frequency noise.

While these interveners acknowledged Agrium's commitment to restrict the use of heavy equipment during the construction phase to daytime hours, they argued that Agrium should have done noise modelling to determine the impacts of construction noise on neighbouring landowners. The NSCRG expressed some concern as to whether the other noise mitigation steps proposed for the construction phase would be effective. It also suggested that comprehensive noise monitoring be instituted to ensure that construction did not give rise to noise levels in excess of the EUB guidelines.

These interveners said that the Natural Resources Conservation Board (NRCB) should not limit its consideration to the noise associated with the construction and operation of the proposed extension. They stated that approval of the project would likely mean an additional 20 or more years of exposure to disruptive noise from the facility.

**Mr. Smulski**

Mr. Smulski noted that one of the ways that noise impacts associated with construction could be mitigated would be to shorten the construction time by running more than one shift. Mr. Smulski estimated that the 'topsoil' removal component of construction could be completed in three weeks using this method rather than in the three months anticipated by Agrium.

**Alberta Justice representing Alberta Environment and Alberta Health and Wellness (Alberta)**

Alberta stated that it was aware that noise was one of the landowners' main concerns with respect to the proposed extension. However, it stated that it did not have any specific expertise related to noise, and it did not have noise guidelines or standards. It confirmed that the EUB noise control directive applies to Agrium under an EUB Industrial Development Permit.





## 4.0 SOCIO-ECONOMICS

### 4.1 Economic Benefits

#### 4.1.1 Views of Agrium

Agrium stated that there would be an economic impact associated with construction of the gypsum stack extension, but also stated that without the extension, the facility would be required to shut down. Agrium indicated that, at current production rates, the useful life of the existing gypsum stack was roughly two or three years. With the proposed extension of the storage area, the production life of the facility would be extended for about 26 years.

Agrium estimated that the construction activity for the extension project would cost \$22 million and would result in approximately 106,000 hours of work.

Agrium argued that if its Redwater facility were to close, there would be a negative economic impact on the region. The plant currently employs 266 people directly with an annual payroll estimated at \$18.5 million. Agrium estimated that another 400-500 jobs are indirectly supported by the operations of the plant (i.e. mining operations in Ontario, rail and truck transport, sulphur purchases from Fort McMurray and ammonia purchases from the nearby plant).

Agrium stated that the fiscal impact associated with the phosphate operations was approximately \$10 million in yearly federal and provincial taxes, and approximately \$640,000 per year for Sturgeon County municipal taxes.

#### 4.1.2 Views of the Interveners

##### Sturgeon County Residents (SCR)

The SCR indicated it was not against industry, and agreed that there were economic benefits derived from Agrium's Redwater facility. Nevertheless, the SCR indicated that it believed industrial development must proceed responsibly, and that the company must be accountable for any impacts originating from its activities.

##### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG believed that there were significant benefits generated by the plant. However, it also believed that the burdens associated with the plant (e.g. health related concerns and cost of reclamation) needed to be taken into account.

## 4.2 Land-use Conflict

### 4.2.1 Views of Agrium

Agrium indicated that land use, and in particular conflict between country residential development and industrial development, was the central reason for objection to the gypsum stack extension. Agrium stated that it did not cause the land use conflict in the area, as Agrium did not encroach on country residential development; rather, country residential development had encroached on the existing plant.

Agrium stated there were practical impediments to addressing the requests by various landowners to be ‘bought-out’. One impediment suggested by Agrium was the difficulty in establishing criteria to determine which landowners should be included in the ‘buy-out’. Another problem was that Agrium was one of a number of heavy industrial operations in the immediate area, and therefore it would be difficult to determine which company should be held responsible to purchase a property. Agrium indicated there was no mechanism in place to establish a property’s fair market value. Lastly, Agrium questioned whether all landowners should get the benefit of inflated industrial land values, even though some landowners may have only recently purchased their property.

Agrium’s position was that in the absence of any statutory framework or principles and procedures, there was no way to arrive at a mechanism that would be workable and fair to all parties.

### 4.2.2 Views of the Interveners

#### Sturgeon County Residents (SCR)

The SCR expressed the view that Agrium’s Redwater operation was having a negative effect on health, quality of life and on the value of their properties. The group stated that Agrium should be responsible for relocating residents, should the lands surrounding the plant become unsuitable for living.

#### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG stated that the region had become highly industrialized and residents were trapped, required to live with industry and the impacts imposed on them. Furthermore, it said that when the county zoned their properties heavy industrial, it placed numerous restrictions on what the residents could and could not do with their lands. Despite that, the group argued that the land use issue could not be resolved in the context of the NRCB application, as it was outside the Board’s jurisdiction. It argued that the issue would require evidence from other parties that had not appeared before the Board. The group believed that the Board should not concern itself with the land use issue. Instead, it believed it was incumbent upon the Board to examine the impact on the residents from a social, economic, health and environmental perspective, and if the impacts were deemed to be unacceptable, the gypsum stack extension project must be refused.

## 5.0 AIR QUALITY and HUMAN HEALTH

Agrium stated that it would not be expanding its phosphate production operations and no incremental production would be associated with the proposed extension. Thus, it submitted that there would be no incremental impacts of any significance compared to current operations. Agrium said that it was committed to a company-wide program of continuous improvement, and that it had installed the best available demonstrated technology to deal with point source emissions.

Agrium assessed dust, fluoride, and radioactivity from the operation of the gypsum stack extension and evaluated the cumulative impacts of emissions from the operating gypsum stack and the facility with the extended gypsum stack. Agrium said that it characterized the existing air quality based on available data and developed estimates of air emissions of dust, fluoride and radioactivity based on the project description, available measurements, and data from published literature. It noted that the United States Environmental Protection Agency (USEPA) did not consider wind blown dust to be a significant source of emissions from phosphogypsum stacks. It used emission estimates and air dispersion modelling to predict air concentrations of dust, fluoride and radon in the vicinity of the stack extension.

Agrium explained that it had modelled air quality under existing and future conditions with the phosphogypsum stack extension to determine whether there would be any incremental impact on air quality. It concluded that extending the gypsum stack to the north would have no significant incremental impact on air quality other than shifting the footprint of air quality effects somewhat to the north. It noted Alberta Environment's statement that methods used by Agrium were appropriate.

Agrium also commissioned a health risk assessment to examine whether its phosphogypsum stack extension could pose unacceptable risks to the health of community residents. Agrium emphasized that the health risk information presented was only intended to be at a screening level. It conceded that although there might be some debate about the suitability of the models, the health risk assessment protocols it used followed concepts and methods generally accepted and endorsed by Federal and Provincial regulatory jurisdictions. If significant potential health hazards were identified, Agrium acknowledged that progression to a more complete and detailed assessment of risk would be needed. Agrium explained that a screening-level health risk assessment was a decision-making tool, employing qualitative and quantitative analyses of the likelihood of adverse health effects. It said that the multi-media pathway analysis of different exposure levels to potential contaminants of concern involved very conservative modelling assumptions. A screening-level risk assessment was not intended to be a public health statement. It did not involve a review of personal or group medical histories, nor describe long-term trends from a chemical exposure. Although predictive and probabilistic in nature, a screening health risk assessment could not provide a statement of exact quantitative health risk, such as a potential cancer risk of  $10^{-4}$ .

Agrium suggested the definition of 'adverse health effect' was subject to some debate, and particularly pertinent to this enquiry, was whether mild dental fluorosis represented an adverse

health effect or an aesthetic effect. Agrium stated that, in its opinion, very mild to mild dental fluorosis was not an adverse health effect, but rather an aesthetic effect.

## 5.1 Naturally Occurring Radioactive Materials (NORM)

### 5.1.1 Views of Agrium

Agrium said that it undertook some radon flux measurements in 2002 that showed very low radon flux rates. For its radon evaluation, it said that it bracketed the range of possible incoming radium in the source rock and made conservative assumptions for radon by firstly using published literature values for surface flux of radon based on phosphogypsum facilities in Canada, and then by making adjustments across the surface of the phosphogypsum stack to account for ‘ponded’ areas (areas with standing water on the surface) and for water content of the phosphogypsum. It predicted the contribution of its operation to off-site radon levels for all scenarios to be very low, and generally below 0.2 Becquerels per cubic metre (Bq/m<sup>3</sup>)<sup>a</sup>. It noted that this would be indistinguishable from variations in the natural background.

Agrium commissioned a screening radiological risk assessment of air and soil dependent exposure pathways to evaluate radiological impacts on health from two potential sources; suspended phosphogypsum stack particles (i.e. fugitive phosphogypsum dust emissions) and radon gas released from the gypsum stack. Agrium stated the radiological assessment for radon gas included an estimate for the ingrowth of radon progeny. Agrium said the primary radiation exposure pathways were air and soil dependent. Agrium indicated primary exposure to radon gas was possible through inhalation of released radon gas, as well as, phosphogypsum contaminated suspended dust. Agrium explained that soil dependent gamma radiation exposure pathways involved the ingestion of phosphogypsum contaminated soil or the consumption of crops or animal products produced on phosphogypsum contaminated soil. Agrium noted secondary radon gas exposure also occurs via a soil dependent pathway. Employing input data based on air dispersion modelling, Agrium examined the screening radiological risk assessment for future and current phosphogypsum stack scenarios to determine the net health impact due to the proposed stack extension on an adult male.

Agrium explained that the CALPUFF dispersion modelling used published literature values for surface radon flux which were based on measurements at phosphogypsum facilities in Canada. Agrium concluded the predicted incremental off-site radon levels, for all risk assessment scenarios, were less than 0.2 Bq/m<sup>3</sup>; a value that would be indistinguishable from natural radon background levels.

Agrium said published studies (e.g. 40 Code of Federal Regulations Part 61 *National Emission Standards for Hazardous Air Pollutants*) supported the view that very low radionuclide

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<sup>a</sup> “The Becquerel (Bq) measures the quantity of radioactivity present without consideration for what kind of radiation is emitted. 1 Bq = 1 nuclear transformation (disintegration) per second.” (Canadian Guidelines for the Management of NORM, 2000). The Bequerel replaces the earlier unit, the Curie.

concentrations were found in airborne particulate dust samples from phosphogypsum stacks and, consequently, this exposure pathway was insignificant.

Once the radionuclide concentration in soil had been modelled using a mass balance approach, Agrium stated RESRAD 6.2 was used as a model to assess radiological risks due to soil dependent exposure pathways. Agrium noted this model was recognized universally and by all relevant U. S. Federal Agencies (e.g. USEPA, Department of Energy, and the National Research Council). Agrium said RESRAD 6.2 assumes a decommissioned site where operations have stopped and a static set of conditions exist. Agrium stated the model assumptions allow valid application of RESRAD 6.2 to current and future risk assessment scenarios.

Agrium stated that naturally occurring radioactive materials (NORM) typically account for about 65 percent of overall radiological exposure and indicated the following were representative values for concentrations and specific radiological exposure doses for a typical Canadian:

- Total annual effective dose for an average Canadian: 2.0 milliSieverts per year (mSv/yr)<sup>b</sup>  
Average Radon gas exposure levels:
  1. Worldwide Outdoor – 10 Becquerels per cubic metre (Bq/m<sup>3</sup>)
  2. Alberta Outdoor – 7.4 to 44 Bq/m<sup>3</sup>
  3. Edmonton Indoor – 53 Bq/m<sup>3</sup>
  4. Canada Indoor – 45 Bq/m<sup>3</sup>
  5. Health Canada “Action Level” – 800 Bq/m<sup>3</sup>
- Typical measured background radiological exposure at Redwater, Alberta site:
  1. Gamma radiation – 0.63 (mSv/yr.).
  2. Radon – 0.68 mSv/yr. (based on concentration of 41 Bq/m<sup>3</sup>)  
(Total radiological dose – 1.31 mSv/yr).

Agrium reported that for all modelled pathways and receptors in the current scenario, the calculated radiological dose due to the phosphogypsum stack alone ranged from 0.003 – 1.3 microSieverts per year (µSv/yr). Agrium said this dose constituted less than 0.1 percent of background at all locations. Agrium stated a similar assessment of the future scenario resulted in a calculated exposure dose that ranged from 0.007 – 6.3 µSv/yr in the most likely condition where the source rock is of low radioactivity Kapuskasing phosphate rock or 0.005 – 6.5 µSv/yr, under the most conservative conditions, where historical source rock was used. These doses were less than 0.5 percent of background at all locations. Agrium noted the difference in dose between future and current scenario (i.e. net radiological dose) represented the incremental radiological dose due to the proposed stack extension, and was estimated to range from 0.001 – 5.2 µSv/yr. The net dose was less than a 0.4 percent increase of the average background radiation. Agrium noted a much lower incremental radiological dose would result at greater distances from the source.

Agrium explained that one could estimate the variability in background radiological dose in the Redwater area by dividing the difference in the range of background radiation values (i.e. 1400 µSv/yr – 460 µSv/yr = 940 µSv/yr) by the measured average radiation value (i.e. 1310 µSv/yr).

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<sup>b</sup> “The Sievert (Sv) is the unit of Effective Dose of radiation, and accounts for the total effect of different types of radiation on different parts of the body.” (Canadian Guidelines for the Management of NORM, 2000).

From this result, Agrium concluded background radiological dose could vary as much as 70 percent. Further, Agrium stated the maximum modelled net dose from the proposed extension (i.e. 5.2  $\mu\text{Sv}/\text{yr}$ ) represented a mere 0.4 percent increase over background radiation and therefore was obscured by the high variability in background radiation.

Agrium said, according to the Health Physics Society of Physicians, a radiological dose of  $10^5$  (100,000)  $\mu\text{Sv}/\text{yr}$  above background should exist before health risk estimates are reported. Agrium indicated that dose-response relationships at lower doses were much less well characterised and that there was much uncertainty at very low doses. Agrium noted the dose range, 0-100  $\text{mSv}/\text{yr}$ , may be considered a low dose for health risk estimates. Consequently, Agrium viewed these model estimates as highly uncertain and speculative. Agrium estimated that at receptor location number three, the risk of cancer due to radiation would be 0.06 per  $10^9$  to 0.38 per  $10^6$ . Agrium said the highest potential estimate of residential risk due to radiation was 0.05 per  $10^6$  individuals.

As modelled results were indistinguishable from background, Agrium concluded there would be no measurable radiological impact to anyone living or working near the plant as a result of the planned extension.

### 5.1.2 Views of the Interveners

#### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG concluded the modelling and measurements by Agrium were not consistent and contained source errors in the dose calculations. It stated that expected radiation doses and corresponding risks were grossly underestimated. The NSCRG emphasized that the exposure pathways involving water ingestion, incidental soil ingestion and particulate matter inhalation had not been considered. The NSCRG questioned the validity of using RESRAD 6.2 to model soil dependent exposure in this radiological human health risk assessment.

The NSCRG said the radiological risk assessment did not take account of the exposure of children, which in their opinion would be the most susceptible human receptor. It said a child would have a more rapid rate of respiration, ingest more soil, and be closer to the ground than an adult, consequently experiencing higher doses of gamma radiation from 'ground shine' (National Commission on Radiological Protection NCRP-129). In addition, the NSCRG indicated a child would have more rapidly growing tissue cells more likely to be damaged by radiation, and would have a longer anticipated future lifespan than an adult, and so a longer period at risk of developing adverse effects of radiation. The NSCRG said the radiation monitoring data used in the Agrium radiological risk assessment was inadequate.<sup>c</sup>

The NSCRG said that if results of direct measurements were different from modelled predictions, preference must be given to the measured results. The NSCRG argued that it had used valid data as suggested in an applicable comprehensive USEPA reference (i.e. NCRP-129).

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<sup>c</sup> Chiu, 2002: Radioanalytic Report: Agrium Redwater Fertilizer Operations. June 21, 2002

The NSCRG estimated the radiological dose from exposure to air particulates was 60 times that estimated by Agrium. The NSCRG acknowledged that air particulates were a small but arguably still significant contributor to cumulative radiological dose. The NSCRG concluded radiological dose from this pathway should be 2  $\mu\text{Sv}/\text{yr}$ , rather than the 0.04  $\mu\text{Sv}/\text{yr}$  reported by Agrium.

The NSCRG believed that radon constituted a much larger contribution to the overall radiological dose. It adopted 19  $\text{Bq}/\text{m}^3$  as an appropriate background concentration for radon. The NSCRG explained this background concentration was the average of a large number of values measured throughout Alberta. As a result of these considerations, the NSCRG said the net measured radon concentration was 167 times greater than the modelled value reported by Agrium. The NSCRG also disagreed with Agrium's calculation of radiation resulting from radon ingrowth (i.e. progeny formation resulting from radon decay) using the Bateman equations. The NSCRG concluded that the total radiological dose from primary radon calculated by Agrium (i.e. 22  $\mu\text{Sv}/\text{yr}$ ) was in error by a factor of 8020. The NSCRG stated the adjusted radiological dose from primary radon should be 1801  $\mu\text{Sv}/\text{yr}$ .

The NSCRG stated that Agrium estimated the radiological dose through incidental soil ingestion using RESRAD 6.2. In doing so, Agrium assumed that radioactive particulate material from the phosphogypsum stack was diluted in 15 cm of surface soil material. The NSCRG said, in reality, particulate material deposited from the phosphogypsum stack would more likely remain within the top one centimetre of the soil surface. The NSCRG estimated that the adjustment, in radiological dose for adults from this pathway, would be 16 times that calculated by Agrium (i.e. 0.04  $\mu\text{Sv}/\text{yr}$ ). The NSCRG concluded the radiological dose from ingestion of soil was 1  $\mu\text{Sv}/\text{yr}$ .

The NSCRG reported that actual measurements of gamma radiation were used in its assessment of radiological dose from this pathway. The NSCRG stated the gamma radiation was measured across the river and reported.<sup>d</sup> The NSCRG concluded that these gamma radiation values were net (i.e. total minus background) and not background. The NSCRG stated a dose from gamma radiation for an adult was equivalent to a 30 percent higher gamma dose for children under 15 years of age because the organs of these subjects were closer to the ground (NCRP 129). The NSCRG concluded the radiological dose for adults from direct gamma radiation was 359 times that estimated by Agrium (i.e. 1.10  $\mu\text{Sv}/\text{yr}$ ). The NSCRG reported that the radiological dose from direct gamma radiation was 395  $\mu\text{Sv}/\text{yr}$ .

The NSCRG concluded the resulting estimated radiological dose from all sources was 2264  $\mu\text{Sv}/\text{yr}$  compared to 6.58  $\mu\text{Sv}/\text{yr}$  reported by Agrium. The NSCRG stated that this dose exceeded regulatory guidelines for industrial receptor sites (i.e. 1000  $\mu\text{Sv}/\text{yr}$ , Canadian NORM Guidelines) and the application should therefore be rejected. The NSCRG noted most of the calculated dose was due to primary and secondary radon (76 percent), with gamma radiation accounting for about 17 percent of the radiological dose.

The NSCRG said that, according to international scientific opinion, no threshold exists for health effects due to radiation exposure and, consequently, each radiological dose increases the likelihood of health effects such as cancer.

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<sup>d</sup>1992 Sherritt Memo (Exhibit NSCRG-19)

The NSCRG considered the Canadian NORM Guidelines regulation of 1000  $\mu\text{Sv}/\text{yr}$  too high when compared to similar regulations in other jurisdictions. The NSCRG noted that USEPA Superfund guidelines for remediation and reclamation of radiological wastes required clean-up measures sufficient to meet a  $10^{-4}$  to  $10^{-6}$  incremental cancer risk. The NSCRG stated a  $10^{-4}$  cancer risk translated into an approximate yearly radiological dose of 67  $\mu\text{Sv}$ .

During the hearing, the NSCRG concluded that radiological dose values reported by Agrium were incremental, while the NSCRG's own values, based on actual measured radon and gamma radiation data, represented total doses, and included all plant sources of radionuclides (i.e. operating facilities and phosphogypsum stack). The NSCRG agreed a direct comparison of the NSCRG and Agrium radiological values was not possible since one would be comparing "apples and oranges".

#### Alberta Justice representing Alberta Environment and Alberta Health and Wellness (Alberta)

Alberta said that Agrium's studies have shown the quantity or concentration of background radiation in the area was typical, and that the effects of the proposed phosphogypsum stack extension would be negligible. Alberta said that Agrium's conclusions regarding radiation health risk and impact to the public were reasonable and said that it expected Agrium to meet and follow the Canadian NORM guidelines.

It was noted that Alberta Environment had no guidelines for radiological emissions; however, in the year 2000, Health Canada developed Canadian Guidelines for the Management of NORM. Alberta said that Alberta Environment would rely on NORM guidelines that require that an annual maximum incremental dose of radiation to occupationally exposed workers not exceed 20 mSv. For incidentally exposed workers and members of the public, the maximum incremental radiation dose should not exceed 1 mSv per year. It noted that these limits were exclusive of natural background and medical exposures.

Alberta stated that a typical Canadian receives an average background radiation dose of 2 mSv per year of environmental radiation. Agrium performed tests in the early 1990's to determine the environmental background radiation levels in and around the Edmonton-Redwater region. The results showed an annual background radiation dose of 1.31 mSv/yr, which is approximately 35 percent less than the Canadian average. However, Alberta noted that due to the variability in radon gas levels, which were highly dependent on seasonal climate, the background radiation in the area could range from 0.464 to 1.40 mSv/yr.<sup>e</sup>

Alberta concurred with Agrium's prediction that the incremental radon concentrations would be indistinguishable from natural background levels. It said that Agrium's radiation risk assessment used acceptable, conservative methodology and took into account the potential radiation exposure pathways. It said that Agrium's studies showed that the quantity, or concentration of

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<sup>e</sup> Alberta Environment is referring to a statement in Agrium's radiological air quality assessment Tab 7.6 p25: "The gamma and radon background variability components when combined lead to a maximum variability of -65% and +107% from the 1.31 mSv/a average. This is equivalent to a range in background radiation dose from 0.46 to 1.40 mSv/a." The calculation contains an arithmetic error. The higher limit should be 2.71 mSv/a.



background radiation in the area, was typical, and that the effects of the proposed phosphogypsum stack extension would be negligible.

Alberta said that guidelines such as the *Alberta Ambient Air Quality Guidelines (AAAQG)* were working tools or goals, and that they were not legal limits in themselves, nor were they meant to indicate the point at which effects occur. If monitoring or conservative modelling indicated levels below guideline values, Alberta stated that problems would be unlikely. It stated that effects may not automatically occur when levels exceeded guideline values, at least in part because guidelines generally had safety factors built into them. It noted, however, that values in excess of guidelines suggested the need for further action that may take the form of more detailed monitoring, including ecological effects monitoring and careful scrutiny of whether further control measures would be feasible.

### 5.1.3 The Board's Analysis

The Board has reviewed Agrium's model of the dispersion of radionuclides from the site and its screening level health risk assessment of naturally occurring radioactive materials (NORM) impacts in detail, carefully considering the challenges presented by interveners. The Board believes it is a matter of importance to evaluate the evidence for and against the two very different expert accounts it heard of the risks to the surrounding community of NORM at the Agrium site. The applicant concluded that its project, either in its current configuration or with the proposed extension, would not contribute an appreciable incremental risk to human health because the incremental radiation dose ( $< 7 \mu\text{Sv}/\text{yr}$ ) would be insignificant in relation to background exposures in the order of  $2 \text{ mSv}/\text{yr}$  (i.e.  $2000 \mu\text{Sv}/\text{yr}$ ). The NSCRG said that the applicant's assessment seriously underestimated the radiation dose and failed to assess the risk to the most vulnerable receptors: children.

The Board understands that in order to conduct a screening level assessment of the health risk posed by radiation, Agrium estimated the quantities of radioactive gas and particulates emitted by the phosphogypsum stack, modelled their dispersion and finally modelled a number of exposure pathways to estimate the potential dose of radiation that hypothetical receptors could receive at specific locations. These values were compared to estimates of environmental background radiation and to national guidelines.

The Board notes that Agrium's estimates of background levels of radon and its progeny, were challenged by interveners. The Board is persuaded that the  $41 \text{ Bq}/\text{m}^3$  value used by Agrium to represent background levels of radon is too high. In reaching this conclusion, the Board notes that the authors of the 1994 report that is the source of the values inappropriately describe their offsite measurements as environmental background when their own data strongly suggest that their measurements were affected by the Agrium operation. The authors of the report note that the average of  $41 \text{ Bq}/\text{m}^3$  includes upwind values with a mean of  $16 \text{ Bq}/\text{m}^3$  ( $n=15$ ) and downwind values with a mean of  $84 \text{ Bq}/\text{m}^3$  ( $n=12$ ). Although the Board agrees with the authors of the report that these limited data are not sufficient to demonstrate that elevated downwind values are due solely to emissions from the Agrium operation, the clarity of the pattern makes it quite plausible that the upwind values reflect environmental background radon levels, and the downwind values were elevated by radon emissions from the operation.

During the hearing, Agrium noted that the mean radon concentration measured above the stack was also 41 Bq/m<sup>3</sup> and concluded that since there was no difference between the onsite and offsite means, there was no incremental contribution of the stack to ambient radon levels. The Board believes this conclusion is spurious because the comparison is between two sets of samples potentially affected by the operation rather than an affected sample and a proper control. The Board also believes it would be surprising if no evidence for elevated ambient radon levels could be detected above the phosphogypsum stack, considering the estimated radon flux from that source is currently  $1.5 \times 10^5$  Bq/s.

The Board notes that a value as great as 41 Bq/m<sup>3</sup> would be an outlier in the 1991 Alberta radon survey data (mean and standard deviation: 19 and 8 Bq/m<sup>3</sup> respectively). The upper 99 percent confidence limit for those data is 39.64 (i.e.  $19 + 2.58 \times 8$ ), implying that less than half of one percent of radon levels in Alberta would be expected to be that high. The Board also finds it cannot reconcile the choice of a 41 Bq/m<sup>3</sup> background value with the unreferenced statement in the application that current estimates of natural radon levels in the Redwater area are about 15 Bq/m<sup>3</sup><sup>f</sup>.

The Board notes that Agrium modelled the dispersion of radon from its current and expanded phosphogypsum stacks and concluded that their contribution was insignificant compared to the background radon concentration. Specifically, Agrium predicted that all but two of the future annual incremental radon concentrations at offsite receptor locations would be less than 0.1 Bq/m<sup>3</sup>, two orders of magnitude below the lower estimate (15 Bq/m<sup>3</sup>) of the background radon level.

The Board heard two lines of argument against Agrium's conclusions. The first argument was that Agrium had employed inappropriate assumptions in its modelling, which led the company to underestimate radon concentrations and doses. The NSCRG questioned Agrium's occupancy factor (i.e. the proportion of time that a human receptor would occupy a receptor site); the radon progeny equilibrium factor (i.e. the unitless ratio of radioactivity due to the progeny of radon versus radioactivity due to radon itself); and the dose conversion factor (i.e. the time-specific effective radiation dose in mSv delivered by a given radon concentration). Without venturing an opinion as to which of the parties was correct in these matters, the Board observes that had Agrium employed all of the higher values suggested by the NSCRG, the effective dose would have to be multiplied by a factor of roughly 50<sup>g</sup>, which would increase the predicted maximum effective doses at the two receptor locations immediately adjacent to the proposed extension, locations 3 and 16, to 17 and 12 µSv/yr respectively<sup>h</sup>. The Board observes that these maximum

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<sup>f</sup> Agrium EIA, Section 7.1, p 39, p 41.

<sup>g</sup> The factors NSCRG proposed were: occupancy – 1.25; radon progeny equilibrium factor – 21.7; dose conversion factor – 1.8. The product of these factors is 49.

<sup>h</sup> The predicted maximum radiation doses at receptor locations 3 and 16 were 0.3428 and 0.2465 µSv/yr respectively (Agrium EIA Tab 7.6, Table 4.2).

predicted doses are dwarfed by background radon levels in the order of a few hundred  $\mu\text{Sv}/\text{yr}$ <sup>i</sup>. The Board also notes that the maximum predicted radon doses at receptor sites across the river are much lower at about two orders of magnitude less than the background radiation. The Board therefore concludes that none of these factors would have a material effect on Agrium's conclusion that the dose due to radon from the phosphogypsum stacks is insignificant.

The second argument was that the model predictions were too low to explain measurements of ambient radon. The NSCRG calculated a ratio of the measured and predicted values and concluded that the modelled predictions of ambient radon concentrations were low by a factor of 167. The Board notes that this matter was resolved when the NSCRG agreed with Agrium that the measurements, which reflect all sources of radon, and the modelled values, which describe only the effect of the phosphogypsum stacks, are not comparable and that it would be inappropriate to inflate the model predictions by their ratio.

The Board also notes that it would be incorrect to multiply the factors in the two foregoing arguments to obtain an overall adjustment factor for radon, as was proposed by the NSCRG. The reason is that the ratio of measured to predicted values would decline if the predictions in the denominator were increased by the proposed multipliers.

Having carefully examined Agrium's modelling of radon and the intervenor's critique thereof, the Board believes Agrium used appropriate values and methods to predict the impact of the stack on ambient radon concentrations. The Board is therefore convinced that Agrium is correct in stating that the contributions from the current phosphogypsum stack and the proposed extension are orders of magnitude below any reasonable estimate of the radon background level, and are therefore inconsequential.

The Board notes that the modelled contribution of radon from the phosphogypsum stacks is too low to account for mean ambient radon concentrations measured on the stack ( $41 \text{ Bq}/\text{m}^3$ ), at the fence line ( $72 \text{ Bq}/\text{m}^3$ ) and offsite ( $41 \text{ Bq}/\text{m}^3$ ), given the nominal regional background of 15 to  $19 \text{ Bq}/\text{m}^3$ . The Board can only infer that emissions from the remainder of the operation, which were not included in Agrium's model, may account for the roughly  $20\text{-}25 \text{ Bq}/\text{m}^3$  difference. The Board believes this is plausible because higher radon levels have been measured at the rock handling and storage areas.

The Board believes that the utility of Agrium's radon dose estimates is limited to a comparison of the existing and proposed stack configurations. This comparison has allowed the Board to understand that the incremental effect of an approval of the stack extension on radon exposure would be negligible, with the possible exception of those sites immediately adjacent to the stacks (sites 3 and 16). The Board also infers that a denial of Agrium's application for the extension would result in a reduction in the amount of radon released from the operation. Since Agrium did not model sources other than the phosphogypsum stack, the Board cannot be confident about the size of that potential reduction.

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<sup>i</sup> Agrium estimated a background radon dose of  $680 \mu\text{Sv}/\text{yr}$  based on  $41 \text{ Bq}/\text{m}^3$ . The  $15 - 19 \text{ Bq}/\text{m}^3$  range of radon backgrounds the Board finds plausible translates to  $250 - 317 \mu\text{Sv}/\text{yr}$ , using Agrium's dose conversion factor (DCF), or  $450 - 570 \mu\text{Sv}/\text{yr}$  allowing for the higher DCF proposed by the interveners.

Although there were many points of contention between Agrium and the NSCRG with respect to the remaining significant exposure pathways of the radiological assessment (i.e. inhalation, ingestion and gamma radiation), the Board notes that all of the multipliers proposed by the interveners, summarized in the following table, were less than ten.

<b>Exposure Pathway</b>	<b>Intervener Critique of Agrium's Methods</b>	<b>Proposed Multiplier</b>
Particulate Inhalation	Include all progeny Isotope-specific lung clearance rates	4.5
Ingestion	Include all progeny Assume shallow soil mixing Children ingest more soil	1.5 (adult) 9.1 (child)
Gamma*	Include all progeny Children's organs closer to gamma sources	2.6 (adult) 3.4 (child)
* Gamma irradiation associated with deposition of phosphogypsum dust.		

Again, without venturing an opinion as to which of the parties was correct in these matters, the Board notes that if the effective doses of these particulate-mediated pathways were multiplied by a factor of 10, the predicted effective radiation dose at receptor location 3 with the extension in place would be 61.4  $\mu\text{Sv}/\text{yr}$ <sup>j</sup>, which is more than an order of magnitude below Agrium's 630  $\mu\text{Sv}/\text{yr}$  estimate of the background gamma dose. As was the case with radon, the radiation dose due to these exposure pathways drops an additional order of magnitude at receptor 4 and a further order of magnitude at locations 5 through 7. Thus, even after allowing for the multiplicative factors proposed by the interveners, the Board finds that the modelled radiation dose from these pathways at offsite receptors would be 100 to 1000 times below background at locations where the public might actually be affected. The Board therefore accepts Agrium's conclusion that the radiation dose due to particulate-mediated exposure pathways from the phosphogypsum stacks is inconsequential.

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<sup>j</sup> Table 4.5 "Summary of Radiological Assessments (Discrete Receptor Locations)", p 23 of Agrium EIA Tab 7.6 gives current values of 0.005 and 0.077  $\mu\text{Sv}/\text{yr}$  for inhalation of suspended dust and ResRad model pathways respectively and future values of 0.037 and 6.1  $\mu\text{Sv}/\text{yr}$ . Ten times the sum of those pathways is 0.82 and 61.4  $\mu\text{Sv}/\text{yr}$  for the current and phosphogypsum stack extension scenarios respectively.

The Board notes that in addition to its critique of the model inputs, the NSCRG sought to test the appropriateness of the gamma exposures predicted by Agrium's model by comparing them with estimates built on actual measurements. The Board believes the NSCRG's comparison and its conclusion that the model underestimated the gamma dose by a factor of 287<sup>k</sup> are invalid because the estimated gamma dose derived from dosimeter readings includes all sources of gamma beyond the background, whereas Agrium's modelled value is limited to the effect of the phosphogypsum stacks. The Board believes the fact that the two values were not comparable was understood by all participants during the hearing. Again, the Board observes that it would be incorrect to calculate an overall adjustment factor for gamma exposure by multiplying the proposed model adjustment factors and the ratio of observed to modelled gamma doses, even if that ratio were valid, for the same reasons that this approach was incorrect with respect to radon.

The Board understands that all of Agrium's RESRAD model exposure pathway estimates, including gamma exposure, were derived by modelling the contamination of soil due to the deposition of suspended phosphogypsum dust<sup>1</sup> and that Agrium did not model direct exposure to gamma emissions from the stack itself or other on-site gamma sources. The Board understands that the omission is warranted in a screening level assessment of off-site risks because gamma exposure declines exponentially with distance from the source. Agrium's 1992 gamma data appear to bear out this pattern. There is a decline in gamma doses from the phos-acid operation (2.75 µSv/hr) to the material handling and storage and the gypsum stack (0.14 and 0.13 µSv/hr respectively) to the fence line and rural background (both 0.09 µSv/hr).

The Board has reviewed the evidence and arguments with respect to the radiological effects of the project in detail in order to satisfy itself that the Agrium operation, and more specifically the extension it has been asked to approve, pose minimal risks to the public.

The Board was surprised that Agrium's application relied on radiological data that was at least a decade old. Although the Board has no reason to suspect that these data are not representative of current conditions, it has no evidence to assure itself that radiological emissions in 2004 are as they were in 1992 and 1994. The Board would have much preferred current evidence to a plausible argument that the old evidence still applies. The Board is prepared to rest its conclusions on the assumption that the data at hand are representative of current conditions, only because it believes the prospect of data so radically different as to require a re-evaluation of the risk assessment is remote.

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<sup>k</sup>The Board understands that the factor of 287 was calculated as the ratio of an annual dose of 315.6 µSv based on the 0.06 µSv/hr 'net results above background' recorded at Candle Station L8 in the spring of 1992 to the modelled value of 1.09 µSv/yr at receptor location 3. The radiological units in the 1992 memo are Gy (Grays), which are related to Sieverts (Sv) as  $Sv = Gy * QF$ , where QF is a "quality factor" which depends on the type of radiation. For gamma radiation,  $QF = 1$ . NSCRG's value of 315.6 uSv/yr was calculated as  $0.06 \text{ uSv/hr} * 8760 \text{ hr/yr} * 0.6$ , where the final term accounts for 50% indoor occupancy with shielding factor 0.7 and 25% outdoor occupancy. The factor of 287 =  $315.6 \div 1.09$ .

<sup>1</sup> cf Agrium EIA, Tab 7.6, section 4.2.3, page 19.

The Board does not concur with Agrium's view that the current and future activities of its Redwater operation are unlikely to have any radiological impact on the surrounding population<sup>m</sup>. It believes the 1994 ambient radon data suggest that Agrium's operation has an effect of approximately the same magnitude as the regional radon background of 15 – 19 Bq/m<sup>3</sup>, or roughly a quarter of the total radiation from all sources, whereas Agrium attributes none of the ambient radon to its operation. The Board believes this matter can and should be resolved by gathering ambient radon data designed to compare the regional background with ambient levels potentially affected by the operation. The Board recommends that Alberta Environment require Agrium to undertake this work in the context of its environmental approvals.

Although the Board attributes a portion of the radiological exposure due to radon to the Agrium operation, it is worth stating that this attribution has no effect on the estimate of total radiological exposure because Agrium attributed a correspondingly greater amount to background radon. The Board concluded that none of the other exposure pathways would contribute significantly to the radiological exposure of the surrounding population. The Board notes that the magnitude of Agrium's impact is well below the Health Canada guideline of 1 mSv/yr and the total exposure to all sources, including Agrium, is less than the typical Canadian radiological exposure of 2 Sv/yr.

The Board concurs with Agrium's assessment that the incremental radiological exposure from an approval to extend its phosphogypsum stack would be insignificant. The Board finds that an approval would also entail a continuation of existing radiological impacts of the operation, which are small enough to be acceptable. The Board finds that a denial of the extension would prevent an insignificant increment in radiological exposure due to the stack extension itself and could reduce radon exposure from other sources.

## 5.2 Fluoride

### 5.2.1 Views of Agrium

Agrium stated that using conservative, worst case assumptions, it predicted future ambient concentrations of fluoride in this area would not change in any material way as a result of the project. It said that it used a tuneable diode laser system to measure hydrogen fluoride (HF) concentrations over the existing phosphogypsum stack and to estimate HF emissions from the stack. It said its modelling of fluoride ambient concentrations included maximum reported emissions from process point sources (13 tonnes/year for existing case), as well as the phosphogypsum stacks (34 tonnes/year for existing case). It viewed that use of maximum process emissions likely overestimated those sources by a factor of two or three on an annual average basis. It said that it had also modelled a scenario based on licensed process emissions which would be double the historical values used. It noted that not all fluoride compounds (e.g. silicon tetrafluoride) were included in the modelling, but said that the relative contribution of these compounds would be small.

Agrium indicated that the one-hour HF guideline for off-site locations under current and future scenarios would be exceeded under some instances. It stated that compliance with the HF

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<sup>m</sup> cf Agrium EIA, Tab 7.6, page 25.

guideline, based on modelling with a one-year local meteorological data set, would be 98% to 600 m, 99% to 900 m and 99.8% up to 1.5 – 2 km. Agrium said that the Alberta Environment deposition guideline of 40 µg/ 100 cm<sup>2</sup> per 30 days would not be exceeded off-site under current conditions, but would be exceeded between March and December at Agrium-owned receptor location 3, between April and December at receptor location 16, and between July and August at receptor locations 2 and 4, after the extension.

Agrium said that it proposed to focus on obtaining additional fluoride information both on and off-site. It would continue to collect additional information using the laser system and would endeavour to measure for silicon tetrafluoride. Agrium proposed that it would expand and refine its vegetation monitoring program. It noted that it already completed an annual study of fluoride in vegetation at various locations around the site.

Agrium said that it had undertaken a series of measures to reduce fluoride emissions, primarily directed at reducing point source emissions. It stated the measures had involved considerable investment directed at capturing increasingly small quantities of fluoride and that potential opportunities to minimize fugitive fluoride emissions were currently being investigated. Nevertheless, it noted that a condition requiring absolute reductions in fluoride emissions would be unreasonable and unworkable. Agrium stated, however, it would be prepared to accept the challenge should Alberta Environment require evidence of the implementation of management practices over time to improve performance.

Agrium provided a screening level health risk assessment of the impacts of fluoride emissions from its existing and planned operations. It chose to model as the receptor subsistence farmer/residents (i.e. infant, preschooler, child and adult) to represent a worst hypothetical case. Agrium explained a reasonable maximum exposure methodology was followed in the screening-level health risk assessment and outlined the key assumptions involved:

- human receptor spends entire life at a certain exposure location
- human receptor lives an exaggerated lifestyle, maximizing potential exposure (i.e. 50 percent diet is 'homegrown')
- Published USEPA default values were used in risk assessment calculations
- Hydrogen fluoride (HF) was considered principal form of fluoride with a small fraction of fluoride associated with particulates
- Fluoride in groundwater was considered naturally occurring i.e. not from Agrium operations and therefore not included risk assessment

Agrium said three possible fluoride exposure scenarios were developed for the risk assessment and described the assumptions involved.

- Average (i.e. exposure conditions were based on predicted geometric mean fluoride concentrations from 16 receptor sites based on Future 1 predicted air emissions)
- Conservative (i.e. exposure conditions were the post-extension maximum predicted exposure to fluoride arising from Future 2 predicted air emissions)
- Actual (i.e. exposure conditions based on actual average measured concentrations in vegetation from ongoing monitoring and existing average predicted air concentrations at 16 receptor locations)

Agrium indicated the Future 2 scenario assumed that all permitted sources released maximum approved fluoride emissions. The latter included those sources which were no longer used for phosphate production, although they had been in the past and could be improbably transferred to phosphate production in the future.

Agrium stated that an oral reference value of 0.06 mg fluoride/kg body weight/day (USEPA, 2001), linked to dental fluorosis as a health effects end-point, was adopted in its human health risk assessment. Agrium acknowledged that a new oral reference value of 0.04 mg fluoride/kg body weight/day for fluoride had been released by the California EPA in 2002. However, Agrium said the risk assessment had been completed before the release of this new reference value.

Agrium cautioned that the Hazard Quotient (HQ) values, calculated in the course of the risk assessment, require careful interpretation. Generally, Agrium said an HQ less than 1.0 indicated the probability of no adverse health effects, and an HQ much greater than 1.0 necessitated an examination of reasons for this result. In normalizing the published “no observable effects level” (NOEL) values for fluoride on different biological systems in humans (e.g. respiratory, cardiovascular, hepatic, renal, dermal) to that for human dental fluorosis, Agrium estimated these toxicological effects occurred over a range of relative HQ values between 80 and 100. Likewise, Agrium noted significant toxicological effects in animals occurred over a similar relative HQ range.

Agrium noted that results of its risk characterization showed an HQ greater than 1.0 for fluoride, only under the conservative and actual scenarios, for only the infant (0 – 6 months) and preschooler living a subsistence lifestyle. The latter lifestyle assumed a diet of 50 percent home grown garden produce and dairy. Agrium noted that if home grown dairy milk, with an assumed highly elevated fluoride concentration of 5 mg/l, was eliminated from the diet, the elevated risk was reduced. Agrium concluded that the assumptions it had applied in this instance were too conservative and indicated that a more realistic value for fluoride content in dairy milk was 0.287 mg/l (National Research Council, 1977). In examining fluoride concentrations in milk-based infant formula, soy-based infant formula and human breast milk reported in the literature, Agrium confirmed that very little fluoride was concentrated in human breast milk.

Agrium examined the risk to subsistence farmer preschoolers in the Future 2 predicted air emissions scenario for all 16 receptor sites and found that an HQ greater than 1.0 was obtained at sites 3 and 16 only. These were both sites on the Agrium plant property and the likelihood of establishing a farm to raise dairy cattle at these locations was considered extremely remote.

In its cumulative health risk characterization for a subsistence farmer preschooler at receptor site 3, Agrium estimated its specific contribution to cumulative risk from general fluoride exposure from sources such as soil, air, food, water and household products via pathways of ingestion, inhalation and/or contact, may be as high as 41 percent of a total cumulative HQ of 3.9. This calculation, however, involved an assumed concentration of fluoride in home-produced dairy foods that was much higher than is realistically ever found. After adjusting for this fact, Agrium estimated that their contribution might more realistically be 4.4 percent of a cumulative HQ of 2.4, for the same scenario. Therefore, Agrium stated its estimated contribution to the cumulative HQ of 2.4 was 0.10 (i.e. without Agrium’s additional contribution the HQ would still be 2.3).



For the average and actual exposure scenarios in this case, Agrium said its contribution to the cumulative HQ was 0.06 and 0.03, respectively.

Agrium concluded that although it was contributing to the overall cumulative dose of fluoride, its contribution was small, and even for the most conservative scenario the likelihood of health risks would be within acceptable limits, particularly when compared to typical potential Canadian fluoride exposure from dietary sources.

## 5.2.2 Views of the Interveners

### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG noted that Agrium's model predictions indicated levels exceeding the one-hour HF guideline in the future scenario, and a static fluoridation rate exceeding the guideline under existing and future emission scenarios. It said that predicted annual average fluoride concentrations for both the existing and the two future scenarios would exceed the Netherlands vegetation standard of  $0.02 \mu\text{g}/\text{m}^2$  for all receptors, and would exceed the 1984 World Health guidelines of  $0.2 \mu\text{g}/\text{m}^2$  for all but four receptors.

The NSCRG viewed Agrium as the only significant source of fluoride pollution in the area and concluded the current health risk assessment was based on an incomplete identification of hazards and unsubstantiated assumptions. NSCRG stated the risk assessment was neither conservative nor representative but deficient and unreliable. It identified the following issues:

- nature of the fluorides (i.e. gas, particulate, aerosol) was not considered
- size fractions of fluorides and particulates were not addressed
- contribution of fluorides in the particulate phase was not assessed
- chemical transformation of fluorides once emitted was not addressed
- nature of fluoride release (i.e. continuous, intermittent) was not considered
- fluoride content in drinking water ( $\sim 0.7 - 1.0 \text{ mg/l}$ ) was omitted from the risk analysis
- fluoride exposure from the consumption of local wild game and fish was not evaluated
- new California EPA (CALEPA) total acceptable daily intake reference value for fluoride (i.e. 40 micrograms/kg body weight /day) was not used
- silicon tetrafluoride emissions were neither quantified nor considered in the risk assessment

The NSCRG stated the Government of Canada considered fluorides as a first priority substance on its Priority Pollutant List.

The NSCRG stated excess human exposure to fluoride was marked by periodontal disease (i.e. gum recession, loose teeth, gaps between the teeth). The NSCRG noted that excessive fluoride intake during tooth development (i.e. birth – age eight) could result in dental fluorosis. The NSCRG explained that because the tooth enamel would not be formed properly at that age, it would become weak, flake off, or become mottled, and posed significant problems when corrective dental procedures were required. The NSCRG indicated fluoride-related cosmetic effects to teeth were difficult to treat, and viewed these consequences as not merely cosmetic

effects, but rather adverse health effects. The NSCRG stated that skeletal fluorosis, characterized by an increase in bone density and fractures, was only one of the possible medical health effects end points. It said early stages of skeletal fluorosis resulted in calcification of the ligaments and joints, leading to arthritic-like symptoms.

The NSCRG maintained that a diagnosis of dental fluorosis did not require an actual “hands-on” examination of a patient’s teeth but could be accomplished using photographs. It said research, as well as an estimate of the severity of dental fluorosis, was also possible using photographs.

The NSCRG confirmed that a number of children in the community neighbouring Agrium had been diagnosed, using photographs, with varying degrees of dental fluorosis. Based on the examination of community children, the NSCRG concluded a cluster of fluorosis existed near Agrium. On cross-examination, the NSCRG confirmed that 10 – 20 percent of the Canadian population exhibits mild dental fluorosis.

The NSCRG confirmed that the drinking water criterion for fluoride in the United States was 4.0 mg/l and 1.5 mg/l in Canada. It acknowledged the local well water contained <1.0 mg/l fluoride. The NSCRG estimated that the community residents are exposed to an environmental equivalent of about 4.0 ppm fluoride. The NSCRG stated that daily exposure to fluoride through sources such as consumer products, health care products and prepared foods could only be considered equivalent to living in an area with 1.0 ppm fluoride exposure. The NSCRG concluded the additional fluoride must be coming from the atmosphere.

The NSCRG stated fluoride affects the pineal gland and is a neurotoxin at concentrations greater than 3.0 ppm, affecting all mineralizing tissues under formation in humans. The NSCRG noted that one child in the community had fluorosis of her primary baby teeth which would have developed *in utero*.

The NSCRG stated the US National Academy of Sciences was re-examining key issues related to fluoride and human health such as:

- The medical diagnosis of dental and skeletal fluorosis
- Whether dental fluorosis was a cosmetic or adverse health effect
- Whether the NOEL (no observable effects level) threshold of 1.0 ppm for drinking water was adequate to prevent objectionable dental fluorosis

### **Sturgeon County Residents (SCR)**

The SCR said that issues raised by the NSCRG reflected their own concerns regarding air quality impacts. It noted that the phosphogypsum stack extension to the north would have the effect of moving HF and particulate emission sources closer to Sturgeon County residents.

### **Alberta Justice representing Alberta Environment and Alberta Health and Wellness (Alberta)**

Alberta concluded that Agrium’s modelling and assessment for HF was conducted using acceptable methodology, and that the conclusions were reasonable. Alberta was of the view that

the potential impacts associated with HF emissions from Agrium's existing operations and the future scenarios would be minimal. Alberta noted that its views were based on:

- the predicted low frequency of exceeding the Alberta Ambient Air Quality Guideline (AAAQG) values,
- the close proximity of the predicted exceeded guideline values to Agrium's operations,
- the absence of obvious widespread impacts on vegetation in the area, and
- the predicted HF concentrations well below human health protection air inhalation guidelines.

Alberta noted that there were two Alberta Ambient Air Quality Guidelines related to HF; the one-hour average HF level of  $4.9 \mu\text{g}/\text{m}^3$ , and the static fluoridation rate of  $40 \mu\text{g}/100 \text{cm}^2/30$  days. It noted that both values were based on effects that could pose a potential impact to the most sensitive receptor, in this case, vegetation.

Although Agrium predicted the AAAQG would be exceeded in some cases, Alberta noted that the model predictions of HF concentrations at the 16 receptor locations in all scenarios were well below acute and chronic guidelines protective of human health. Based on the information presently available, Alberta viewed the potential impacts associated with HF emissions from Agrium's existing operations and the future scenarios to be minimal.

Alberta noted that it may include requirements in its *EPEA* approval for additional HF ambient air monitoring, as well as studies to confirm the absence of adverse effects related to HF on vegetation in the area. It also noted that Alberta Environment may include conditions requiring Agrium to investigate and report on any viable mitigation techniques to reduce ambient HF levels.

### Capital Health Authority (CHA)

In responding to questions regarding the incidence of fluorosis, the CHA referred to the results of an oral health survey of elementary school children in the Capital Health region, conducted between 1998 and 1999. The CHA indicated that about 30,000 elementary students between grades two and six were involved in this study. The CHA stated the incidence of fluorosis in these children was about 25 percent<sup>n</sup>. The CHA strongly disputed the NSCRG's conclusion that a cluster of fluorosis existed around Agrium.

### 5.2.3 The Board's Analysis

The Board has reviewed Agrium's evidence and the interveners' critique of the evidence with respect to fluoride emissions. The Board believes that the following facts, most of which were established through direct observations, are uncontested: Agrium is the sole industrial source of hydrogen fluoride (HF) in the Redwater area. The ambient concentration of HF is greatest at the Agrium site and declines with distance from the site. Some off-site measurements as far as 2 km from the ponds exceed the one-hour average AAAQG of  $4.9 \mu\text{g}/\text{m}^3$ . The concentration of

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<sup>n</sup> The Board has noted that Exhibit Capital Health #2, page 18, reads "...fluorosis, on any level, was detected in 36% of the children who were scored for this index."

fluoride in vegetation is also highest near the Agrium operation and declines with distance from the site. Vegetation fluoride concentrations within 1.5 km of the site exceed the Canadian reference level of 30 mg/kg (dry weight).

The Board notes that Agrium used a dispersion model to estimate fluoride concentrations and deposition rates. Agrium urged the Board to rely on its model predictions, emphasizing that they were developed with conservative assumptions. Interveners contested many of the assumptions employed in the model and urged the Board to conclude that the model underrepresented fluoride emissions.

The Board has considered the fluoride dispersion modelling in detail, including the choice of the dispersion model, the assumptions and methods used to derive model inputs, and the model verification process. The Board has undertaken this level of scrutiny because it believes the credibility of the environmental and health risk assessments rests in the first instance on establishing that Agrium used a reasonably conservative approach to predict ambient fluoride concentrations and deposition rates.

The Board notes that the NSCRG criticized Agrium's choice of the CALPUFF dispersion model because it said it could not adequately model topographic effects and was not suitable for predicting impacts within a five mile radius of the operation. The Board heard Alberta Environment express the opposite opinion: that CALPUFF was appropriate, because it was capable of modelling dispersion at scales as low as a few hundred metres and was accepted in Alberta's Air Quality Model Guidelines. The Board also notes Alberta Environment's comment that the alternative codes suggested by the interveners were more appropriately applied to release events and would therefore not be applicable to this assessment. The Board finds that the CALPUFF model was suitable for the Agrium assessment.

The Board notes that although Agrium urged the Board to rely on its modelling results, it acknowledged several sources of uncertainty that require further investigation: uncertainties associated with ambient concentration measurements; uncertainties arising from the conversion of measurements taken over five minute intervals to hourly predictions, and potential silicon tetrafluoride emissions as a source of HF.

The purpose of the fluoride dispersion modelling was to generate estimates of ambient concentrations and deposition rates to be compared with published guidelines and to generate estimates of fluoride exposures in the environmental and health risk assessments. The Board therefore believes that demonstrable caution, that is, a 'conservative' approach, is appropriate in this context. Accuracy, which is greatly valued in some modelling exercises, is not the primary objective here. Instead, predictions should be biased toward overestimation in order to err on the side of caution.

The Board believes the process stack emission estimates were suitably cautious because the maximum emission rates in the current and 'Future 1' scenarios and approval limits in the 'Future 2' scenario clearly overestimate the expected fluoride emissions. The Board notes that Agrium estimated that the 13 tonnes/annum stack emissions used in the 'Future 1' scenario likely overestimated actual emissions by two to three times.

The Board is less confident that the methods and assumptions Agrium used to estimate fluoride emissions from the phosphogypsum stack produced comparably conservative estimates. The Board notes that Agrium could not provide assurances that the phosphogypsum stack emissions used in the dispersion model were cautious through recourse to one or more conservative scenarios comparable to those it applied to the process stack emissions. No such assurance could be given because Agrium had no estimates of actual phosphogypsum stack emission rates, comparable to the estimates of actual process stack emission rates, with which to demonstrate the relative conservatism of model inputs.

The Board believes Agrium understood this difficulty and attempted to err on the side of caution in its estimation methods and assumptions<sup>o</sup>. Nevertheless, the NSCRG questioned Agrium's approach in every detail: the accuracy of the laser measurements; the potential bias in box model estimates of flux, the conversion of five-minute laser readings into hourly estimates, the justification for the temperature adjustment and the assumption that the phosphogypsum stack extension would not increase total HF emissions.

The Board believes Agrium's approach to modelling the phosphogypsum stack fluoride emission rates was plausible, but not transparently conservative. Agrium cited three sources of conservatism in its approach. First, it said that tuneable diode laser measurements tend to be biased high. The Board understands that this would introduce a conservative bias, although it cannot be sure how significant this upward bias might be, or what the net effect on emission calculations would be if the NSCRG is correct in stating that the box model calculations introduce a counterbalancing downward bias. Agrium said that its model made no allowance for the portions of the ponds that were drying or ice-covered. The Board understands that making no allowance for the dry portions of the ponds could have introduced a conservative bias if measurements had been gathered over wet ponds, where HF emissions were expected to be greatest. However, the Board heard Agrium's experts say that the concentration measurements were gathered 'primarily over the wet portions of the ponds' and included some measurements over dry portions. The Board therefore believes any potential conservative bias would have to be discounted to the extent that the HF measurements included dry areas, which are not expected to emit as much HF. The Board also understands that making no allowance for ice formation could conservatively bias winter emissions, but it believes this would have a minor effect on annual emissions and no effect at all on the maximum emissions.

The Board notes that Agrium's experts believed that they had appropriately overestimated phosphogypsum stack HF emissions and that they suggested a factor of two to four. The Board does not discount their professional opinion, but observes that it cannot independently verify the estimate, since the purported conservative biases in the modelling approach were not quantified in the evidence.

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<sup>o</sup> In its reply to the Board's post-hearing request for clarification of its evidence concerning fluoride emissions, Agrium stated that SENES had employed maximum emission rates in estimating phosphogypsum stack emissions. The Board cannot reconcile this statement with the evidence presented by SENES in its written or oral evidence that emission rates were calculated from seasonally adjusted weighted average concentrations.

The Board notes that Agrium's model did not include any fluoride emissions from the phosphogypsum stack except from the ponds. The Board believes Agrium's assumption that the remaining portion of the stack emits no fluoride of any kind is less than cautious, in light of its limited understanding of the relationship between the state of the stack surface and fluoride emissions. The Board believes fluoride may be emitted from at least some portion of the non-pond areas of the stack, because those areas are not expected to be dry. The Board understands that during the life of the plant, and possibly afterwards, the phosphogypsum ponds will maintain the water table at the surface on the side slopes of the stack. In the Board's view, it is quite plausible that fluoride compounds in solution may be released to the atmosphere through evaporation on the stack walls.

The non-pond portion of the phosphogypsum stack currently accounts for slightly less than 40 percent<sup>p</sup> of the aerial extent of the stack. With the extension and no increase in the pond areas, the non-pond part of stack would increase to 64 percent<sup>q</sup> of the aerial extent of the stack, which is a 60 percent increase over the current non-pond portion of the phosphogypsum stack. The Board notes that if the remaining portions of the stack do emit fluoride, those emissions could be expected to increase by roughly the same percentage. It cannot assess with the evidence it has whether fluoride emissions from this portion of the stack are significant. The Board does conclude that fluoride fluxes from the phosphogypsum stack may have been underestimated by assuming no fluoride emissions from the non-pond areas.

The Board notes that Agrium was aware of possible emissions of silicon tetrafluoride (SiF<sub>4</sub>). Unfortunately, Agrium's efforts to measure SiF<sub>4</sub> concentrations above the phosphogypsum stack in the summer of 2003 were unsuccessful. The lack of information on the subject of SiF<sub>4</sub> concerns the Board since each molecule would yield four molecules of HF in the atmosphere and could therefore contribute disproportionately to total fluoride emissions. Although Agrium argued that the flux of this gas should be low, the Board believes the matter can only be resolved with data. The Board concludes that fluoride fluxes from the phosphogypsum stack may have been underestimated by neglecting SiF<sub>4</sub>, although the significance of this omission is currently unknown.

Summarizing the Board's views on the dispersion model inputs, the Board believes the process stack fluoride emission estimates were appropriately conservative, but is less confident that the phosphogypsum stack fluoride emission estimates were conservative. This is unfortunate because, of the two sources, the phosphogypsum stack emissions represent the greater part of Agrium's total fluoride emissions.

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<sup>p</sup> Existing scenario phosphogypsum stack non-pond areas =  $(172 \text{ ha} - 105 \text{ ha})/172 \text{ ha} * 100 = 39\%$ . The actual surface area of the non-pond portion would be somewhat larger because the area of the sloping stack walls is greater than their two-dimensional projection.

<sup>q</sup> Expansion scenario phosphogypsum stack non-pond areas =  $(172 \text{ ha} + 119 \text{ ha} - 105 \text{ ha})/(172 \text{ ha} + 119 \text{ ha}) * 100 = 64\%$

The Board has some concern with the procedure Agrium used to assess whether its model was a fair representation of fluoride emissions and dispersion. The first concern is that the comparison of model predictions and measured HF concentrations was conducted at the source of the emission. It is not clear to the Board that an acceptable correspondence between observed and predicted values at the phosphogypsum stack source conveys any information about the predictive value of the model at any distance from the phosphogypsum stack. The second concern is that the comparison between measured and predicted HF concentrations above the stack was misinterpreted. The statement in the application that "...the predicted concentrations are comparable to or higher than the values measured in May 2001" is not supported by the observations and measurements presented in the application. In fact, the predicted concentrations<sup>r</sup> are significantly lower (Paired t-test,  $P < 0.05$ ) than the measured values.

The Board is also not sure it can take any comfort from the observation that the average measured and modelled concentrations fall within a factor of two, which the applicant said was an acceptable multiple according to Appendix W of the USEPA Federal Register 2001. The comparison in that document is between concentration maxima at some distance from a source, not averages at a source. Although no comparison between predicted and observed maxima at a distance from the phosphogypsum stack can be made with the data at hand, the Board notes that the highest measured fluoride concentration above the phosphogypsum stack<sup>s</sup> is more than twice the highest predicted value.

The Board does not wish to place a greater weight on these comparisons than they deserve. The Board merely observes that these comparisons lend no support to Agrium's assertion that its modelling was appropriately conservative.

The Board observes that the predicted ambient fluoride concentrations in the immediate area of the plant were relatively insensitive to the approximate doubling of process stack emissions between the 'Future 1' (1.478 kg/h) and 'Future 2' (3.28 kg/h) scenarios, as depicted in Agrium's Figure 5.2-2. This is not entirely surprising because the process stacks disperse pollutants away from the site. In contrast, the Board expects that predicted ambient fluoride concentrations in the study region would be more sensitive to changes in phosphogypsum stack fluoride flux rates because these ground-level emissions lack the elevation, exit velocity and thermal loft to disperse away from the vicinity. The Board notes that previously mentioned potential sources of model underestimation (i.e. the assumption that non-pond areas emit no fluoride, the absence of silicon tetrafluoride measurements, and the lower-than-measured model predictions of HF concentrations above the stacks), affect ground level emission estimates that would be expected to have a disproportionate effect on the predicted ambient concentrations in the study area.

The Board notes that the maximum and mean one-hour ambient fluoride concentrations in Agrium's 2003 air quality data exceeded the *AAAQG* of  $4.9 \mu\text{g}/\text{m}^3$  at four and nine of twenty-two locations respectively, even though the measurements were collected for only a

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<sup>r</sup> Agrium EIA, Tab 7.1, Appendix C, Table C.1

<sup>s</sup> Ibid.

few hours. These data clearly show that measured ambient fluoride levels exceed the guideline value more often than predicted by the dispersion model<sup>t</sup>.

In summary, the Board finds that the fluoride dispersion modelling, which Agrium described as ‘conservative’, contains a mixture of appropriately conservative assumptions, questionable omissions that could cause the model to underestimate ambient concentrations, and uncertainties that could affect the estimates either way. These difficulties might have been mitigated had Agrium demonstrated a substantively conservative relationship between predicted and observed ambient fluoride concentrations in the study area. Since this was not done, and since the available comparisons between observed and predicted values indicate that the model underestimates, the Board finds that Agrium has not demonstrated that the predictions of the fluoride dispersion model adequately and conservatively correspond to the situation they purport to model. Consequently, the Board finds that it cannot rely on those predictions.

The Board believes that any comparison of predicted ambient fluoride concentrations with ambient guidelines is premature and could be potentially misleading until Agrium remedies the deficiencies noted above. Similarly, the Board’s conclusion that the fluoride emission estimates may not be conservative casts doubt on their use in the environmental and health risk assessments.

The Board finds there is evidence that ambient hydrogen fluoride concentrations in the vicinity of the operation frequently exceed the Alberta one-hour ambient guideline, which is intended to protect vegetation. The Board recognizes that the 2003 data were collected in the summer, precisely the season when fluoride concentrations should be greatest. The Board also understands that the ambient guideline is not intended as a statutory limit, but as Alberta Environment advised, a threshold indicating that there might be a need for further action, possibly including detailed monitoring, ecological effects monitoring and careful scrutiny of whether control measures are feasible. The Board finds that the double-digit proportion of observations exceeding the guideline is ample reason to place Agrium’s fluoride impacts under greater scrutiny. The Board therefore welcomes Agrium’s commitment to improve its ambient and vegetation fluoride monitoring. The Board recommends that Alberta Environment oversee this effort both to ensure that the monitoring data can be used to document changes in the proportion of hourly measurements that exceed the ambient guideline and to provide the company with guidance as to what is ultimately acceptable.

The Board finds there is no evidence to suggest that ambient fluoride levels are currently high enough to pose a significant risk to human health. The Board notes, for example, that California’s chronic reference exposure level (REL) for dental and bone fluorosis and

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<sup>t</sup> The presentation of the data in Table 2 of Agrium’s December 2003 Air Quality Follow-Up do not allow the Board to calculate the exact proportion of observations that exceed the guideline. It is possible to calculate a conservative minimum, by assuming that the guideline was exceeded for just one hour at the five locations where the means were below the guideline and the maxima were above, and just half of the hours were above the guideline at the four locations where both the means and maxima were above the guideline. This works out to approximately 17%, which is well beyond the 5% Agrium predicted for its worst case: receptor location 3.



respiratory irritation is  $14 \mu\text{g}/\text{m}^3$ . The Board understands this to mean that an individual exposed indefinitely at that level would not experience an adverse effect. The Board finds that the mean chronic exposure is currently well below that level, based on the means of the 2003 data. The corresponding acute REL for eye and respiratory irritation is  $240 \mu\text{g}/\text{m}^3$ , which is more than ten-fold higher than any one-hour value in the 2003 data.

The Board is not prepared to rely on Agrium's assertion that fluoride emissions would remain at current levels with the extension due to its misgivings with the fluoride modelling and in particular the assumption that the expanded non-pond areas of the stack will emit no fluoride. Confirmation or denial of this assertion will have to await a better understanding and improved estimates of the phosphogypsum stack emissions. However, even without the insights that the Board hopes will come from further study of the phosphogypsum stack emissions, the Board cannot imagine a plausible way that expanding the phosphogypsum stack could increase ambient concentrations enough to exceed the chronic REL and thus become a concern for human health<sup>u</sup>. The Board therefore finds that ambient fluoride concentrations with the extension of the phosphogypsum stack would not pose a threat to human health.

The Board has more difficulty in reaching a definitive conclusion with respect to the ingestion-mediated fluoride exposure pathways because it cannot rely on the model and cannot compare the observed environmental concentrations to a standard such as the REL for ambient concentrations.

The Board understands that neighbours of the Agrium facility, particularly those who consume locally-grown produce, are exposed to elevated levels of fluoride. In the Board's view, this fact alone is not sufficient evidence to establish a causal link between dental symptoms in the neighbours and exposure to Agrium's emissions. The Board does believe the fact of exposure establishes the potential for an effect, which is a concern that warrants careful assessment.

The Board believes that fluorosis in children near the Agrium plant is not necessarily a cause for alarm in light of the prevalence of dental fluorosis in a recent CHA survey of elementary school children in the Capital Health Region. The Board heard that thirty-six per cent of school-aged children examined for fluorosis in that study showed evidence of fluorosis. It is therefore quite possible that the fluorosis observed near the plant is part of a regional pattern unrelated to fluoride emissions from the Agrium plant. Conversely, the Board does not believe the regional prevalence of fluorosis alleviates the need to assess the possible contribution of the Agrium facility to dental fluorosis near the plant.

The Board's view is that the causes of fluorosis in neighbouring children and the brittle teeth reported by Ms. Gorgichuk can only be determined by medical practitioners examining their symptoms in light of individual risk factors including exposure to other sources of fluoride. The Board heard that ingestion of fluoride in toothpaste, mouthwash and certain foods was likely responsible for a substantial portion of fluoride exposure in many of the neighbours. Since these

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<sup>u</sup> The weighted average one-hour concentration in the 2003 data is  $3.08 \mu\text{g}/\text{m}^3$ . Thus the expansion would have to increase fluoride emissions by more than four fold to exceed the chronic REL of  $14 \mu\text{g}/\text{m}^3$ .

individual assessments have not been done, the Board does not have the evidence it would need to establish whether or not the Agrium plant has contributed to the dental symptoms of nearby residents.

The Board observes that an expert on behalf of NSCRG diagnosed at least two cases of ‘moderate to severe’ dental fluorosis: one of Ms. Garon’s children and a neighbour of Ms. Brown. The Board is not certain if the assessment of the severity of fluorosis in these cases was based on clinical criteria and a scoring system comparable to that used in the Capital Health oral health survey. The Board notes that in that study, ‘moderate’ fluorosis was defined by clinical symptoms of staining or pitting of the enamel and ‘severe’ fluorosis was defined by staining, pitting and substantial erosion of the enamel. By contrast, ‘mild’ fluorosis was defined by the clinical symptom of opaque ‘parchment white’ areas. If the two cases diagnosed as moderate to severe do entail staining and/or pitting of the enamel, they would be more severe than 95 percent of the fluorosis observed in the regional study and would therefore be a cause for concern.

The Board would recommend that any individual with clinical symptoms of moderate to severe fluorosis be examined by a dentist. If the diagnosis is confirmed, the Board would recommend that an assessment of individual risk factors be undertaken to determine the relative contributions of all potential sources of exposure with a view to curtail manageable exposures. The Board appreciates the CHA’s expression of willingness to assist with this kind of investigation, when it appears to be warranted.

The Board heard that children are most vulnerable to dental fluorosis from birth to eight years of age. The Board therefore believes that any assessment of the risk of environmental exposure should consider cumulative fluoride exposure over this critical developmental period. The Board understands that Agrium’s fluoride emission rates declined in recent years due to improved scrubbing of stack particulate emissions and the substitution of lower-fluoride Kapuskasing phosphate rock, which reduced the fluoride concentration in the phosphogypsum pond water to less than half the level it was four years ago. One implication of this positive development is that ambient concentrations, deposition rates and potential environmental exposures may have been higher in the recent past than they are now. The Board therefore finds that model predictions based on current emission rates do not provide a suitable basis for assessing the cumulative environmental exposure of children currently exhibiting symptoms of fluorosis.

The Board cannot judge the magnitude or potential significance with respect to the risk of dental fluorosis of higher fluoride emissions of the recent past because the dispersion modelling and risk assessment reflecting those conditions were not available to it. The Board believes that any assessment of individual risk factors should take this recent history of higher environmental exposures into account. The Board therefore recommends that Agrium undertake a screening level risk assessment based on historical process stack emission data and its records of the concentration of HF in the gypsum stack pond. The Board recommends that Agrium share the results of this simulation with CHA to facilitate the assessment of individual risk factors for any neighbours diagnosed with moderate to severe fluorosis.

### 5.3 Particulate Matter (PM) and Additional Air Quality and Human Health Issues

#### 5.3.1 Views of Agrium

With respect to specific air contaminants, Agrium stated that measured particulates including total suspended particulates (TSP) and fine particulates (PM<sub>10</sub> and PM<sub>2.5</sub>) in the vicinity of its plant were within Alberta and Canada Wide Standards. Agrium suggested that best available evidence demonstrated that the dust emissions from the stack extension would be minimal, even without the mitigation measures proposed by Agrium. It indicated that particulate matter emissions were estimated from USEPA construction and vehicle activity factors assuming dry weather and no dust control mitigation. It noted that actual moisture content of the phosphogypsum, mitigation measures and the implementation of rim-ditching methods for stack construction would reduce dust relative to the assumptions used in its evaluations. It said that the incremental impact of the proposed project on particulate concentrations would be small (i.e. 0.5 µg/m<sup>3</sup> increment in TSP) and that predicted off-site TSP, PM<sub>10</sub> and PM<sub>2.5</sub> levels would be less than applicable air quality criteria.

#### 5.3.2 Views of the Interveners

##### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG noted that no or very little data was provided to characterize phosphate rock supplies, emission releases and particulate emissions compositions. The NSCRG noted that although fluoride can be emitted in many forms (e.g. particulates, gases and aerosols), Agrium only measured the hydrogen fluoride (HF). It observed that Agrium did not account for silicon tetrafluoride.

The NSCRG said that although the CALPUFF dispersion model used by Agrium was an excellent tool, the model had limitations in predicting air quality close (within five miles) to emission sources. It stated that while the modelling was inaccurate, it nonetheless predicted parameters exceeding guideline values. NSCRG said that there was no real testing to verify the ultimate predictions, even though the plant had been operating for 35 years.

The NSCRG stated that Agrium did not assess potential issues related to metals content of air emissions. It noted that these substances are enriched in the fine particulate fraction and include carcinogens, kidney toxins, nervous system toxins, respiratory system toxins and bone toxins. Metals were not assessed, nor were the combined effects of exposures to these metals or metal complexes. Similarly the NSCRG said that the cumulative impact of the extension, including emissions from the existing plant and other industry in the area, was not analyzed. The assessment omitted Agrium's and the adjacent industries' release of total carcinogens into the air, water and soil including contributions of particulate matter precursors such as SO<sub>2</sub> (Sulphur Dioxide), NH<sub>3</sub> (Ammonia), NO<sub>x</sub> (Oxides of Nitrogen), Polycyclic Aromatic Hydrocarbons (PAH) and Volatile Organic Compounds (VOC). It said Agrium's assessment omitted their own

and adjacent industries' contribution to nervous system, bone, cardiovascular system, endocrine system and immune system toxins.

### **Sturgeon County Residents (SCR)**

The SCR believed that industrial development must be done responsibly, employing the precautionary principle to never risk the health of the people in the area. The SCR viewed application of the precautionary principle as due diligence, requiring the independent site-specific environmental monitoring and health assessments of area residents and animals. It noted significant industrial development in the Fort Saskatchewan area and plans to further encourage such growth. Consequently, the SCR viewed cumulative effects and total exposure of animals and humans to industrial contaminants as priority concerns.

The SCR expressed fear for the health of families, pets and livestock because of unaddressed concerns regarding the safety of homegrown area food and forage. The SCR reported seeing dust blowing off the phosphogypsum stack during high winds and witnessing off-site deposition of this material in the area. The SCR said their exposure to emissions from Agrium has resulted in general poor health for many community members with symptoms such as headaches, fatigue, nausea, stiffness and respiratory problems. The SCR reported that several individuals suffer more adverse health effects that included dental fluorosis, sinus problems, chronic leg pains, weepy eyes, and migraine headaches.

The SCR indicated that the mental and emotional stresses from the lengthy uncertainties and struggles with the issues related to expansion in the Industrial Heartland, including Agrium's operations, have adversely affected work, family and interpersonal relationships.

The SCR stated that local health issues had been reported to many government bodies (e.g. CHA, Alberta Environment, County Council) as well as local industries, but repeated requests for a health assessment of residents had not been accepted. The SCR said it was informed that an epidemiological study was not possible for such a small group. The SCR indicated a 2001 health study was completed in the Fort Saskatchewan area by members of the Fort Air Partnership. The SCR said that participants in this study, however, were not allowed to view their personal results.

The SCR stated odours from Agrium were frequently encountered and disruptive. It said odours caused variable effects including tightness in the chest and nausea. The SCR noted that although a Heartland Odour Protocol had been initiated in 2002, response times were slow and the capability of the attending fireman to deal with the issues meaningfully was poor.

### **Alberta Justice representing Alberta Environment and Alberta Health and Wellness (Alberta)**

Alberta noted that there were no *AAAQG* for  $PM_{10}$  and  $PM_{2.5}$  particulate fractions. However, it stated that the Canadian Council of Ministers of the Environment (CCME) Canada Wide Standards process agreed to an ambient guideline level for  $PM_{2.5}$  of  $30 \mu\text{g}/\text{m}^3$  by 2010, based on the highest 98<sup>th</sup> percentile, 24-hour average over three consecutive years of monitored data. It noted that the Canada Wide Standard for  $PM_{2.5}$  had been adopted by Alberta.

Alberta stated that Agrium's modelling and assessments of TSP and PM had been conducted using acceptable methodology and viewed the conclusions as reasonable. Given the monitoring completed for existing conditions and the small amounts of predicted incremental offsite concentrations of TSP, PM<sub>10</sub> and PM<sub>2.5</sub>, Alberta Environment agreed with Agrium's conclusions.

It noted that Alberta Environment may include conditions in any *EPEA* approval that may be issued for the project requiring Agrium to control dusting levels to the lowest practicable level through the use of appropriate control technologies. Alberta said that Alberta Environment may also include conditions requiring Agrium to enhance ambient air monitoring for TSP, PM<sub>10</sub> and/or PM<sub>2.5</sub> in the vicinity of the plant in collaboration with the Fort Air Partnership or on its own.

Alberta noted that from 1998 through 2003, Alberta Environment had received 15 odour complaints related to the Agrium Redwater facility (exclusive of any that might have been received through the Heartland Odour Protocol). It said that Alberta Environment did not anticipate any additional odours due to the proposed phosphogypsum stack extension; however, Alberta Environment might include conditions in any *EPEA* approval issued for the project requiring Agrium to continue to participate in the Heartland Odour Protocol.

Alberta stated the health risk assessment for particulate matter, although it employed conservative assumptions, did not show any unacceptable health risks for any of the off-site receptors modelled. Alberta stated the conclusions regarding the health risk assessment on particulate matter were reasonable.

Alberta indicated results of the "Community Exposure and Health Effects Assessment Program", conducted in the Fort Saskatchewan region by Alberta Health and Wellness (AH&W) and other regional stakeholders was released in June 2003. AH&W said this study provided an understanding of the current health status and environmental profile of residents living in and near Fort Saskatchewan. AH&W noted that, according to the study, ambient concentrations of contaminants were well below guidelines and no evidence of significantly elevated personal exposure to airborne contaminants existed. AH&W also indicated there was no evidence of significantly higher morbidity for asthma, bronchitis or chronic obstructive pulmonary disease in the area.



## 6.0 WATER

### 6.1 Groundwater

#### 6.1.1 Views of Agrium

Agrium defined the geologic and hydrogeologic setting, both locally beneath the area of the proposed extension, and on a regional basis. It showed that the surficial geologic materials beneath the proposed extension consist of sand units overlying a unit of silt and clay. The silt and clay unit in turn overlies a unit of clay-till, which lies directly on bedrock. In the extension area the surficial deposits range from about four to 10 metres in thickness.

Agrium reported the bedrock consisted primarily of shale and sandstone of the Belly River Formation. Drilling data to depths as great as 37 m showed that as many as four sandstone units, ranging from one to 10 metres thick, and separated by shale units of similar thickness exist beneath the extension. The uppermost sandstone unit forms the bedrock surface over a large part of the proposed extension area, but is eroded in the eastern part of the extension area. Agrium also provided evidence that the sandstone unit is eroded to the west of the extension and should not extend more than 4000 ft in that direction.

Agrium presented regional geologic and hydrogeologic information by means of a cross-section extending from the northwest of the extension to the southeast. It stated that the cross-section showed that, whereas the surficial deposits beneath the proposed extension are very thin, the east side of the North Saskatchewan River is dominated by a thick layer (50 m) of surficial deposits, including sand and gravel of the pre-glacial Empress Formation, lying within a pre-glacial channel known as the Beverly Channel. Agrium indicated that the thalweg, or centre, of the channel is located about 4.5 km from the bank of the North Saskatchewan River.

Agrium's evidence also indicated, that whereas the North Saskatchewan River is deeply incised and extends into the Empress Formation, the formation does not extend westward beyond the North Saskatchewan River and is not present beneath the area of the proposed extension.

Agrium interpreted the regional groundwater flow to be toward the North Saskatchewan River from the southeast and the northwest. It stated that beneath the extension area the surficial deposits are very thin and the bedrock surface is greatly elevated compared with the east side of the River. Its interpretation was that the easiest path for groundwater flow beneath the extension area is along the top of the bedrock surface and toward the North Saskatchewan River.

Based on a map of water table contours, Agrium reported that in general groundwater flow is from the northeast toward the North Saskatchewan River. In the area west of the facility groundwater flow is to the south, but with a minor easterly component. North of the facility and in the area of the proposed extension, Agrium interpreted the flow to be essentially to the east. In its main hydrogeological assessment Agrium stated that the groundwater originating from the northwest appears to flow around the existing gypsum stack and that some minor influence from the gypsum stack is occurring near its northwest corner and along the north and west boundaries.

Agrium presented averages of field determinations for hydraulic conductivity of the various geologic materials present beneath the extension area and estimated average linear groundwater velocities of 0.38 m/yr in sand, 0.13 m/yr in clay, and 0.09 m/yr in clay till.

Agrium testified that it had defined the baseline groundwater conditions for the extension area from water level and hydrochemical data collected from five nests of four monitoring wells each that were installed in and adjacent to the extension area in 1992, at depths ranging from four to 37 metres. Water levels were reported to have been stable with a slight decreasing trend since 1998. The decrease was reported to be more accentuated in shallow wells. Agrium also noted that there are steep vertical hydraulic gradients between shallow and deep wells and interpreted this to indicate low hydraulic conductivity in the bedrock.

Agrium reported that groundwater quality varies greatly both with depth and spatially and that no clear water quality patterns could be established. It believed that the complexity of groundwater chemistry relates to complex groundwater flow patterns beneath the extension. Groundwater is typically of the sodium-bicarbonate type and average total dissolved solids over the period of monitoring ranged from 468 to 3,287 mg/L and average pH ranged from 7.6 to 9.0. In data provided in Agrium's hydrogeological assessment, however, average reported laboratory pH ranged from 7.6 to 12.05. Sulphate concentrations ranged from 10.1 to 472 mg/L.

Agrium pointed out that in two wells, located northeast of the proposed gypsum stack area, much higher average concentrations of sulphate of 670 and 1,870 mg/L were recorded. Agrium believed that these higher values still represented background conditions for three reasons:

- the wells were the farthest of all monitoring wells away from the existing gypsum stack,
- groundwater at that location appeared to be derived from a bedrock high located about two miles to the west, and
- concentrations of sulphate in wells much closer to the existing gypsum stack were much lower.

Agrium responded to questioning by the Board if it would be possible to determine the source of the high sulphate concentrations in two monitoring wells located about 0.75 miles northeast of the existing gypsum stack. Agrium agreed that it may be possible to determine the source isotopically.

Based on chemical analyses for the two shallowest wells at all five monitoring sites, Agrium proposed that baseline conditions for potential indicator parameters should be as follows: pH 7.0 to 9.5, electrical conductivity of 0.65 to 1.75 mS/cm, sulphate of 20 to 1100 mg/L, fluoride of <0.1 to 2.7 mg/L, nitrate nitrogen of <0.1 to 10 mg/L, ammonia nitrogen of <0.5 to 10 mg/L, and orthophosphate of <0.1 to 2 mg/L.

Agrium stated that, of 522 sulphate concentration analyses for a number of water wells near the facility, about 90 percent had sulphate concentrations of less than the Canadian Drinking Water Guideline of 500 mg/L. Ninety three percent had less than 800 mg/L and seven percent had concentrations between 800 and 2500 mg/L. Agrium stated that these data indicated that water



from the two monitoring wells located northeast of the proposed gypsum stack with sulphate concentrations of 670 and 1870 mg/L fall within regional background groundwater quality.

Agrium also indicated that 99 percent of fluoride concentrations in nearby water wells were less than two mg/L and 88 percent had less than the Canadian drinking water guideline of 1.5 mg/L. Four analyses showed fluoride concentrations greater than two mg/L and the maximum reported concentration was five mg/L.

Also with respect to fluoride, Agrium presented data from 40 analyses of water from 30 wells located in 22 sections on the east side of the North Saskatchewan River and east of the Agrium facility. Agrium indicated that most of the analyses had fluoride concentrations of less than two mg/L, two had concentrations greater than 0.6 but less than 1.5 mg/L, and two had concentrations greater than 1.5 but less than two mg/L.

Agrium concluded that there are only four wells on the west side of the North Saskatchewan River that are located downgradient of the proposed phosphogypsum stack extension area. Two of these wells were shown to be located between the east side of the proposed gypsum stack and the North Saskatchewan River and Agrium indicated they have the potential to be affected.

On the basis of probable groundwater flow directions derived from Agrium's analyses of the water table contours, Agrium determined that a third well, less than 0.25 miles northeast of the proposed gypsum stack and a fourth well, located about 0.75 miles northeast do not have the potential to be affected. Agrium indicated that the first three wells are located on Agrium property and will be decommissioned; the fourth well is on private land and will remain in place.

In response to questioning by Alberta, Agrium indicated that the fourth resident's well was being monitored twice per year and that it would continue to be monitored as part of the groundwater monitoring program for the proposed gypsum stack.

Agrium indicated that the process water which carries gypsum to the existing stacks is characterized by low pH (<2) and high sulphate (7,000 to 10,000 mg/L), fluoride (9,000 to 10,000 mg/L) and phosphate (4,000 to 6,000 mg/L) concentrations. In addition, ammonia nitrogen may be present in concentrations up to 1,000 mg/L. It reported that the potential impacts from the operation to groundwater would be associated with seepage from the stacks that could cause elevated water levels and changes in groundwater quality around the perimeter of the stack.

Agrium reported that the existing gypsum stack was constructed on natural terrain consisting of a surficial layer of clay interspersed with sand layers and lenses, underlain by clay till and bedrock. It indicated that the hydraulic conductivity of the clay and clay till is low ( $9 \times 10^{-12}$  to  $4 \times 10^{-6}$  m/s) and that the low permeability limits the amount of seepage from the stack.

Agrium reported that nests of monitoring wells installed immediately adjacent to the gypsum stack indicated that an upward vertical hydraulic gradient exists, but the gradients are generally low. It reported upward gradients ranging from 0.018 to 0.221 m/m at nests of monitors located west and east of the gypsum stack. Agrium also reported that high piezometric levels occurred

beneath the northeast corner of the gypsum stack and that these were substantially controlled by a series of 116 dewatering wells in that area.

To further control high groundwater levels, Agrium indicated that it had installed dewatering and groundwater interceptor systems around virtually the entire gypsum stack. Agrium reported that the interceptor systems have been effective in lowering the water levels around the perimeter of the phosphogypsum stack, but the northern part of the west interceptor has had less than acceptable performance and that improvement in that area is needed. Agrium reported that a total of 219,000 m<sup>3</sup> of groundwater was recovered from the system in 2001.

Agrium stated that the principle contaminants in groundwater near the perimeter of the existing gypsum stack are sulphate, ammonia, fluoride and phosphate. It indicated, however, that ammonia, fluoride and phosphate are readily adsorbed by soil and do not travel far from the gypsum stack, leaving sulphate as the only indicator parameter to allow assessment of gypsum stack impacts on groundwater. Agrium also indicated that the soils in the area have a very high buffering capacity and the low pH of water moving from the gypsum stack quickly rises to background levels.

Agrium presented a map that showed contours of sulphate concentrations of 4000 and 2000 mg/L near the stack derived from monitoring data collected in 2001. Agrium reported that the sulphate impacts that have been observed are restricted to the shallow subsurface between three to seven metres deep and that limited or no impacts were found in groundwater at depths of seven to 12 metres or greater. Agrium indicated that the sulphate impacts on the west side of the gypsum stack appear to be limited to the east side of Highway 643. It reported that, north of the gypsum stack, impacts appear to be limited to the areas south of Township Road 564. Agrium indicated that there have been impacts to the east of the gypsum stack and these have been addressed by a series of dewatering wells. Agrium said that elevated sulphate concentrations south of the phosphogypsum stack are partially associated with seepage from the cooling pond, but could also be affected by the phosphate fertilizer plant and its associated sulphuric acid unit. Agrium stated that it installed a south interceptor system in 2001 to control seepage in that area.

Agrium indicated that it will incorporate new engineering measures in the proposed gypsum stack extension to prevent impacts on the soil and groundwater. It reported these to be:

- a bentonite slurry wall along the north border of the existing gypsum stack to prevent groundwater from the existing gypsum stack from moving north and beneath the proposed extension. The slurry wall will extend through the surficial deposits (clay and clay till), any near-surface sandstone units that may be present, and into the underlying shale. Agrium indicated that the slurry wall would extend the entire length of the existing gypsum stack and the extension. It proposed the slurry wall will have an approximately 15-metre southward extension at its western end to overlap with the existing groundwater interceptor at that location. At the east end, the slurry wall is to extend east to beyond the east side of the proposed extension and an additional wall will extend southeast adjacent to the northeast edge of the existing gypsum stack. Agrium indicated that a new interceptor leg will be installed at the east end of the area between the two slurry walls. It stated that the new interceptor leg would be tied into the existing east interceptor system.

Agrium said the interceptor system to the north of the existing phosphogypsum stack will be removed after the slurry wall is installed. Agrium indicated that it did not anticipate any problems with advancing the slurry wall through five metres or more of sandstone to tie into the underlying shale.

- Agrium stated that the area of the proposed extension north of the slurry wall is underlain by a natural clay liner consisting of clay till. It indicated that in addition to the natural clay liner, it will place a 60-mil high density polyethylene synthetic liner beneath the entire proposed extension area. The area between the existing natural clay liner and the synthetic liner will be prepared with soil or sand, and/or gypsum. Agrium indicated that the synthetic liner will be keyed into the slurry walls along the south end of the extension.

Agrium explained that it had conducted computer modelling on the effects of the slurry wall on groundwater flow. It indicated that the slurry wall would be effective in preventing flow to the north and that no changes in groundwater flow are expected in that area. It also indicated that groundwater levels are expected to rise south of the slurry wall and then flow in an easterly direction. Agrium explained that the groundwater that could potentially flow west along the slurry wall will be contained by the south extension of the slurry wall at its west end, and it does not expect changes to the groundwater flow directions in that area.

Agrium stated it expects no changes to the groundwater flow direction beneath the extension. It indicated, whereas there will be some consolidation of the clay till beneath the proposed extension, and it expects this to cause a decrease in the hydraulic conductivity of the clay till, the decrease will not be great enough to cause deflection in groundwater flow. Agrium stated it expects the groundwater levels below the proposed extension to be lower than historical levels because there will be no infiltration of precipitation in that area.

Agrium explained that it had considered that minimal leakage could occur through isolated pinholes in the synthetic liner beneath the proposed extension. It estimated that as much as 5,140 L/year could flow through a 2 mm pinhole. It further indicated that the industry standard expected number of pinholes is one per 0.40 ha of synthetic liner and that this would translate to an equivalent of 1.27 mm/year of groundwater recharge. Agrium indicated that after 25 years (the expected life of the proposed gypsum stack) the leakage would amount to about 32 mm, which would cause an increase in groundwater levels beneath the gypsum stack of about 160 mm to 320 mm if the soil porosity were 0.1 to 0.2. Agrium observed that this amount of increase is less than natural fluctuations that have been measured in the past.

Agrium indicated that the area that lies south of the proposed slurry wall, which will be covered with the gypsum stack, is expected to be impacted by seepage from the extension. It predicted, however, that this impact should only extend to seven to nine metres below ground level and that shale layers at depth would prevent deeper contamination.

Agrium indicated that north of the proposed slurry wall the impacts of leakage on groundwater quality are expected to be minor and that the resulting sulphate concentrations would be similar to those observed in seven percent of water wells in the area and in monitoring wells located about 0.25 miles northeast of the proposed stack area.

Agrium indicated that any cumulative effects of potential impacts on groundwater will be negligible because the proposed liner system for the expansion will be effective and because seepage from the existing stack has been contained by interceptor systems.

Finally, Agrium proposed a groundwater monitoring system for the extension. It proposed to install eight nests of two monitoring wells each, two located on the east, three along the north, and three along west sides of the stack. The two wells in each nest would include a shallow well to about six metres and a deeper well to about 10 metres. Agrium proposed to sample the monitoring wells for two years and perform extensive chemical analyses to determine baseline conditions for each monitoring site, after which the analyses would only be performed for indicator parameters.

Agrium acknowledged that there have been exceedances of both nitrates and sulphates in various areas of the existing facility and that high nitrate and ammonia concentrations have been found near the ammonia plant and an associated old nitrate landfill. It stressed, however, that the ammonia side of its operations is completely separate from the phosphate side and is not related to the proposed extension of the gypsum stack. Agrium also stated that it had budgeted \$150,000 for 2004 to address and remediate the problems identified in Alberta Environment's letter.

Agrium explained that the past impacts that have occurred near the ammonia plant do not all indicate recent releases. It indicated that it has removed the sources of nitrate and ammonia contamination in the areas where impacts have occurred. It explained that ammonia binds to the soil and does not move very far in the subsurface. Agrium indicated that high nitrate concentrations identified by Alberta Environment in a number of monitoring wells are actually showing decreases in nitrate concentration since the monitors were initially installed. It explained that some recent increases in shallow monitors are actually fluctuations caused by differences in precipitation from year to year; in times of high precipitation the nitrate concentrations are diluted with fresh precipitation water whereas in dry years they are not. Agrium stressed that it is therefore natural to expect fluctuations, but that groundwater in the area moves very slowly and the nitrates are essentially staying in place.

Agrium explained that high concentrations of nitrates in deeper monitoring wells (12 m) were not representative of actual conditions at that depth. It stated that there were problems with those wells in that the bentonite seals were not properly installed. Agrium indicated that the two 12-metre wells have since been decommissioned and new wells were installed. It stated that analyses of both soil and water from the new wells show no contamination at that depth.

Agrium said there were two possible sources of high sulphate and arsenic concentrations found in a monitoring well in the northern part of the fertilizer production area. Agrium noted that since the monitoring well was located south of the cooling pond, it was possible the cooling pond was the source of these elevated parameters. It explained, however, that the south intercept system was installed in 2001 to intercept seepage coming from that source. Agrium indicated that this would remedy the problem if the cooling pond was the source. Agrium also believed it was also that a tank farm located near the monitoring well may be the source of the elevated sulphate and arsenic concentration. It explained that there have been secondary upgrades in the tank farm area and these would have resolved the issue if that were the source.

Lastly, with respect to the arsenic issue, Agrium stated that typical Canadian soils contain 7.2 parts per million arsenic and that levels measured in the groundwater were in the range of 0.12 to 0.14 ppm.

Agrium explained that the nitrate fines landfill was capped in 1995 and an interceptor system was installed west of the landfill in 1996 to lower the water table. It expected that these measures have sufficiently isolated the landfill from the groundwater system. Agrium further explained that groundwater moves very slowly in this area, and that the current effects showing up in monitors represent residual contamination from a time before the above remedial measures were implemented.

Agrium confirmed that nitrate concentrations had indeed increased from 200 mg/L in 1996 to 600mg/L in 2002 in a monitoring well completed in bedrock and located about 100 metres south of the southeast corner of the landfill. To confirm if contamination was or was not present in the bedrock, Agrium stated it had drilled a nest of three monitoring wells north and east of the existing bedrock. Two of the wells extended into bedrock and Agrium observed that the nitrate contamination was limited to soil above the bedrock only.

Agrium disagreed with the view expressed in Alberta Environment's letter that rapid vertical contamination had occurred to a depth of 17 metres as indicated in a monitoring well located at the northwest corner of the landfill. It explained that the well was not 17 metres, but only 6.1 metres deep. It also explained that the well was located east of an interceptor and has been essentially dry since the interceptor was installed.

Agrium agreed that concentrations of nitrates down gradient from the landfill have increased significantly since 1994 (from 389 to as much as 1540 mg/L). It indicated however that the increase was not recent, and concentrations have ranged from 2500 to 3200 mg/L since 1996. Agrium contended that this represented a fairly stable situation. In response to a statement in Alberta Environment's letter that nitrate concentrations have increased steadily to as much as 880 mg/L in a monitoring well located about 150 metres north of the landfill and adjacent to the gypsum stack, Agrium replied that the source of the nitrates was not known.

Agrium responded to questions about continued high sulphate concentrations in the area located between the northeast part of the gypsum stack and the North Saskatchewan River. It acknowledged that the area had been impacted by seepage from the gypsum stack in the past and pointed out the two dewatering systems were installed to lower water levels and control seepage from that part of the gypsum stack. It explained that the dewatering systems were effective because they have reduced water levels in the area, and decreased sulphate concentrations are also apparent in some monitoring wells.

Agrium explained that groundwater moves very slowly, and it would take time from the residual sulphate concentrations to dissipate. It pointed out that because water levels near the gypsum stack have been lowered by the groundwater interceptor systems, the hydraulic gradient toward the North Saskatchewan River had also decreased, and this had resulted in a further decrease in groundwater velocity toward the river.

Agrium explained that as part of the preparation for the proposed gypsum stack extension, the existing northeast interceptor system will be replaced by a slurry wall and a new interceptor system to contain any contamination that had occurred in the past.

Agrium agreed that sulphate concentrations have been rising at the northwest corner of the gypsum stack. Agrium indicated there were two problems in that area. One was that the north interceptor system could not be fully extended to the west because of number of utilities located in that area. It reported the second problem to be poor performance of the west interceptor system. Agrium explained the problems would be resolved by the configuration of the proposed slurry wall in that area and by replacement of the northern part of the west interceptor.

In response to questioning by the Board about Mr. Smulski's assertion that discontinuities in deep sandstone units may indicate the existence of a deep seated shear zone through the clay shale where the sandstone is discontinuous, Agrium replied that this was not the case. It explained that the Belly River Formation was a non-marine formation, that the sandstones were deposited in river-like situations, and it would expect them to be discontinuous. It did not believe the discontinuities in the sandstone to be the result of a geological fault.

Responding to questions by the Board, Agrium clarified that ammonia is strongly adsorbed by clay by a cation exchange process and that fluoride interchanges with aluminium and is retained in the mineral structure. Agrium was unsure of the retention method for phosphate but it has observed that phosphate, like fluoride and ammonia, does not move with the groundwater.

After Board questioning about the fate of 0.625 mg/L arsenic and 4.12 mg/L uranium that were measured in gypsum stack water, Agrium responded by stating that neither ion could travel far in the groundwater. Agrium clarified that uranium is either adsorbed by the soil, or precipitates out of solution. Arsenic was also expected to precipitate as the pH rises with water moving through the soil. Agrium stated it had both field data and results from laboratory simulations to confirm those observations.

In response to questioning by the Board, Agrium indicated that the existing sets of monitoring wells located north of the existing gypsum stack will remain in place and become part of the monitoring system for the proposed gypsum stack extension. It clarified the monitoring system would consist of eight new piezometer nests in addition to the five existing nests.

Agrium clarified that two existing nests of monitoring wells located west of the proposed gypsum stack would remain in place and would be monitored both for elevation of water levels and for water quality. It stated that monitoring of the water table would allow them to determine if mounding were taking place before it became a matter of concern. Agrium indicated that it would be able to determine if mounding were occurring by comparing the water levels in the two western nests to those in more distant nests, which should show baseline conditions.

Agrium stated there were two issues with respect to the maintenance of the interceptor system. The first was a construction issue that affected the west interceptor and did not allow water to be collected and transmitted efficiently. The second issue involved precipitation of gypsum in

collector ditches if the seepage was exposed to air. It explained that the precipitation blocks the pipes and prevents seepage from entering. Agrium indicated that it planned to increase the frequency of monitoring water levels in manholes of the interceptor systems so that appropriate maintenance or cleaning of pipes could be achieved. It also indicated that new interceptor systems were designed so that the drainage pipes remain flooded to avoid exposure to air and precipitation of gypsum.

### 6.1.2 Views of the Interveners

#### Sturgeon County Residents (SCR)

The Sturgeon County Residents raised concerns about maintaining the quality of water from the well of one of its members whose residence is located about two miles from the north end of Agrium's gypsum stack. The SCR stated that the well water was tested in 1995 and showed fluoride to be somewhat higher than normal levels. It raised a further concern that the location of the residence is not shown on Agrium's map of locations of neighbors.

#### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG expressed concern about Agrium's groundwater analyses. It noted consistent elevated levels of iron, manganese, aluminum and barium and occasional exceedances of arsenic, lead, chromium and fluoride. It also pointed out some consistent increases above background of lithium, strontium and silicon. It indicated that aluminum and manganese concentration exceeded the Canadian Drinking Water Guidelines in all samples tested. The NSCRG further noted that strontium and lithium concentrations exceeded background levels in virtually all samples.

Referring to Agrium groundwater monitoring data, the NSCRG pointed out that some wells beneath the plant site had nitrate concentrations of several thousand mg/L while others near the periphery of the gypsum stack had concentrations in the hundreds and up to 1000 mg/L. It reported that phosphate concentrations were as high as 10,000 mg/L and some had pH values between 1.5 and 3. The NSCRG indicated that under such conditions of low pH the mobilization of trace metals would be extreme.

The NSCRG stated that there were significant nitrate and ammonium concentrations in water from wells around the existing gypsum stack. It indicated this could be because groundwater was carrying these parameters farther than anticipated because permeability had been underestimated, or the process water used to carry phosphogypsum slurry to the stack was high in ammonium and nitrate. The NSCRG explained that the nitrification of ammonium to nitrate yields hydrogen ions and causes a lowering of pH. It believed this could be part of the groundwater acidification problem.

The NSCRG stated that the range of groundwater velocities in the vicinity of the gypsum stack that was presented by Agrium may have been significantly underestimated. It indicated that

groundwater commonly moves through macropores such as tree-root holes, rodent burrows, soil cracks or fractures in the bedrock. The NSCRG stated that groundwater movement through macropores could have resulted in the high nitrate and ammonium found in groundwater wells around the gypsum stack.

The NSCRG expressed concern about the life of the synthetic liner Agrium was proposing to use beneath the gypsum stack extension, stating that they do have a finite lifetime. It pointed to potential problems such as rodent penetration or ground shifts that would eventually cause the liner to degrade.

#### **Mr. Smulski**

Mr. Smulski expressed two fundamental concerns related to the existing and proposed phosphogypsum stacks. His first concern was that the existing and proposed stacks would change the nature of the groundwater flow across Mr. Smulski's land which is located immediately west of the stacks. He explained that the tremendous weight of the gypsum stacks will compress the soil beneath the stacks and the compressed soil will redirect groundwater flow. He called this a damming effect.

Their second concern was that over time, as the phosphogypsum stacks compress by their own weight, the 15 to 20 percent water contained within the stacks would add to seepage coming out of the stacks. Mr. Smulski stated this seepage would merge with and add to the groundwater flow passing through the Smulski lands. Mr. Smulski said that in addition to changing the nature of the groundwater flow, it would also affect the quality of the groundwater and soil on the Smulski lands.

Mr. Smulski presented Agrium's computer simulation of the water table in the area and explained that this showed the directions of groundwater flow as it would be if the existing phosphogypsum stack had never been built. He stated that the direction of flow would have been from the northwest to the southeast, toward the North Saskatchewan River.

Mr. Smulski showed results of a hydrogeological study performed on his land in 1992. He explained that the data showed that the groundwater flowed from the northwest to the southeast until it reached the phosphogypsum stack, and then deflected to the south. He explained that the deflection was consistent with groundwater flow that has impinged onto compressed ground.

Mr. Smulski stated his groundwater study was performed in late summer of 1992 and that in the fall of 1992 the west groundwater interceptor ditch was installed. He explained that subsequent water level monitoring from 1992 to 1996 indicated no change in the groundwater flow directions from those observed in 1992 prior to the construction of west interceptor ditch.

Mr. Smulski also presented an Agrium map of their interpreted water table contours for May of 1992. He contended that the groundwater flow directions derived from the contours showed that the regional flow was again from the northwest to the southeast and turned southward adjacent to the phosphogypsum stack. He further stated that the contours indicated flow coming out from the phosphogypsum stack along its entire western side.



Mr. Smulski showed results of a computer simulation of the groundwater flow distribution after the installation of the proposed slurry wall north of the present phosphogypsum stack, contending that construction of the slurry wall would make things worse for him. He said that groundwater flow along the slurry wall was shown to be split near the mid-point of the wall and about half would be directed to the east and half to the west. He stated the west-directed flow would be directed onto Mr. Smulski's property.

Mr. Smulski referred to statements by Agrium that the impact of the existing phosphogypsum stack on groundwater quality was limited to the shallow groundwater three to seven metres deep and that impacts from the proposed extension would be to a similar depth south of the proposed slurry wall. Mr. Smulski stated that the thickness of the surficial deposits on his land ranges from about five metres at the north end of the existing phosphogypsum stack to greater than 10 metres at the south end. He stated that the predicted shallow groundwater quality impacts would hurt the Smulski farming operation because they would affect the soil that is used for farming.

Mr. Smulski contended that if the proposed extension of the phosphogypsum stack were allowed, the ground would become compressed, there would be more damming of the groundwater flow, and more groundwater flow would be directed south across Smulski's property.

#### **Alberta Justice representing Alberta Environment and Alberta Health and Wellness (Alberta)**

Alberta indicated that phosphogypsum stacks in general can affect groundwater levels, quality, and the groundwater flow regime. It stated that seepage of process water through the phosphogypsum stack could raise groundwater levels beneath and adjacent to the stack, resulting in groundwater mounding and possible deflection of natural groundwater flow. Alberta indicated that the weight of the phosphogypsum stack could also contribute to groundwater mounding through consolidation of underlying strata.

Alberta stated that seepage water from phosphogypsum stacks was characterized by low pH and high sulphate, fluoride and phosphate concentrations, but that processes such as dilution and diffusion improved the seepage water quality over time.

Alberta said construction of the existing phosphogypsum stack began in 1968, that it was built on natural surficial materials, and that no special engineering measures to minimize impacts on groundwater were incorporated. It indicated that a groundwater interceptor system was installed around the stack in 1989 and 2001.

Alberta stated that Agrium's *EPEA* approval includes requirements to monitor groundwater levels and quality and that such data have been collected since 1986. It said that recent monitoring results indicated that the groundwater interceptor system along the western edge of the phosphogypsum stack may not be fully functioning as designed.

Alberta reiterated that the proposed phosphogypsum stack extension design included several engineering measures to minimize effects on groundwater. It stated these methods included a

synthetic liner, a border dyke, underdrains on the liner, and a slurry wall along the north side of the existing phosphogypsum stack.

Alberta expressed the view that potential groundwater effects were inherently minimized by the natural groundwater flow to the North Saskatchewan River. It believed that the proposed stack extension would not significantly contribute to groundwater mounding because of consolidation of underlying strata. It stated the underlying material consisted of glacial till and bedrock which was already consolidated, and it did not expect the added weight of the proposed phosphogypsum stack to cause significant further consolidation. Alberta indicated that any consolidation that may occur would accrue slowly over time, allowing increased pore pressure to dissipate without causing significant changes to the water table.

Alberta indicated that it considered the engineering measures and groundwater monitoring proposed by Agrium to be reasonable and proper means of managing the potential impact on groundwater resources. It viewed Agrium's predictions in the EIA as reasonable but stated that groundwater monitoring would be essential to verify those predictions and Alberta's view that the proposed extension would not cause significant groundwater mounding.

Alberta said it may include a condition in an *EPEA* approval requiring Agrium to submit a detailed groundwater monitoring plan. The plan would include triggers for water level measurements and groundwater quality concentrations that would prompt the implementation of contingency plans to control groundwater impacts.

Alberta stated that it viewed the groundwater interceptor system installed around the existing phosphogypsum stack to be an appropriate system for seepage control. It believed, however that the system would be more effective if it were better maintained. Alberta said it may require Agrium to implement better maintenance procedures for the interceptor system as part of an *EPEA* approval.

Alberta acknowledged that there have been past situations where contaminants have entered the groundwater beneath the existing operations. In response to questioning by the NSCRG, it indicated that several occurrences of groundwater contamination were apparent in the 2002 monitoring report submitted to Alberta Environment.

Alberta indicated that one case of apparent contamination at the plant site was traced to improperly functioning bentonite seals and the problem was remedied by constructing new monitoring wells. A second was traced to improper handling of fertilizer and had also since been rectified.

Alberta also acknowledged that contaminant problems have been noted at the northeast corner of the existing phosphogypsum stack. It stated that these related to residual contamination which occurred before an interceptor system was installed.

Alberta agreed that monitoring had shown that the northern part of the west interceptor system was not working properly. It indicated that Agrium would address the problem by installing a

new interceptor and by conducting better maintenance along the compromised portion of the west interceptor.

Alberta also acknowledged that nitrate contamination had been found in the past between Agrium's nitrate landfill area and the North Saskatchewan River. It stated that monitoring wells were installed and the horizontal and vertical extent of the contamination was assessed. Alberta stated the nitrate landfill problem was addressed by installing a cover over the landfill and by purging water from wells installed in the landfill.

Alberta agreed with Agrium's interpretation that high sulphate concentrations found in monitoring wells located in the northeast part of the proposed extension represented background concentrations for that area. It stated that the new proposed monitoring wells for that area would help to confirm that interpretation.

Regarding the desirability of leaving the north interceptor in place until the performance of the proposed slurry wall could be monitored, Alberta said it had checked with its counterpart in Florida and was assured that slurry walls perform well in Florida. Accordingly, Alberta expressed confidence that the proposed slurry wall would work well in this situation, especially since it would be constructed in conjunction with numerous monitoring wells around the proposed phosphogypsum stack extension.

Regarding a question by Mr. Smulski about the desirability to leave a 500-foot setback along the west boundary of the proposed phosphogypsum stack extension to facilitate the installation of an interceptor system there if it were ever needed, Alberta responded that the current proposed setback should be enough.

Alberta replied to Mr. Smulski that it believed soil consolidation beneath the proposed extension and subsequent groundwater flow distortion would not be a problem. It explained that the hydraulic conductivity of the glacial till beneath the extension was already very low and the till had already been consolidated by as much as 1600 metres of ice during the last glaciation. Alberta stated that the 50 metres of gypsum should not have significant influence on further consolidating the soil.

Alberta stated that Agrium would be required to increase the frequency of acidification of the interceptor system to enhance its efficiency, and reconfirmed that the northern part of the west interceptor system would be reconstructed. It also expressed satisfaction with the south interceptor system that was installed in 2001, saying it was performing very well.

Alberta said that Agrium's proposed monitoring system of two wells per nest, with the deepest being about 10 metres, could be improved with the addition of wells deeper than 10 metres. It indicated this would be a requirement in the *EPEA* approval; Agrium would be required to include such information in their detailed design of the monitoring system. Alberta explained that inclusion of deeper monitoring wells would allow proper assessment of potential vertical contamination and allow better assessment of background water quality. Alberta confirmed that it would require three monitoring wells per nest, not two. Alberta confirmed that if groundwater

were to flow through or beneath the proposed slurry wall, or beneath the proposed liner, the contamination associated with that would be detected by the groundwater monitors.

Responding to a question from the Panel, Alberta stated it was confident that the groundwater monitoring system would be able to detect both mounding of the water table and contamination, if those should occur around the proposed extension. It acknowledged that for several reasons, such as the need to monitor seasonal trends and the very slow rate of groundwater movement it would likely take one or two years before the need for interceptor systems could be established.

## 6.2 Surface Water

### 6.2.1 Views of Agrium

Agrium provided its assessment of the impacts of the proposed project on surface water. Existing baseline water quality, sediment quality, and aquatic resource conditions (indicated by benthic invertebrate communities) were provided for the North Saskatchewan River (NSR). Components of the proposed project that could affect the baseline conditions were assessed for the local and regional study areas.

Benthic invertebrate monitoring studies were conducted on the NSR between 1986 and 1990 in the vicinity of what is now the Agrium facility. These studies indicated that wastewater effluent from the Agricultural Chemicals Complex (now Agrium's property) likely caused some modifications to the left downstream bank benthic communities in the study area to at least as far as the Vinca bridge (7.5 km downstream). The effect of the wastewater discharge from what is now the Agrium facility was characterized as primarily an enrichment effect, resulting in eutrophication of the river in addition to that caused by upstream sources, and the development of benthic populations more tolerant of stress.

A detailed study of water quality and environmental integrity of the NSR in the Edmonton to Fort Saskatchewan area conducted between 1992 and 1994 concluded that changes in benthic invertebrate community composition in the study area were caused mainly by nutrient enrichment resulting from the municipal wastewater effluents.

Agrium conducted a preliminary benthic invertebrate assessment in conjunction with the nitrate fines landfill river survey described in the application. Data collected in the vicinity of the gypsum stacks were compared to upstream and downstream areas (assessed as part of the nitrate fines survey) to assess whether any effects on the benthic community could be attributed to the gypsum stacks.

Agrium's assessment of the water quality data indicated no major differences between the two gypsum area sampling sites and the upstream and downstream sampling areas. It reported a slight increase in conductivity and orthophosphate at the two gypsum area sampling sites and in Total Kjeldahl Nitrogen at the upper gypsum area site compared to the upstream reference areas.

Agrium explained its view that the nitrogen-rich groundwater in the area of the nitrate fines landfill was releasing nutrients through the sediment into the river. Nitrate nitrogen and sulphate concentrations decreased at the gypsum area sampling sites compared to the reference area concentrations, but total phosphorous concentrations were generally higher than the reference area, being highest in the near field area (closest to the nitrate fines landfill) and slightly lower at the gypsum area sites (but still higher than the reference area). Sediment pore water exceeded Surface Water Quality Guidelines for Alberta values for nitrate, nitrite, and ammonia, which were in some instances significantly higher values than background.

Agrium's view was that the downstream nutrient enrichment could be attributed to the nitrate fines landfill at least in part because additives, including di-ammonium sulphate and di-ammonium phosphate, were used as part of the plant's ammonium nitrate process to which the nitrate fines landfill was linked. Agrium concluded that the wastewater discharge plume would likely have minimal effect on the benthic invertebrate community at a distance of 1.9 km downstream (the furthest gypsum stack sampling site from the reference area).

Agrium reported that increases in the abundance of some organisms were likely a result of mild nutrient enrichment effects in the near-field and gypsum areas, and continuing to the far-field area. Agrium believed that nutrient enrichment had not had an adverse effect on the benthic invertebrate communities in the NSR as a whole.

Agrium explained that because the proposed gypsum storage area would include a number of engineered measures to prevent impacts to soil and groundwater (e.g. synthetic liner, slurry wall), no impacts on the NSR water quality or benthic invertebrates were expected as a result of the extension project. Agrium also reported that because no impacts were expected, no overlapping effects between other future projects and the proposed extension could occur; therefore, no cumulative effects were anticipated.

Agrium indicated that it intended to complete the most recent benthic invertebrate study, as well as continue monitoring benthic communities in the NSR. It indicated that the final report would be submitted to Alberta Environment. Agrium stated that further benthic invertebrate sampling programs and studies were planned for 2004 and 2006, which could produce more statistically valid results than those presented in the application.

Agrium explained that at present, there is a possibility that surface water from the area located north of the proposed extension area could flow through the extension area and into the NSR. Agrium presented three options for surface drainage, and noted that before it implemented any drainage option, it would conduct a field survey or make observations during a storm runoff event. Agrium reported that the internal intercepting drainage system and storm water management facilities on-site would collect surface runoff generated on the site. The collected water would be returned to the plant as process water. Agrium indicated that no untreated surface water runoff from process and storage areas of the site, including the gypsum and cooling ponds, would drain into the NSR. Agrium also stated that no additional water from the NSR was expected to be withdrawn for the proposed extension, but that if added water was required, the volume would be within Agrium's current *Water Act* approval.

## 6.2.2 Views of the Interveners

### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG argued that at a broader scale geographically than the Agrium facility alone, there is an over-supply of fertilizer which ultimately results in the contamination of North American and European surface water bodies. The NSCRG provided examples of the direct influence of fertilizer plants on freshwater systems, and evidence of regional scale eutrophication problems resulting from the excessive use of fertilizer on farm lands generally (non-point sources of pollution).

The NSCRG noted that the process water used to carry the phosphogypsum slurry to the stack was high in ammonium and nitrate, and in addition to the high phosphate values reported, it believed disaster would result if a significant amount of phosphogypsum entered fresh water. Further, this intervener commented that if one wanted to prevent phosphate and nitrogen from reaching fresh water, a facility would not be located immediately adjacent to a water course. The NSCRG said that industrial development in such a location was the antithesis of current thinking in watershed planning in North America, and was counter to the intent of Alberta's Water for Life program.

The NSCRG said that despite Agrium's position, ammonium and nitrate were not a concern for the proposed application. The NSCRG measured nitrate and ammonium values from monitoring wells throughout the Agrium site have been increasing over time at most depths, including depths greater than 10 metres. The NSCRG explained that from their review of the data, nitrate exceeded drinking water quality guidelines in many instances, and ammonium concentrations were also very high. It argued, therefore, that the source of nitrate was in fact the Agrium facility, and presented a potential human health concern. In addition, it noted that the source of ammonium at the site would exacerbate the nitrate problem through nitrification.

The NSCRG also presented evidence that the eutrophication problem in rivers was different from what could occur in lakes. The NSCRG did not believe that the Agrium facility presented an immediate risk of eutrophication of the NSR near the facility. Its concern was that the Agrium facility would contribute to cumulative downstream eutrophication problems. However, it believed Agrium to be a relatively small contributor to the broader eutrophication problem. The NSCRG indicated that its greater concern was the potential for some major breach of structure, which might result, for example, from an unforeseen weather event. The NSCRG indicated that it was not aware of any mitigation measures for eutrophication, other than long periods of time, and that the main focus for addressing eutrophication problems should be pollution prevention.

In response to questions from the NRCB regarding the levels of total phosphorous, nitrite nitrogen, and sulphate reported by Agrium (in their sediment pore water samples), the NSCRG indicated that the water overlying a benthic stratum is usually not a good indicator of what is happening in the aquatic ecosystem generally. The NSCRG stated that phosphorus and nitrogen are taken up so rapidly within aquatic ecosystems that algal mats and invertebrate communities are much better indicators of pollution than chemical concentrations.

## Alberta Justice representing Alberta Environment and Alberta Health and Wellness (Alberta)

Alberta stated that there are two pieces of legislation relevant to potential impacts on the NSR; the *Water Act* and the *Environmental Protection and Enhancement Act (EPEA)*. One of the main features of the *Water Act* is regulation of changes to surface water drainage through alteration of drainage patterns. *EPEA*'s focus as it pertains to water was described as the protection of surface water and groundwater quality.

Alberta noted that Agrium had done some preliminary surface drainage planning to re-route the flow of runoff, and had applied under the *Water Act* for an approval to modify the local surface drainage. Agrium's preliminary work indicated that surface runoff could be routed around or away from the phosphogypsum stack extension effectively.

Alberta acknowledged that these drainage modifications could be constructed with minimal impact to the lower reaches of the natural drainage channels that would receive the rerouted runoff; however, Alberta Environment had not yet received and reviewed the final design.

Alberta indicated that it may include a condition in any *EPEA* approval issued for Agrium's proposed project requiring the timely submission of final surface drainage design reports to allow for pre-construction review of the drainage modification works. Alberta believed that these works, which require a *Water Act* approval, should allow surface runoff to be routed around or away from the proposed phosphogypsum stack extension, such that the risk of channel erosion and flooding would be minimized.

Alberta stated that the potential of the existing plant operations, as modified by the phosphogypsum stack extension, to influence water quality of the river was associated with groundwater flow and chemistry, and settling pond discharges.

Alberta stated that nitrogen and sulphate-rich groundwater originating from the existing operation does reach the river, and that it originated from the nitrate fines landfill area located near the Agrium plant. Alberta also described surface discharge to the river from a settling pond located in Agrium's plant area, which receives water from several of Agrium's processing units. The current *EPEA* approval for the facility regulates discharge from the pond. Discharges from the settling pond are not expected to change with the development of the proposed phosphogypsum stack extension.

Finally, Alberta noted that a number of benthic invertebrate surveys indicated mild nutrient enrichment, influencing the diversity and density of benthic invertebrates in the NSR near the Agrium site, compared to control locations. Alberta did not view these effects as significant. Alberta believed that Agrium's design for the proposed phosphogypsum stack extension incorporated a number of engineering measures to mitigate the seepage of gypsum pore water to groundwater.

Alberta Environment concluded that the potential impacts of the proposed phosphogypsum stack extension on water quality of the NSR could be mitigated through the implementation of the engineering measures designed by Agrium to prevent the migration of contaminated water off

site. However, it said, with the continuing operations of the Agrium facility, the potential groundwater and settling pond discharge impacts to the river should continue to be monitored.

Alberta Environment indicated that it may include a condition in any *EPEA* approval issued for the proposed project requiring Agrium to conduct river monitoring studies or participate in studies that are being conducted by either industry or municipal facility operators. The objective of these studies would be to verify Agrium's assessment of its effects on the NSR.



## 7.0 VEGETATION

### 7.1 Views of Agrium

Agrium provided a floristic description, including a rare plant survey, of the vegetation in the study area that would be affected by the proposed extension in order to design mitigation based on the survey. Agrium did not find rare plants, and therefore proposed no mitigation for potential loss of rare plant communities or species due to vegetation clearing during construction activities. Agrium proposed to minimize the disturbance of native vegetation due to access roads and construction staging areas, by locating these facilities on previously disturbed land. Agrium also committed to conserve or establish native plant communities adjacent to the proposed extension area. Agrium said it would continue its attempts to establish vegetation on the phosphogypsum stacks.

Agrium considered native vegetation as one of the receptor types in its examination of potential impacts of fluoride in the Human Health and Ecological Risk Assessment. The assessment was intended to be a screening level risk assessment, examining three potential exposure scenarios; actual, average, and conservative. Predicted potential impacts from chronic exposure to fugitive fluoride emissions using values from the air quality impact assessment were filed as part of Agrium's application.

Agrium stated that the Alberta Research Council had monitored fluoride concentrations in crops and native vegetation near the Agrium site since 1970. Agrium reported that unwashed leaf fluoride concentrations at most sites within 1.5 km (or 2 km from the centre of the stack/pond area) of the Agrium facility exceeded the Canadian reference level for fluoride in vegetation of 30 mg/kg dry weight (DW). The geometric mean of all samples also exceeded this value. Measured concentrations at two sites on Agrium-owned land exceeded the threshold identified for moderately tolerant plant species (100 mg/kg DW) and one site on Agrium-owned land exceeded the threshold for tolerant species (200 mg/kg DW).

Agrium concluded that the effects of measured fluorides on native vegetation were low based on field observations of limited stress from season to season, site to site, and within and across species. Agrium reported that fluoride levels in vegetation close to the Agrium facility exceeded those at which stress was reported to occur in the literature; however, observed signs of stress on the vegetation (visual assessment) were highly variable both within and across sites and plant species. Agrium noted that many factors besides fluoride could explain the observed vegetation stress, including pesticide and herbicide usage, drought, or disease. Agrium reported that fluoride levels decreased with increasing distance from the centre of the phosphogypsum ponds, and that the relationship between measured levels of vegetation fluoride and field observations of plant stress would need to be evaluated further as new data were collected.

Agrium said that vegetation fluoride samples and observations of necrosis and chlorosis were collected in the spring, early summer, and fall of 2003. Additional species and sites had been added to the original vegetation sampling program discussed in the application, a spring season assessment was added, and a biologist participated in the vegetation survey to correlate

vegetation health observations to fluoride analyses and other factors such as drought conditions and land use.

## 7.2 Views of the Interveners

### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG referred to the Canadian Council of Ministers of the Environment (CCME) reference level for fluoride in vegetation of 30 ppm. It concluded from its own examination of Agrium's data that in 1998, as much as 45 percent of vegetation samples exceeded this CCME guideline. It also noted that 25 percent of the 1998 samples exceeded 80 ppm.

The NSCRG conducted its own sampling program for fluoride in vegetation. It noted that few samples of livestock forage had been taken to date. It reported fluoride levels in vegetation samples taken from a farm located one kilometre east of Agrium ranging from 8.92 mg/kg (ppm on dry basis) in Gladioli to 434.30 mg/kg in wild hops. The NSCRG noted that this site was "downwind" of the Agrium plant. It pointed out in particular the concentration of fluoride found in lettuce (137 ppm) at the same site, stating that human consumption of one ounce (28.4 g) of such lettuce would result in an intake of 3.9 mg of fluoride. Additional vegetation samples were collected at the Ziegeman farm 1.5 miles (2.4 km) away from the Agrium facility and analyzed for fluoride content. The NSCRG indicated that some fluoride concentrations found at this distance from the plant were higher than those found in vegetation at a 1 km distance from the plant, and that this was a significant result. NSCRG concluded by emphasizing that Agrium is a known fluoride emitter, and that farms as far away as 4 km are affected.

The NSCRG also believed it noteworthy that Agrium had not tested for fluoride concentrations in spruce trees that had died, and noted that spruce trees were known to be susceptible to fluoride damage. It also noted that the dying Poplar trees (*Populus spp.*) and Saskatoon bushes (*Amelanchier alnifolia*) should be considered significant in the context of potential fluoride pollution. Further, the NSCRG believed the vegetation sampling program contained poor representation of annual and perennial vegetation, as well as sampling sites located in pasture lands.

The NSCRG concluded that vegetation was being impacted by fluoride emissions from Agrium, and noted that the predicted annual average fluoride concentrations for both existing and future scenarios presented in the Agrium extension application exceeded the Netherlands vegetation standard of 0.02 ug/m<sup>2</sup> for all receptor sites, and exceeded the 1984 World Health guidelines of 0.2 ug/m<sup>2</sup> for all but four receptors sites.

### Sturgeon County Residents (SCR)

The SCR noted that fluoride bio-accumulates to a degree, and specifically that it appears to accumulate in vegetation. This was considered to be a potential cumulative impact of the proposed phosphogypsum stack extension.

**Alberta Justice representing Alberta Environment and Alberta Health and Wellness (Alberta)**

Alberta indicated that the existing *EPEA* approval required vegetation monitoring, and that results to date did show some fluoride values in excess of 30 mg/kg dry weight at sampling locations within 1.5 km of facility centre. It noted that sampling sites farther away than 1.5 km were below this measured value. Alberta indicated that the 30 mg/kg reference value appears in a federal document (National Ambient Air Quality Objectives for Hydrogen Fluoride), and is intended to be protective against fluorosis in wildlife and livestock from consumption of forage.

Alberta said Agrium's predictions exceeding the *AAAQG* values, and the elevated fluoride concentrations measured in vegetation, provided a caution and suggested the need for additional action. Accordingly, Alberta was considering the following as potential *EPEA* approval requirements if the proposed extension project was approved: ambient air quality monitoring, further investigation of impacts on vegetation, and investigation and reporting on ambient hydrogen fluoride mitigation techniques.



## 8.0 ANIMAL HEALTH

### 8.1 Views of Agrium

Agrium conducted a wildlife assessment to determine mammalian and avian wildlife resources in the study area prior to the proposed extension. It provided an impact assessment and mitigation information based on these surveys. It also evaluated natural areas within the study area, specifically the wetland at the northeast corner of the existing phosphogypsum storage area, the constructed wetland at the southwest corner of the plant site, and the east bank of the North Saskatchewan River valley for comparison to adjacent natural areas.

Impacts were predicted to include loss of wildlife habitat, fragmentation of wildlife habitat, disturbance to wildlife, and mortality of nesting birds and other wildlife during both construction and operations (mortality of nesting birds was only expected to occur during construction activities). The reasons for these impacts included removal of native vegetation and altering the landscape of the extension area, excluding wildlife from the extension area and obstructing wildlife movement, noise and human activity causing wildlife avoidance of natural areas in proximity to the extension, and movement of construction equipment and vehicles causing bird and wildlife mortality. Direct contact with process water on the gypsum storage area also had the potential to cause wildlife mortality.

To address these impacts, Agrium proposed the following mitigation measures:

- increasing prime waterfowl habitat in the southwest constructed wetland on the facility site to replace loss of habitat due to the extension;
- conserving or establishing native vegetation cover on lands adjacent to the extension area to preserve or enhance wildlife movement and to provide a buffer from industrial activities;
- limiting construction activity to daytime hours;
- scheduling vegetation clearing for construction to avoid critical breeding/rearing periods;
- fencing the construction staging and extension areas in order to limit wildlife access;
- reducing speed limits and increasing awareness on access routes during peak hours of wildlife movement;
- extending the existing wildlife deterrent system to the extension area; and,
- recording wildlife contact with the gypsum ponds or mortalities to determine if a more effective deterrent system is required.

Agrium also conducted an ecological risk assessment as part of the extension application, and included an animal receptor. The rationale for including wildlife in this assessment was that fluoride concentrations that are not toxic to plants may elicit chronic effects in long-lived herbivores such as deer. White-tailed deer (*Odocoileus virginianus*) was the receptor selected since it was considered to be a sensitive wildlife indicator for fluoride exposure. Various fluoride sources and exposure pathways were considered over a 4500 ha area where ambient fluoride ground level concentrations were predicted to exceed  $0.2 \mu\text{g}/\text{m}^3$ , excluding the working facility area.

Agrium concluded that the extension project was unlikely to result in population level effects on white-tailed deer. However, fluoride levels sampled from vegetation within approximately 1.5 km of the facility exceeded the Canadian reference level for fluoride in vegetation (30 mg/kg dry weight), recommended for protection of herbivores such as deer. Agrium was of the view that deer consuming vegetation above this reference level may demonstrate dental fluorosis, which it believed to be an aesthetic effect, but suggested that such effects would not necessarily result in population level effects on deer. Agrium noted that the next step to better define the potential hazard would be to examine deer within a 2 km radius of the facility for signs of dental fluorosis.

Agrium stated that domestic animal health problems observed during field investigations were rarely the result of poisoning or toxicological issues. Instead, greater than 90 percent of problems observed would be expected to be the result of one or more management practices or related matters, such as an infectious disease, or poor nutrition.

Agrium also discussed safe tolerance levels of dietary fluoride for various animal species, and clarified that tolerance levels refer to potential exposure from the complete diet of an animal, rather than forage alone. Agrium referred to a document authored by the National Research Council (NRC) in the United States entitled "*Mineral Tolerance of Domestic Animals*", published in 1980 (the latest edition). It cited the maximum fluoride levels for young cattle at 40 ppm. It indicated that minor morphological lesions may be seen in cattle teeth when dietary fluoride during tooth development exceeds 20 ppm; however, a relationship between these lesions and animal performance (milk production, animal movement, chewing ability) had not been established.

Agrium challenged the validity of hay samples submitted by the NSCRG, indicating that clinical toxicology would normally require information regarding how the sample was collected, whether multiple cores of the same feed source were taken, and whether the sample was representative of the feed the animals actually consumed. Nonetheless, Agrium provided their interpretation of the evidence submitted by the NSCRG. It referred to NSCRG feed samples taken at various locations which resulted in fluoride values of 20.3, 6.2, 8.9, and 3.8 ppm found at distances east of the Agrium plant of 0.5, 1.0, 2.0, and 4.0 km, respectively. Agrium noted that all fluoride values were within the normal expected range reported by the NRC and would not cause declines in animal performance.

Agrium cited "*Pathology of Domestic Animals*," as a standard reference text book in veterinary medicine. It noted a number of differential diagnoses (other causes) based on certain symptoms which could also be interpreted as excessive fluoride exposure. Other diagnoses included bovine virus diarrhoea, high levels of tetracycline antibiotics, and Vitamin A deficiencies, which all have the potential to cause abnormalities of tooth enamel similar to what fluoride might cause. Nutritional deficiencies, particularly calcium levels, as well as phosphorous and Vitamin D were also reported by Agrium to affect tooth development. Agrium cited genetic diseases in some cattle (e.g. osteoporosis in Angus and Hereford cattle) which could mimic effects of high chronic fluoride exposure. Vegetation pigment and the intake of sand or rock with forage were also reported to affect the appearance and wear of cattle teeth, further complicating the diagnosis.

Agrium then compared data for the concentration of fluoride in bone presented by the NSCRG to reference values cited from “*Mineral Levels in Animal Health*,” authored by R. Puls. Agrium compared NSCRG’s evidence of fluoride measured on a dry basis of a cow mandible (464.2 ppm), coyote mandible (218.6 ppm), and a five year old male sheep mandible (625.9 ppm) to Puls’ reference “normals” (fat free) for a bovine rib (<1800 ppm), fox mandible (<1100 ppm) and sheep mandible (normal 50 – 150, high 1500 – 2500 ppm), respectively. Agrium noted that while the sampled value for the sheep mandible was considered to be elevated above normal, it would not be considered as a high value. All other values were within the expected range of fluoride concentrations.

For the sake of comparison to NSCRG’s evidence, Agrium presented photos of cattle teeth taken from both a North Dakota State University beef herd and at an unidentified location near or within the study area of the proposed project. The North Dakota cattle in the photos were aged four, seven and 10 years. The local cattle were nine and five years old. The North Dakota herd was considered to have no exposure to fluoride other than consumption of fluoridated water (<1 ppm) for six months per year. Agrium described the tooth morphology and wear as normal. Agrium suggested that the pictures of the cattle from the local herd were not appreciably different from those of the North Dakota herd. It indicated that fluoride affects the developing tooth, but rarely affects teeth of newborn calves. Generally, fluorosis would occur in developing or permanent teeth over a period of years from six months to 30 months of age. Beyond the 30 month age, cattle exposed to fluoride generally would not acquire enamel pitting or staining. Agrium argued that it had found no data from field investigations or controlled studies that supported the theory of a “generational effect” cited by the NSCRG, or fluoride exposure *in utero* resulting in higher body burdens in young cattle than would be expected without fluoride exposure.

In Agrium’s view, the observed effects on teeth such as uneven wear, fine striations, and staining, could be expected in cattle of various ages due simply to regular use, and were impossible to differentiate from fluorosis without knowing the age of the animal. Further it argued that when diagnosing fluorosis, it was critical to correlate all observations. Observations of dental lesions should be compared to a standard scoring system such as the National Research Council’s ranking system from 0 to 5 for fluorosis, and these results should be compared to clinical symptoms such as skeletal lameness, dry skin, decreased performance (e.g. milking ability). Those results should further be compared to chemical analyses of bone, urine, or serum samples. Agrium indicated that other studies had observed mild to moderate brown staining of the teeth of dairy cattle with no effect on mastication (chewing) ability or appetite. Some vertical striations in tooth enamel had been observed in cattle exposed to a known fluoride source, but the severity of lesions was not found to be different from an unexposed control herd.

Agrium also commented on the effect of fluoride exposure on milk production. It noted that other management factors, such as the use of bovine somatotropin (a growth hormone) to increase milk production, handling of dairy cows (e.g. in tie stalls or receiving insufficient exercise), and body condition resulting from these factors, affect milk production to the extent that a cause and effect relationship between fluoride exposure and milk production cannot be established based on dietary fluoride levels and milk production alone.

Based on its literature review and communications with veterinary toxicologists in the United States, who deal with fluoride contamination issues, Agrium concluded that the concentrations of fluoride in bone and feed presented by the NSCRG were within the normal range of the nationally established standards or tolerances. Further, based on field investigations, Agrium observed no chronic fluorosis in herds near the existing facility.

Agrium was of the view that apart from examining deer for signs of fluorosis, there was no need for further conditions requiring investigations into animal health. In its view, investigations of animal health were complete.

## 8.2 Views of the Interveners

### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG was of the view that industrial fluoride emissions were about half gaseous and half particulate, and that the particulate fraction was more important than the gaseous one, because it could settle on vegetation, be incorporated into vegetation parts (e.g. leaves), and consequently provide an exposure route to wild or domestic animals. It suggested this chain of events could result in fluoride poisoning of those animals.

The NSCRG quoted fluoride leaf concentration values from Agrium's application, and interpreted them as being very high or alarmingly high values (e.g. 594.7 ppm 0.8 km north of the plant entrance and 0.4 km from the gypsum stack). It also believed that a fluoride leaf content of 20.3 ppm at a distance of 2.4 km from the gypsum stack was an alarmingly high value.

The NSCRG was concerned that the EIA did not contain sufficient information on the current or predicted concentrations of fluoride in the diet of wild animals. It believed that inclusion of information on dead animals would have been relevant. The NSCRG believed that Agrium's conclusion that potential effects on the regional white-tailed deer population were unlikely was unsubstantiated. Further, NSCRG argued that fluoride concentrations in vegetation close to the Agrium facility in excess of what might be expected to cause fluorosis in deer cast doubt on Agrium's conclusion that effects of fluoride emissions on the deer population were unlikely.

The NSCRG believed that the lack of evidence of the impact of fluoride on farm animals in the original application presented a serious deficiency in Agrium's application. This intervener cited a number of publications discussing fluoride pollution resulting from various industry types. It believed that given the high profile of these historical cases of industrial fluoride pollution, Agrium should have considered the potential for cattle fluoride poisoning in its application. Because the proponent did not collect data on farm animal health and production, an evaluation of potential impacts of the proposed extension on domestic livestock was not possible. The NSCRG argued that basic data including analysis of forage samples for fluoride and assessment of cattle teeth by a competent expert were required, and indicated that such evaluation should include farms within 10 km of the Agrium facility.



The NSCRG submission included samples analysed for fluoride content independently of the Agrium application. Results in mg/kg (ppm) of fluoride on a dry basis indicated 6.2 and 20.3 ppm fluoride in hay sampled at the Marquardt farm 0.5 and 1.0 km east of the plant, respectively. Bone from the mandible of a cow also on the Marquardt farm was reported to contain 464.2 ppm fluoride. At the Sawatzky farm, fluoride content of feed sampled at 2 and 4 km east of the Agrium plant was reported to be 8.9 and 3.8 ppm, respectively. The mandible of a coyote from the Ziegman farm was found to contain 218.6 ppm fluoride. The NSCRG was of the view that the forage samples at both the Marquardt and the Sawatzky farms revealed fluoride levels high enough to cause negative health impacts in cattle.

The NSCRG presented evidence on the tolerance levels for dairy cattle derived from experiments conducted in the 1950's and 60's. It argued that those studies were biased due to funding provided by industries which are also fluoride emitters. The NSCRG argued that the findings of the National Academy of Sciences in the United States on the effects of fluoride in animals ignored previously published scientific literature on the effects of dietary sodium fluoride (NaF) on dairy cattle. Further, the NSCRG cited a study conducted to examine fluorosis in cattle and sheep, stating that it reported that beef cattle exposed to 37 ppm fluoride in feed showed severe dental fluorosis, which could also be detected at feed fluoride levels as low as 7 ppm.

NSCRG stated that loss of milk production was the primary financial consequence of excessive dietary fluoride intake by dairy cattle. The NSCRG indicated that when cattle are exposed to fluoride in feed, it replaces the hydroxyl ion and calcium-fluoro-apatite becomes built into the bone tissue. Increasing feed in order to increase milk production, in this instance, would in fact just expose the cattle to additional fluoride, resulting in higher levels of fluoride in cattle and declining levels of milk production. By way of example, the NSCRG explained that the Puls reference values were based on milk production of control cows of about 30 pounds per day (lbs/day). At that low rate of milk production, up to 40 ppm fluoride in feed could be tolerated. The NSCRG argued, however, that current milk production rates are about three times as much as they were when the tolerance levels for fluoride were established. NSCRG argued that for each kilogram (kg) of milk produced, 0.5 kg of dry matter feed would have to be consumed. An increase in milk production from 30 to 90 lbs/day (difference of 27 kg) would require an additional 13.5 kg of feed. At 40 ppm fluoride, this would result in the cow being exposed to an additional 540 mg (based on 40 mg/kg), which would ultimately limit milk production for the reason described above. The NSCRG presented results from a study conducted in the United States correlating declining milk production levels to increased forage fluoride levels, and further commented that the reference levels used to interpret historic data did not necessarily apply in current situations. Specifically, NSCRG believed the tolerance level of fluoride in dry dietary matter for mature dairy cattle of 40 ppm cited in both "*Mineral Levels in Animal Health*" authored by R. Puls and the National Academy of Sciences (1980) publication "*Mineral Tolerance of Domestic Animals*" was obsolete.

The NSCRG provided their analysis of pictures of cattle teeth to determine dental fluorosis. It commented that the evaluation was complicated by the small number of observations per farm, the age of cattle at the Sawatzky farm, and the fact that the ages of cows at the Marquardt farm were not known. The NSCRG commented that ideally, teeth of three to four year old cows would provide the best evaluation of dental fluorosis in cattle, since it would allow examination

of delayed eruption of permanent teeth. Nonetheless, the NSCRG presented photographs demonstrating fan shaped teeth, gaps between teeth, recession of the gums, and excessive wear on cattle teeth, which it concluded were consistent with dental fluorosis resulting from chronic fluoride poisoning. Additional photos from the Radke farm were examined and initially believed to be evidence of chronic fluoride poisoning; however, it was later determined that the primary source of fluoride exposure in that case was through feed supplements.

The NSCRG also presented analysis of a five year old sheep mandible collected from the Henkelman residence. It concluded that the gross morphology and radiographic findings were consistent with chronic fluoride poisoning. The fluoride content of the mandible was 625 ppm (dry basis); however, the NSCRG found no experimentally derived fluoride reference levels suitable for comparison for sheep.

The NSCRG argued that the Agrium animal health expert had no specific expertise with respect to fluorosis, and that evidence submitted by Agrium regarding the health of local cattle could not be considered because the location of the cattle examined was not disclosed. It stated that the residents' reports of animal health problems such as cancer, degenerative spine problems, joint problems, eye problems, loss of teeth, and unexplained death and vomiting further supported the potential of fluoride contamination in the area.

#### **Sturgeon County Residents (SCR)**

This intervenor group expressed broad concerns about potential impacts resulting from the existing Agrium operations and proposed extension, which included impacts to cattle and horses on their lands. Specifically, the group expressed concerns regarding bioaccumulation of fluorides or hydrogen fluorides in flora and fauna resulting from both the current phosphogypsum storage area and proposed extension. In their submission, the SCR stated that low levels of fluoride can result in accumulations which may be injurious to animals, as well as plants and humans. This group noted that the World Health Organization has recognized that fluorides can bioaccumulate and may travel significant distances.

## 9.0 RECLAMATION

### 9.1 Technical Feasibility

#### 9.1.1 Views of Agrium

Agrium stated that it was in the process of developing the optimum reclamation strategy for the phosphogypsum storage area at its Redwater facility. Agrium argued that it was pursuing a prudent reclamation approach in that it was actively involved in research to find more efficient and effective ways to reclaim, including seeking alternate uses for phosphogypsum, and at the same time it was developing a plan to reclaim the gypsum stack in place.

During the hearing, Agrium was asked where it would store topsoil stripped from the extension area, and how it would mark those areas to prevent contamination of those soils. Agrium indicated that topsoil would be stored on adjacent Agrium owned land to the north and east of the gypsum stack extension area, well away from industrial activity. Topsoil storage locations would be clearly documented on Agrium land drawings. Agrium said it had hired consultants to develop detailed topsoil storage plans, including the height and length of storage berms and vegetation strategies.

Agrium explained their conceptual reclamation strategy involved three phases: site-specific assessment (i.e. review of data deficiencies, regulatory requirements and relevant research), planning (i.e. developing reclamation procedures, long-term management plans) and implementation. Agrium said reclamation planning for the Redwater facility was in the assessment phase and, under the terms of their current operating approval, an approved reclamation plan was required to be submitted to Alberta Environment by 2012. Agrium acknowledged their approach to reclamation research and planning could be more structured and visible.

Agrium claimed successful reclamation of decommissioned phosphogypsum stacks was feasible and presented examples selected from about 20 sites in North America undergoing closure to support this view. Agrium described possible closure requirements and options, such as:

- Re-contouring of the stack depending upon design and construction (i.e. slope ratio > 3:1).
- Installation of a synthetic or clay liner over the top surface of the stack to prevent infiltration of precipitation. Subsequent placement of a topsoil cover to support re-vegetation. Re-vegetation of the side-slopes with or without topsoil cover.
- Intermediate closure involving re-vegetation of the side slopes of an operating stack to minimize infiltration of precipitation and to improve visual aesthetics.
- Segregation of precipitation run-off that requires no treatment from internal seepage which will need to be treated or re-used by installing appropriate drainage channels and underdrain systems.

Agrium conceded that, to the best of its knowledge, only one of the 20 decommissioned phosphogypsum sites in North America discussed had reached the point where the site had been reclaimed and abandoned. Agrium noted this site in Florida, decommissioned approximately 10

years ago and closed, had been covered with about six inches of mine overburden and vegetated with grass. Agrium said environmental management at this site still required cutting of the grass and checking of the groundwater monitoring wells.

Agrium stated it was committed to the development of alternative uses and commercial markets for phosphogypsum as an alternative to stack reclamation in place. It discussed available possibilities in this regard, such as:

- engineered markets (e.g. wallboard, plaster, cement retarder, cement bridge abutments, replacement for granite rip-rap for oyster bedding, vitrified products)
- recovery of  $H_2SO_4$  and  $NH_4SO_4$  from phosphogypsum
- intermediate cover material for landfills
- source of calcium for the Consolidated Tailings process used in bitumen recovery from the Fort McMurray oil sands
- component of oilfield casings cement
- amendment for the remediation of brine-contaminated or Solonchic soils
- amendment for composting of, as well as, odour control and emissions reduction from livestock manure

Agrium said the costs of transportation and the perceived risks associated with NORM content in phosphogypsum posed hurdles for the re-use of phosphogypsum. In the agricultural sector, Agrium noted a dozen local field trials were underway to quantify the agronomic benefits of phosphogypsum application and to evaluate the economics of re-use in this case. Agrium indicated all of the phosphogypsum in California has already been used in agriculture and Georgia has been using phosphogypsum as a soil amendment in peanut farming for many years. Although the USEPA allows unrestricted use in agriculture for phosphogypsum containing 10 picocuries<sup>v</sup> per gram or less, Agrium acknowledged the radiological concentration of their phosphogypsum from the Redwater plant was about twice the USEPA standard. Agrium anticipated the possibility of a lengthy process to register and license phosphogypsum as a commercial product in Canada. While involved in research and development, Agrium confirmed it did not have a commercially available product at this time.

Because reclamation of the phosphogypsum stack areas is site specific, Agrium explained it had to conduct its own studies to meet reclamation objectives that included productive future land use, protection of human and ecological health and effective management of timing and expenditures. In this regard, Agrium described re-vegetation plot trials, implemented in 1998 on a side-slope of the Redwater phosphogypsum stack, studying the effects of amendments to the phosphogypsum (i.e. topsoil, feedlot manure, municipal compost, clay). Agrium concluded, based on qualitative assessments of the growth responses of the plant treatments (i.e. grasses, clovers), all amendments worked well and were beneficial in terms of the reclamation plant species germination, establishment and cover. Agrium stated once the pH of the phosphogypsum had been raised above 4.0, through leaching by precipitation or by acid-neutralizing amendments, vegetation could grow well with the addition of essential nutrients

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<sup>v</sup> curie =  $3.7 \times 10^{10}$  disintegrations per second

(e.g. nitrogen, potassium, magnesium). Agrium confirmed that issues such as potential plant uptake of fluoride, re-vegetation with native species, potential long term re-acidification and required cover thickness had not been examined to date.

Agrium said it planned to install a mini-interceptor system to remove the effect of acidic process water and use lime as an amendment in future larger scale test plot studies. Agrium indicated expenditures for research on phosphogypsum use and reclamation was budgeted either as a part of the normal operating allocation or as provisions for specific projects.

Agrium confirmed that reclamation of its Redwater phosphogypsum stack area may involve some reshaping or regrading of the stack. Agrium stated a reclamation plan for the stack slopes at this site had not been established but such a plan would depend upon a number of existing stack conditions (e.g. final stack height, operating side-slope ratio, side-slope stability, side-slope re-vegetation options, options to contour and crown the stack top surface). With a final stack height of about 300 m, Agrium noted maintenance of benches on the side-slopes at closure may be desirable to prevent erosion. On the other hand, Agrium indicated flattening the stack slopes at closure may be a simpler option from a water management point of view. Agrium acknowledged closure of the phosphogypsum stack was possible with current technology. However, Agrium emphasized the most economical, innovative and effective method of achieving reclamation and closure objectives was dependent on research underway. Consequently, Agrium was unwilling to commit to a detailed reclamation plan to be implemented approximately 20 years into the future.

### 9.1.2 Views of the Interveners

#### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG presented their concern that the phosphogypsum stack could remain hazardous for tens of thousands of years, yet only the next 30 years of operations were addressed in Agrium's application. The NSCRG argued that the phosphogypsum at the Agrium Redwater facility should not qualify for unconditional release whether used as a product or reclaimed in place at the end of facility operation.

The NSCRG believed that future occupants of a reclaimed phosphogypsum site would receive a radiation dose much greater than 0.3 mSv/yr, the value not to be exceeded according to the Health Canada document entitled "*Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM)*". By NSCRG's calculations, a resident living on a reclaimed phosphogypsum stack growing all fruits and vegetables in a local garden would receive a radiation dose of 10 mSv/yr, which is more than 30 times the NORM guidelines.

The NSCRG noted that radiation dose declines with increasing soil cover depth. The soil acts as a barrier to radon release, and attenuates the gamma dose. However, the NSCRG inferred that even with a 3 m soil cover, the radiation dose would remain as high as 1 mSv/yr. The NSCRG therefore recommended that in addition to a 3 m soil cover, the stack be mounded to reduce the potential for erosion and standing water. The NSCRG also proposed the stack be covered with a

clay layer to inhibit water infiltration, and finally seeded with grass. The NSCRG acknowledged that it had not calculated the potential cost of these reclamation steps, but believed that planning for the implementation of such reclamation measures was a priority.

The NSCRG doubted the feasibility of the alternate uses described by Agrium in their application, both from a cost-effectiveness and legal perspective. It cited the need for an extension of the phosphogypsum stack as evidence that finding a practical alternative use for the material had not been successful to date. The NSCRG also expressed concern that in the unlikely event that phosphogypsum was treated as a product rather than a radioactive (potentially hazardous) material, an increased radiation exposure and consequent cancer risk would be more widely distributed.

#### **Alberta Justice representing Alberta Environment and Alberta Health and Wellness (Alberta)**

Alberta recognized the possibility that the existing and proposed phosphogypsum stack might have to be reclaimed in place. It indicated that the potential for that circumstance depended upon future commercial markets for phosphogypsum. Alberta agreed with the applicant that further research was needed to develop a feasible and effective long-term reclamation strategy for the phosphogypsum stacks, but also believed that Agrium should prepare to implement conservative reclamation strategies in the event that Agrium's research initiatives did not yield an alternative strategy acceptable to Alberta Environment.

Alberta identified both the final cover design and the availability of cover materials for the phosphogypsum storage area as unresolved issues related to reclamation planning that would need to be addressed by future research initiatives. Alberta did not believe these issues were insurmountable, and commented that the successful reclamation of the phosphogypsum stacks was "likely technically feasible", but potentially costly if conservative reclamation strategies were employed.

Alberta indicated that a final cover for reclamation-in-place of the phosphogypsum stacks would need to perform several environmental functions, such as providing a substrate for vegetation growth, minimizing contaminant uptake by vegetation, minimizing infiltration and downward migration of contaminants from phosphogypsum, directing surface water runoff and minimizing 'ponding', attenuating radon gas emanation and gamma radiation, minimizing wind and water erosion, preventing direct contact (e.g. of humans) with the phosphogypsum eliminating direct exposure pathways, and providing a self-sustaining design. Alberta noted that if a definitive reclamation strategy was not developed in a manner acceptable to Alberta Environment, the requirements for the final cover design would likely be conservative and guided by methodologies used in other jurisdictions that have already dealt with the reclamation of phosphogypsum storage sites. During the hearing, Alberta indicated that covering the phosphogypsum with one metre of cover material (e.g. soil) would constitute a conservative, albeit costly, reclamation solution, and would be consistent with practices used in other jurisdictions (e.g. Florida).

Alberta also addressed the conceptual option proposed by Agrium of creating water bodies on the final reclamation landscape. Alberta did not support a reclamation strategy involving

creation of permanent water bodies on top of the reclaimed phosphogypsum stacks, and was concerned about the long-term environmental impacts associated with such water bodies. It stated its concern that such water bodies could increase the potential for seepage from the phosphogypsum stacks to contaminate groundwater.

During the hearing Alberta indicated that covering the side slopes of the phosphogypsum stack with a soil layer for reclamation purposes prior to establishing vegetation was dependent on moisture levels in the stack. The feasibility of covering side slopes with soil would be evaluated for local suitability. Alberta indicated that it planned to require Agrium to evaluate trace element (i.e. metals) uptake by vegetation from phosphogypsum as part of its future research objectives. Alberta also indicated that evaluation of the function of vegetation, for example in establishing a water balance, would be an important consideration in any cover species required for reclamation. Consideration for native vegetation species would be given, but end land use and potential impacts on the surrounding area would also be factored into the final vegetation cover type.

Alberta indicated that in its view, successful reclamation was largely a function of determining appropriate soil cover depth, identifying sufficient salvage material for the cover, and identifying ongoing water management and maintenance needs. It also indicated that ideally the reclaimed stack would not require ongoing maintenance. While Alberta could not identify a specific completion date or timeline for reclamation, it did indicate that future land use, such as recreation, was an important consideration. Alberta acknowledged that it was considering how best to address reclamation planning requirements for the sake of any Alberta Environment approval that might be necessary for the proposed phosphogypsum stack extension.

Availability of cover material was highlighted by Alberta as a potential complication for the technical feasibility of reclamation, since only 530,000 cubic yards was available for salvage which would amount to covering the entire phosphogypsum stack area at closure with approximately 6 inches of soil. This value did not account for wind and water erosion which might take place during the storage of salvaged "topsoil". Alberta indicated that in the case of a cover material deficiency, off-site sources of cover material would be contemplated.

In its submission, Alberta indicated that Alberta Environment may include conditions in an *EPEA* approval which would require Agrium to submit a reclamation research plan and schedule. Alberta stated that although specific dates for reclamation were currently uncertain, it would require Agrium to develop a more specific reclamation plan within the next few years. It also indicated that the reclamation plan would be revised according to results from Agrium's own and other research.

**Mr. Smulski**

Mr. Smulski argued that Agrium's commitment to reclamation planning or identifying alternate uses for phosphogypsum needed more attention and dedication. With respect to potential alternate uses of phosphogypsum described by Agrium, Mr. Smulski noted

that the experimental use of phosphogypsum as a manure amendment in feedlots was currently small in scale, and that Agrium's shipments of phosphogypsum to Fort McMurray for use as an oil sands tailings amendment had been discontinued.

### Sturgeon County Residents (SCR)

The SCR expressed concerns regarding Agrium's accountability with respect to reclamation in the long-term, and argued that an analysis of the long-term impacts related to reclamation were not readily available. This group also noted that monitoring for an extended period was not currently accounted for in Agrium's reclamation planning information.

## 9.2 Economic Feasibility (Reclamation Security)

### 9.2.1 Views of Agrium

Agrium indicated that it had booked a \$25 million liability in its financial statements for reclamation of the existing gypsum stack. It added that some form of financial security for reclamation was not required for fertilizer plant operations under the *Environmental Protection and Enhancement Act (EPEA)*, unless specifically required by Ministerial order. Agrium estimated that to post financial security for reclamation would increase the overall reclamation cost by approximately 50 percent due to financing costs.

Agrium argued that continued financial strength of the company was the best form of assurance that Agrium's reclamation obligations would be met. Agrium pointed out that no one in the proceeding credibly challenged Agrium's financial strength or its ability to meet its reclamation obligations. Furthermore, Agrium reported that it cannot simply avoid its obligation by selling the plant, due to the fact that Alberta Environment has the ability to grant, refuse or condition any transfer of the current approval from Agrium to another party.

It was Agrium's position that to impose a condition requiring some form of financial security would be unprecedented, and would impose a potentially large cost on the company. Agrium said that this could affect its current credit rating, adversely affecting its ability to grow its business.

### 9.2.2 Views of the Interveners

#### Sturgeon County Residents (SCR)

The SCR indicated that, as a group of taxpayers in Sturgeon County, it was concerned about how Agrium would be held accountable for decommissioning the gypsum stacks. It suggested that an upfront reclamation bond was needed to ensure responsible clean up once operations ceased at the plant. The group pointed to examples in the United States where the state government has been forced to take financial responsibility for decommissioning costs, and suggested the same should not be allowed to happen for this facility, with Sturgeon County being forced to take financial responsibility.



### **Northeast Strathcona County Residents Group (NSCRG)**

The Northeast Strathcona County Residents group pointed out that Agrium had not completed a cost analysis of the conservative reclamation-in-place option, had not demonstrated the company's financial capacity to meet its reclamation obligations, and had not been required to set money aside to reclaim the gypsum stacks. The NSCRG suggested that a strong financial position today is no guarantee that the company will have the financial resources in the future to reclaim the gypsum stacks. The NSCRG also suggested that there was nothing to stop Agrium from selling the facility to another company without the financial resources to complete the reclamation work. The group stated that Agrium, by not properly addressing reclamation now, was passing its burdens another 25 years into the future and onto the next generation.

### **Mr. Smulski**

Mr. Smulski stated that there was enormous environmental liability associated with the phosphogypsum stacks, and that Agrium needed to dedicate more resources toward finding an alternate use for the gypsum, including better defining what would be done with the gypsum stacks if an alternative use was not found. Mr. Smulski suggested that the Board, in its approval process, could use a reclamation bond as a way to provide some assurance and financial security that reclamation would be carried out. He suggested that the reclamation bond associated with the northern extension could be somewhat lower in value given its proposed liner and intercept system, whereas a reclamation bond for the existing gypsum stack should be higher to reflect the lack of these mitigation measures. Mr. Smulski also suggested that a reclamation bond should be placed on the intercept systems located on the east half of Section 19 to ensure that these intercept systems would be maintained.

### **Alberta Justice representing Alberta Environment and Alberta Health and Wellness (Alberta)**

Alberta stated that while Section 17, Sub-Section 1 of *EPEA's* Conservation and Reclamation Regulation does require the provision of reclamation security for certain types of activities, a reclamation security was not required for any kind of industrial plant. Notwithstanding, Section 17, Sub-Section 2 of the *Conservation and Reclamation Regulation* does empower the Minister of the Environment to make an order requiring reclamation security for a designated activity. Alberta indicated that Section 17, Sub-Section 2 had not been utilized in the past.



## 10.0 PUBLIC CONSULTATION AND EMERGENCY RESPONSE

### 10.1 Views of Agrium

Agrium stated that its public consultation process for the proposed extension was thorough and comprehensive. It stated that it consulted the Community Advisory Panel (CAP) to assist in the development of its public consultation program and communication plan. It noted that the CAP consisted of representatives from Agrium, Provident Energy, Degussa, and 12 members of the surrounding community. Agrium noted that it had publicly advertised some of its open houses and circulated an information newsletter on the extension plans to 80 of its neighbours. Agrium also described its website, which provided detailed information about the proposed extension.

Agrium reported that it had held five open houses to discuss the proposed extension, and believed that the advertising for these events had been appropriate. It also noted that it met individually with some of its neighbours and with elected representatives from the surrounding communities and municipal organizations. Agrium stated that it had forwarded detailed minutes of its public meetings to interested participants and had established a follow-up program to ensure that it had addressed all the concerns raised at its open houses.

Agrium indicated that it had taken several steps to address the concerns of open house participants. It noted that it had investigated concerns that fluoride might be affecting livestock and had initiated a survey of fluoride content in local garden vegetables. In response to dust concerns, Agrium reported that it had substantially changed its phosphate rock handling practices.

Agrium argued that it had taken numerous steps to engage and involve the public in its proposed extension. However, it emphasized that it could not compel its neighbours to participate in this process. It noted that some of the interveners had been involved in the public consultation process and agreed that it was not able to address all of their concerns.

Agrium stated that it belongs to the Community Awareness and Emergency Response (CAER) Partnership of more than 40 industries and municipalities. It said that CAER had recently launched a new emergency response initiative called the UPDATEline. The UPDATEline is a single phone number providing community members with information about any non-routine activities at one of the area's industries. Further, Agrium noted that the system also had the capability of performing a call-out to the community in the event of an emergency.

Agrium noted in its submission that it had a fully developed, effective emergency response plan for the Redwater facility. It stated that it has emergency response equipment and trained staff that can respond to any emergency arising as a result of the construction of the proposed extension or relating to the everyday operations of the plant. It stated that it had a 24-hour reporting number neighbours can call with any concerns about the operation of the facility. Agrium noted that its emergency response plan would not require any major changes should the proposed extension be approved.

## 10.2 Views of the Interveners

### Sturgeon County Residents (SCR)

The SCR stated that it did not attend any of the open houses respecting the proposed extension. One of the residents acknowledged that she had been contacted by Agrium to discuss her concerns but stated that she preferred to address these concerns in a public forum.

With regard to emergency response, the SCR pointed out that one of their member's residences was not included in Agrium's Emergency Response Plan (ERP) materials and maps. These interveners also raised concerns about the distribution of ERP materials to local schools.

### Northeast Strathcona County Residents Group (NSCRG)

The NSCRG agreed that Agrium had attempted to include its members in its public consultation process. However, it said the design of the consultation process was flawed. None of its members participated in the CAP and had therefore had no input into how the public consultation process was implemented. The NSCRG also argued that the information provided by Agrium to the public prior to the filing of the application was not sufficiently comprehensive and, in some cases was incomplete or erroneous. The NSCRG also indicated that it would have benefited from access to Agrium's experts or early funding to allow the NSCRG to hire their own experts. The NSCRG stated that Agrium had not lived up to all the commitments made at the open houses. As an example, the NSCRG discussed the issue of pitting on glass due to fluoride exposure. The NSCRG stated that Agrium had not followed up on this issue to its satisfaction.

The NSCRG also expressed concern about Agrium's communication with its neighbours in response to odour, noise and flaring complaints. The NSCRG stated that Agrium had often failed to follow up on these issues, or had denied that they were related to Agrium's operations.

The NSCRG stated that Agrium had not asked any of its members about their current health status or whether they had had any health concerns. It further argued that Agrium did not conduct any tests to determine if local residents had suffered any health effects from emissions.

With respect to emergency response, some members of the NSCRG stated that it was peripherally aware of Agrium's emergency response plan and that its members had been provided a video explaining the plan. These interveners stated that they were aware of the emergency information phone number and the emergency call-out system, but noted that these systems were of no assistance to them when residents were outside.

The NSCRG also expressed dissatisfaction with regard to their interactions with Alberta Environment and Alberta Health and Wellness. It stated that it had taken numerous steps to make Alberta aware of their health concerns, and had requested localized health studies on several occasions. The NSCRG noted that no such studies were ever undertaken and that Alberta has never addressed these concerns.

## 11.0 VIEWS OF THE BOARD

### 11.1 Introduction

The Board has considered all of the written and oral evidence presented during this hearing process. The summary of the Board's findings and views is presented in the same order as Sections 2.0-10.0 of this report, following Sections 11.2 and 11.3, which deal with Corporate Commitments and Alberta's Participation in the Hearing.

### 11.2 Corporate Commitments

Agrium indicated that it has a corporate policy of "continuous improvement" that is also implemented specifically within their Redwater phosphate operation. Examples of "continuous improvement" with respect to this extension application included altering proposed construction hours to address neighbours' concerns, the purchase of additional land to accommodate changing the road design at the north end of the proposed extension and following up on the concern about fluoride concentrations in garden vegetables in addition to the potential impact of fluoride on livestock. In addition, Agrium noted that it has implemented improved control practices for reducing dust from the phosphate supply.

The Board heard many commitments expressed by Agrium during the course of this hearing which the Board incorporated into its deliberations on this decision. Agrium indicated that the proposed extension facility has been designed using "worldwide best practices" and that there would be "minimal impacts to the environment associated with this project". The Board has summarized Agrium's key commitments to minimizing environmental and social impacts associated with this facility in Appendix A of this report.

### 11.3 Alberta's Participation in the Hearing

Throughout the hearing, the role and contributions of Alberta's panels and counsel were much appreciated by the Board. The Board understands that Section 68(4) of *EPEA* directs the regulatory authority, Alberta Environment, to consider a written decision such as this one when considering an approval. The Board agrees with Alberta that the Board's role, if it decides that an Approval should be granted for a project, is to make recommendations on any terms or conditions that it considers appropriate should an *EPEA* approval be issued. Proceeding in this manner assures coordination between the NRCB approval and subsequent *EPEA* approvals.

The Board appreciates the specific information contained in Alberta's final arguments regarding potential conditions that Alberta Environment would consider in an Approval that might be issued to Agrium for an extension of the existing phosphogypsum facility and has incorporated comments on those potential conditions within the relevant portions of Section 11.

## 11.4 Construction

The Board noted Mr. Smulski's proposal that the existing stack and the proposed extension should remain separated in order, amongst other reasons, to ensure effective monitoring of the slurry wall and to provide access for any repair work to the slurry wall. From Agrium's evidence, the Board understands that Agrium is proposing to operate the storage of waste phosphogypsum as one entity. The Board believes that, given the complexities of the storage system, there is more merit to merging the two stacks together than having two separate stacks.

The Board finds that Agrium has completed a thorough design and engineering evaluation of the proposed stack and has proposed an effective design. The Board finds that, in order for this project to meet the public interest test, Agrium must be diligent in its construction protocol and materials selection to ensure that the facility is built to meet all of its design specifications. The Board finds that Mr. Smulski has raised some technical considerations such as the concern about the construction materials used in the current intercept system and urges Agrium to ensure that it uses best construction practices in all aspects of their operation.

The Board does not agree with Mr. Smulski's opinion that the proposed extension does not take into account effects such as groundwater flow or contamination. The Board believes that the proposed extension should improve environmental protection associated with the storage of waste phosphogypsum at this site.

The Board finds that the proposed setback from the highway meets regulatory requirements and does not believe that it should be increased. The Board is satisfied that Agrium has enough room to carry out any required remediation work within the current setback and does not believe that an additional intercept system would necessarily be the answer to any groundwater contamination problems.

Alberta indicated that it concurred with Agrium that the interceptor system along the northwest corner of the existing stack was not performing well. In light of that, Alberta stated that Alberta Environment was considering both a requirement for a better maintenance program for the interceptor system as well as a requirement for a detailed design from Agrium for the planned replacement of the northern portions of the west interceptor as potential conditions in any approval that it might grant Agrium. The Board concurs with both potential requirements as it believes that effective functioning of the groundwater interceptor system for the existing stack is critical to mitigating groundwater effects from this facility.

## 11.5 Noise

This is an area where the Board believes that there is an overlap with the recent zoning changes. The Board heard from Agrium that guidelines were being met, proactive steps were being taken and that the NRCB should leave this component of the application to the EUB under the Industrial Development Permit system. The Board heard from the NSCRG that noise has been one of their greatest concerns with the Agrium facility, despite the noise reduction measures implemented by Agrium.

The Board notes that Agrium's neighbours believe it could do more to resolve noise issues. As a result of the adoption of the Industrial Heartland Structure Plan this area will contain both large industrial developments and residences. The residences were there prior to the zoning changes and the Board finds that Agrium must take all reasonable measures to minimize the impact of its facility on the neighbours. The Board understands that granting this extension means that the plant life will be extended an additional 26 years, whereas denying the project would mean that phosphorus fertilizer production would likely only continue for another two to three years.

Given the strong concerns raised by the neighbours about noise from the facility, the Board is not convinced that Agrium has focused sufficient resources on this issue. It would appear that noise guidelines have been exceeded, that Agrium has not employed someone with appropriate noise training to evaluate complaints and that Agrium has not pursued evaluation of low frequency noise. Given Agrium's corporate commitment to continuous improvement, the Board is disappointed that Agrium has not actively addressed this key issue of the neighbours more proactively.

The Board is hopeful that if Agrium were to show a renewed commitment to addressing noise issues, residential neighbours would be prepared to meet with Agrium through initiatives such as SNAP to ensure that this issue is thoroughly dealt with.

## **11.6 Socio-Economics**

### **11.6.1 Economic Benefits**

The Board finds that there are economic benefits associated with Agrium's continued operation at the Redwater facility. It finds that the perceived magnitude of the economic benefits varied between the parties involved in this hearing. The Board also finds that if the extension were not granted, not all of the benefits of the plant would disappear, unless the plant were to be completely decommissioned.

### **11.6.2 Land Use Conflict**

Over the course of this review the Board obtained some understanding of what, in its view, can only be characterized as a growing land-use conflict. The adoption of Alberta's Industrial Heartland Area Structure Plan by the County of Strathcona promoted further intensive industrial development in the lands surrounding the Agrium proposal and placed restrictions on non-industrial development. The NSCRG identified the desire that a land purchase option be made available to those residents located in the lands that form part of the Industrial Heartland zoning area and that would be directly affected by the Agrium extension. Having regard for all of the submissions, the Board is satisfied that the effect of this rezoning and consequent location of intensive large industrial facilities in the area has resulted in effects on residential and agricultural landowners.

Many of the landowners have land interests that predate the industrial zoning. The Board accepts that the rapid industrial development that has taken place in the Industrial Heartland has

affected the marketability of these land interests. In particular the Board believes that the market demand for residential or agricultural land has been affected by the regional industrial activity. With limited evidence, the Board is not prepared to quantify this effect.

The situation may be further complicated by the potential for the price of land in this area to be supported or even elevated by the speculation on future demand for industrial development lands. While some landowners may wish to speculate on the future demand for industrial lands, many landowners view the current situation as limiting the liquidity of their investment. The Board is prepared to accept the suggestion that landowners wishing to sell their residential or agricultural land within the Industrial Heartland may have to wait for an industrial user to target their lands as a desirable industrial development site.

The Board does not believe that it is within its jurisdiction to direct that a land acquisition mechanism be established. Nor does the Board believe it fair that the responsibility for land acquisition should fall exclusively to an existing industrial user that seeks to extend the life of a long-standing operation. The Board's mandate requires it to assess the effects of the project and determine whether, having regard for those effects, the project is in the public interest. Considerable evidence was presented on the effects from growing industrial land use on local residents; indeed, the Board believes that if Agrium was siting a greenfield project of the magnitude of their development, such a project might not be in the public interest without first dealing with this significant regional social issue.

Having regard for all of the information that was presented during the course of the hearing, including the impressions left with the Board from the site visit conducted, the Board hopes that a mechanism will be developed for responding to this land-use issue. Both industry and the community have established that they have the ability to respond collaboratively to regional noise and airshed issues. The potential exists for these same parties to explore the resolution of land-use conflicts through an industry funded land bank. Such an approach could address liquidity issues related to the remaining non-industrial properties in the Industrial Heartland. While there are always issues associated with such initiatives, the Board believes that these would be manageable.

### 11.7 Air Quality and Human Health

The Board finds that radon gas from the NORM at the Agrium site accounts for roughly half of the radon exposure and roughly a quarter of total radiation exposure in the vicinity of the plant. The Board's finding differs markedly from Agrium's view that its operation had essentially no impact, because the Board believes Agrium misinterpreted radon data affected by the operation as background. The Board believes this matter can and should be resolved by gathering data designed to compare the regional ambient radon background with ambient levels potentially affected by the operation, taking care to avoid confounding these two groups of observations. The Board recommends that Alberta Environment require Agrium to undertake this work in the context of its environmental approvals.

The Board finds that Agrium's portion of the radiological exposure near its plant is well below the Health Canada guideline of 1 mSv/yr and that the total exposure from all sources



of radiation near the plant is less than the typical Canadian radiological exposure of 2 mS/yr. The Board is therefore confident that the low-level radioactivity of the phosphogypsum NORM poses a minimal risk to the public. The Board concurs with Agrium's assessment that the incremental radiological exposure from an approval to extend the phosphogypsum stack would be insignificant. The Board finds that an approval of the stack extension project would also entail a continuation of existing radiological impacts of the operation, which pose a minimal risk to the public.

The Board finds that Agrium's predictions of ambient fluoride concentrations and deposition rates were not transparently conservative, as the Board would expect of values to be employed in environmental and health risk assessments. This is not to say that the Board finds Agrium's estimates were not conservative. Rather, the Board cannot be sure that they are conservative due to uncertainties, omissions and other methodological problems with the modelling. The Board finds that any comparison of Agrium's predicted ambient fluoride concentrations with ambient guidelines is premature and potentially misleading until Agrium resolves the considerable uncertainty surrounding its estimates of fluoride flux from the phosphogypsum stacks (Section 5.2.3). The Board's lack of comfort with these estimates also means that it is not prepared to rely on the environmental and health risk assessments built upon them.

The Board finds it surprising that Agrium has only a rudimentary understanding of fluoride emissions from the phosphogypsum stack after so many years in operation. At a minimum, the Board believes that an understanding of the amount and chemical form of gaseous fluoride emissions in relation to temperature and moisture content of phosphogypsum substrate would be needed to develop reliable estimates. The Board therefore welcomes Agrium's commitment to seek a greater understanding of the relationship between the state of the surface – dry, moist or ponded – and fluoride emission rates and to apply that understanding in designing means to mitigate emissions from the phosphogypsum stack.

The Board recommends that Alberta Environment assume regulatory oversight of Agrium's efforts with a view to assessing the feasibility of regulating the phosphogypsum stack fluoride emissions. The Board understands that these emissions are not currently regulated at least in part because they are hard to quantify, which makes it difficult to establish a reasonable approval limit, and to assure compliance once a limit has been established. The Board believes this impediment to regulation must be overcome because this unregulated ground-level area source is larger and is expected to have a stronger effect on local fluoride concentrations (see Section 5.2.3) than the regulated process stack point sources.

The Board finds there is evidence that ambient hydrogen fluoride concentrations in the vicinity of the operation frequently exceed the Alberta one-hour ambient guideline, which is intended to protect vegetation. The Board therefore welcomes Agrium's commitment to improve its ambient and vegetation fluoride monitoring. The Board recommends that Alberta Environment oversee this effort both to ensure that the monitoring data can be used to document changes in the proportion of hourly measurements that exceed the ambient guideline and to provide the company with guidance as to what is ultimately acceptable.

The Board finds there is no evidence to suggest that ambient fluoride levels are currently high enough to pose a significant risk to human health. The Board can imagine no plausible way that expanding the phosphogypsum stack could increase ambient concentrations enough to exceed the chronic REL and thus become a concern for human health<sup>w</sup>. The Board therefore finds that ambient fluoride concentrations with the extension would not pose a threat to human health. The Board has more difficulty in reaching a definitive conclusion with respect to the ingestion-mediated fluoride exposure pathways because it cannot rely on the model and cannot compare the observed environmental concentrations to a standard such as the REL for ambient concentrations.

The Board believes that the odour complaints brought forward during the hearing are the principal result of the intermingling of residential areas within the Industrial Heartland. While this area is discussed in greater detail in Section 11.6.2 of this report, the Board believes that there is an onus on Agrium to ensure that the residential neighbours are fully aware of the potential odours that will result from the facility's operation and that there is a clear, well established procedure that is acceptable to both Agrium and the neighbours for dealing with any odour concerns. The Board agrees with Alberta that there is a need for a critical analysis of the existing protocol, but also believes that Alberta should consider an annual reporting requirement that documents each odour complaint and its resolution. The Board believes that Agrium should be required to commit to an annual appraisal of the protocol used for responding to odours and that this appraisal should be distributed annually to all complainants.

## 11.8 Water

### 11.8.1 Groundwater

Agrium described the existing hydrogeological regime and noted groundwater monitoring results that showed an impact from historical operations of the Redwater facility. Agrium also described mitigative measures completed and those being contemplated for improved protection of groundwater resources. The Board finds that many of the impacts described by Agrium and discussed by interveners were the result of historical operations that did not include the portion of the facility that was under consideration in the extension application.

During its deliberations, the Board satisfied itself that Agrium is committing an appropriate level and calibre of resources to continue to address groundwater mitigation measures for the entire facility, as well as to proceed with the ongoing hydrogeological monitoring and assessment activities. The Board also finds that Alberta Environment, as the regulator, has been diligent in assessing Agrium's actions in this area and believes that the remediation and proactive protection of groundwater resources at this facility is appropriate.

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<sup>w</sup> The weighted average one-hour concentration in the 2003 data is 3.08 µg/m<sup>3</sup>. Thus the extension would have to increase fluoride emissions by more than four fold to exceed the chronic REL of 14 µg/m<sup>3</sup>.

The Board finds that Agrium's appropriate design for the construction of the extension and its efforts to remedy problems with the interceptor system surrounding the existing phosphogypsum stack will improve groundwater protection and result in the long-term protection that the Board believes is necessary, given the indefinite persistence of the stacks. The Board also finds that Agrium has proposed a comprehensive groundwater monitoring program in the vicinity of the extension that includes background chemical characterization as well as future indicator monitoring programs. The Board believes that the public interest test (see Section 12) in terms of groundwater protection is met with the proposed extension application, given Agrium's commitment and Alberta Environment's regulatory role.

The Board offers the following comments on potential conditions contemplated by Alberta Environment. In addition to the regulatory oversight that was described through the submission of annual groundwater reports and follow-up discussions, Alberta stated that it would consider requiring a detailed groundwater monitoring plan, including water level measurements and water chemistry triggers. The Board believes that such a condition would strengthen Agrium's monitoring program, and also recommends that Alberta Environment establish dates for both submissions and responses in this condition. The Board also recommends that Alberta Environment review Agrium's proposed spacing of the extension monitoring wells because it believes the current proposal might not detect the offsite migration of contaminants if a plume appeared between the widely-spaced wells. The Board believes it might be necessary to reduce the well spacing or alternatively to require that the monitoring well data be supplemented with EM surveys to ensure any potential leakages are detected.

Alberta also indicated that a potential condition would require Agrium to implement a better maintenance plan for the interceptor system that would include increased inspection of the intercept gathering station on the south end of the west interceptor and a requirement for a detailed design of Agrium's planned replacement of north portions of the west interceptor.

The Board believes that effective and well documented operation of the interceptor system is a key component to the successful operation of this facility, with or without approval of the proposed extension. Evidence provided by parties indicated to the Board that the potential for groundwater mounding from the facility's operation exists. The Board believes that this would be an unacceptable future impact of this facility, particularly since it can be mitigated using the hydrogeological and engineering expertise that Agrium has retained. The Board strongly recommends that Alberta Environment regulate the installation, operation and documentation of repairs to the existing interceptor system to ensure it is properly constructed and will serve to prevent groundwater mounding and contamination outside the perimeter of Agrium's facility.

#### 11.8.2 Surface Water

The Board is very concerned about the potential impacts of Agrium's facility on the NSR, given its close proximity to the river. The Board finds that the extension proposal presented by Agrium has included mitigative measures such as surface drainage modifications that will prevent the migration of surface water from the gypsum stack to the NSR. The Board finds that the potential conditions contemplated by Alberta Environment will ensure that these measures are appropriately designed, constructed and operated.

The Board notes that the primary concerns presented by NSCRG include the broad issue of fertilizer impact on surface water bodies on a global basis and the potential for a breach from the gypsum stack resulting in loading of nitrogen and phosphorus compounds into the NSR. The Board agrees that the nutrient loading of surface water bodies is a global environmental challenge; however, it also agrees with NSCRG that the evidence presented indicates that Agrium's Redwater facility is a relatively small contributor to this issue. The Board also concurs with NSCRG that a potential breach of structure represents that greatest potential impact of the gypsum stack on the NSR. The Board finds that Agrium has used recognized expertise in the design of the stack. It did not hear evidence that the proposed stack will be structurally unstable, nor did its review or Alberta's reviews determine risk factors that would raise doubts regarding the integrity of the proposed design.

## 11.9 Vegetation

The Board finds that both the vegetation data collected by Agrium and the NSCRG identifies the need for further quantification and the fate of fluoride that is being emitted from Agrium's facility. The Board finds that the data indicates that fluoride is being taken up by vegetation in the surrounding area, but that neither the magnitude nor the impact of the uptake is well understood. Based on the evidence presented, the Board does not believe that the presence of fluoride in the concentrations measured represents an immediate environmental risk; however, the Board believes that Agrium needs to more fully investigate feasible reductions in fluoride emissions from the facility and understand the impact of the fluoride emissions on receptors. The Board concurs with Alberta that an appropriate *EPEA* approval condition would include the requirement to conduct further investigation of vegetation impacts. The Board recommends that the vegetation fluoride monitoring program make provision for the analysis of locally grown produce and forage. Additionally, the Board recommends that the further vegetation assessments be designed using recognized scientific protocols.

## 11.10 Animal Health

### 11.10.1 Wildlife

The Board heard two key issues about the potential effects of the proposed extension on wildlife. The first related to the loss of habitat associated with the extension, disturbance of the animals, habitat fragmentation and mortality during construction activity. The Board found that Agrium addressed these impacts by proposing mitigation that included enlargement of the constructed wetland in the southwest portion of the facility and enhancement of both the wetland and areas adjacent to the extension through selection of native cover, establishment of buffers and a number of operational measures to minimize the impacts of the facility on wildlife. The Board finds that Agrium has considered the impacts of the extension on wildlife and has addressed them on a proactive basis.

The Board heard concerns about the impact of fluoride emissions on wildlife, despite Agrium's inclusion of an ecological risk assessment, using white-tailed deer as the animal receptor, as part of the extension application. The NSCRG presented evidence that Agrium's risk assessment

conclusion that the extension project was unlikely to result in population effects on white-tailed deer was unsubstantiated. The NSCRG believed that population-level effects could not be ruled out, given the high fluoride concentrations in forage consumed by wildlife.

The Board finds that fluoride emissions and their impact from the phosphogypsum stack appear to be poorly quantified and understood. The Board further finds that this has led to data gaps with respect to potential impacts associated with fluoride emissions, including predicted and measured effects on wildlife. The Board agrees with the NSCRG's evidence that Agrium's wildlife risk assessment is incomplete and cannot, at this point, be substantiated. Therefore, the Board finds that the identified data gaps with respect to fluoride emissions from the stack and the impact of the emissions need to be filled.

The Board notes that Agrium has proposed to examine deer within a 2 km radius of the facility for dental fluorosis. The Board does not believe that such a study would yield conclusive results because a phosphogypsum stack has been at the site for over 30 years, emitting undefined amounts of fluoride. Therefore, it would be very difficult to tie any evidence of fluorosis in deer to the facility and the results would not describe effects that have occurred over the life of the facility. The Board believes that further assessment on impacts to wildlife should consist of a properly designed study including the use of a control group, analysis of forage being consumed and measurements of bone fluoride concentration.

#### 11.10.2 Livestock

The key concern that the Board heard with respect to livestock was the potential impact of fluoride emissions on the animals. Agrium presented the view that apart from examining deer for signs of fluorosis, there was no need for further investigations into animal health. Agrium did not present data on farm animal health and production as part of their application, but did respond to the NSCRG's hay sample results, both challenging the validity and providing their interpretation that all fluoride values were within the expected range and that these levels would not cause declines in animal performance. In addition to the hay samples, the NSCRG presented evidence including fluoride contents of animal bones, anecdotal health observations on farm animals in the vicinity of Agrium's facility and an assessment of cattle teeth which it believed showed evidence of fluorosis.

The Board finds that without a clear understanding of the composition and concentration of fluoride emissions from the gypsum stack and the associated facilities, Agrium is not in a position to fully understand the potential impact of the emissions on the health of livestock living in the vicinity of the facility. Based on the evidence received, the Board believes that the extension would not cause an immediate health risk to livestock in the area. However, the Board believes that this is an area that requires further scientifically defensible investigations.

#### 11.11 Reclamation

The Board strongly believes that reclamation planning associated with this facility has been inadequate to date. Based on the evidence presented during the hearing, the Board is not convinced that a market for the waste phosphogypsum is likely to be developed. Therefore, the

phosphogypsum stack will likely become a feature of the surrounding landscape and needs to be integrated into that landscape.

### 11.11.1 Technical Feasibility

Alberta indicated that provision of a reclamation research plan and schedule is being considered as a potential *EPEA* approval condition. It stated that this would include a requirement for reclamation planning information beyond the conceptual level. It also stated that a requirement for annual reporting on reclamation research is being considered.

The Board finds that there is a need for Agrium to become more proactive in its reclamation planning for the gypsum stack. Issues such as acidity in the waste need to be addressed in developing a plan. Additionally it is impossible, in the Board's opinion, to contemplate any reclamation plan without a statistically sound, complete characterization of the material that forms the stack. The Board urges Alberta Environment to develop comprehensive, enforceable conditions in a potential *EPEA* approval that would include a commitment from Agrium on the annual research dollars that it will spend in order to develop a firm reclamation plan.

The Board believes that a conceptual plan should be developed within a year or two, at the maximum. The Board believes that this conceptual plan should include a comprehensive characterization of the stack material, identification of the key factors that Agrium believes need to be investigated prior to finalizing a reclamation plan, and a timeline for the development and implementation of the reclamation plan.

The Board requires Agrium to seek third party review of its conceptual plan from at least one other phosphogypsum producer in North America that has successfully reclaimed a similar waste stack.

The Board believes that appropriate reclamation of the stack is imperative and was a key part of the public interest test when considering whether this extension should be approved. It was disappointed in the lack of scientific rigour that was brought to this portion of the application and believes that an extension can only be considered if a potential *EPEA* approval includes much more stringent and enforceable conditions surrounding the conceptual plan, the final plan and the research conducted by Agrium to reach the end goal of reclamation than was included in past facility approvals.

Alberta indicated that Agrium needs to be prepared to implement conservative reclamation strategies in the event that research does not yield a more optimized approach. It also indicated that it would be looking for a final reclamation cover that would perform several environmental functions, including a self-sustaining design. Alberta's interpretation of a conservative approach was the placement of 1 metre of cover soil material.

The Board agrees with Alberta that a self sustaining design is required. The Board finds that the definition of "self sustaining" needs to be put on paper and that it should include, amongst other things, consideration of the contour of the stack so that it fits in with the regional topography, assurance that drainage from the stack will be collected, tested and treated if required, criteria for

off-gases that may be released from the stack including a testing and reporting protocol to ensure that the criteria are being met, and a description of the stack vegetation management program. The Board finds that the term “self sustaining” also needs to include a time horizon to ensure that the stack will be environmentally sound in perpetuity. It is the Board’s belief that this also includes a financial commitment by Agrium, in perpetuity, to ensure that funds are available for the proper maintenance of the stack.

The Board finds that there is currently not sufficient knowledge to understand that a conservative reclamation technique would be limited to a 1 metre cover of soil. It could be that a conservative approach would involve a greater depth of cover and/or that the cover may need to be augmented during the lifetime of the stack. Conservative reclamation may involve other components besides cover, for example the installation of tile drainage within the stack, the addition of limestone to neutralize the acidity, and/or the incorporation of organic matter within the surface of the stack. The Board believes that Alberta Environment should not commit to an ultimate definition of conservative reclamation until Agrium has filed research information that defines conservatism, based on field trials and comprehensive evaluation of other similar reclaimed stacks in North America.

### 11.11.2 Economic Feasibility

Alberta discussed the potential use of Section 17(1) of *EPEA*’s Conservation and Reclamation Regulation which requires provision of reclamation security for certain types of activities. Agrium’s Redwater facility does not fall under the activities listed in Section 17. Alberta indicated that Section 17(2) empowers the Minister of the Environment to make an order designating other activities as requiring security, but added that this section has never been utilized.

The Board believes that this is a case that should be considered by the Minister of the Environment as requiring a reclamation security. The Board understands that it has no authority to require a security, but urges the Minister to consider it. The Board believes that this project is similar to oilsands and coal mines, in that the waste phosphogypsum stack is very likely to remain in its existing location in perpetuity. The Board believes that the similarity of this project with the oilsands and coal mines, which are captured under Section 17(1) of *EPEA*, is that the landscape has been permanently altered as a result of this project and that there will be a requirement for ongoing maintenance at the facility forever.

As the Board learned during Agrium’s corporate overview, this facility has been owned by a number of corporations over its lifetime, to date. In the interest of all Albertans, it is important for the government to know that those who have generated the revenue from this facility will also be the ones who will commit to the permanent upkeep of the stack.

The Board believes that in order for this project to be considered as the sustainable development of natural resources, there is a requirement to ensure that the long term costs of the stack maintenance are factored into the ongoing production of fertilizer and that a portion of the profits from the operation are set aside to cover reclamation costs. Requirement of a security deposit under Section 17(2) would be one way to accomplish this goal.

## 11.12 Public Consultation and Emergency Response

The Board finds that Agrium undertook a public consultation process that included a series of advertisements, distribution of a newsletter, open house meetings and a website dedicated to providing information on the proposed extension. The Board heard that the consultation program was developed with input solely through CAP, a group to which none of the NSCRG residents belong. The Board is disappointed that Agrium was not able to reach out specifically to the NSCRG, given their close proximity to the facility. The Board heard a level of frustration on the part of both Agrium and NSCRG that neither party was able to proactively listen to each other. The Board urges Agrium to take all reasonable steps to improve its communication with the surrounding residential neighbours. The Board also urges surrounding neighbours to engage in dialogue with Agrium to ensure that their feedback about the operation is understood.

The Board heard that Agrium has an emergency response plan and that it also participates in CAER which allows area industries and municipalities to have a streamlined notification of any non-routine industrial activities or emergencies. The Board applauds concerted actions like this, but also reminds Agrium of the need to ensure that their own contact information records are maintained. The Board heard that certain individual homes were not listed on Agrium's response list and that there was little knowledge of Agrium's video explaining their emergency response plan within the community. The Board finds that Agrium has worked diligently on their emergency response planning and needs to continue to update their contact records and their timely and efficient distribution of information.



## 12.0 BOARD DECISION

The Board has carefully evaluated the evidence with respect to the proposed extension of Agrium's phosphogypsum stack. It has weighed the evidence in terms of what it believes is the public interest of Albertans. It is the Board's belief that any project must meet three key considerations to be in the public interest. It must produce an economic benefit while ensuring environmental protection of our natural resources and balancing the individual's rights with the potential social impacts to others.

In the case of the proposed Agrium extension, the Board believes that there is an economic and societal need for this project. As the sole source of phosphate fertilizer production in Canada, pressures to produce more food supplies on less land require the ongoing input of soil enrichment products, like the phosphorus fertilizer manufactured at the Agrium facility. With the proposed extension, the infrastructure present at the Redwater facility will be able to manufacture phosphorus fertilizer for an additional 25 years.

The two parts of the public interest test that the Board struggled with in this application are environmental protection and the balance of rights between Agrium and its surrounding residential neighbours. In the case of environmental protection, the Board does not believe that Agrium fully understands the composition, concentration and transport mechanisms of fluoride emissions that are released from the current phosphogypsum stack. This lack of knowledge has impeded Agrium's ability to predict the potential impacts of fluoride emissions from the proposed extension of the stack as well as to assess the cumulative effects of the existing stack plus the proposed extension. The Board has referred to where this lack of knowledge has hindered the prediction of impacts in its technical analysis of the air quality and human health evidence (Section 5.2.3) and in the Views of the Board on those topics (Section 11.7).

The Board welcomes Agrium's commitment to improve its understanding of the phosphogypsum fluoride emissions and to explore mitigation strategies because the Board believes that emissions from this area source may have to be regulated in order to protect the surrounding environment.

The Board requires Agrium to undertake or commission studies to improve its understanding of the factors, including but not limited to moisture content and temperature, that determine the chemical composition and quantity of fluoride emissions from all parts of the existing phosphogypsum stack and to develop a statistically credible procedure to estimate fluoride emissions for the current and extended phosphogypsum stacks. This work shall be conducted to the satisfaction of Alberta Environment and shall be completed on a timeline determined by Alberta Environment to assist them with establishing long-term licensing requirements. The Board recommends that this work be completed by the end of 2005. The Board further directs Agrium to use the upper confidence limits of its emission estimates or another conservative assumption acceptable to Alberta Environment as input to its dispersion model and to conduct screening level health and environmental risk assessments based on the new input. This work shall be conducted to the satisfaction of Alberta Environment and on a timeline determined by Alberta Environment. The Board recommends that this work be completed by the end of 2006. If the revised assessments indicate that the predicted fluoride emissions pose a risk to the

environment or to human health, Agrium shall develop and implement a mitigation plan to the satisfaction of Alberta Environment.

Additionally, with respect to environmental protection, the Board strongly believes that reclamation planning for the gypsum stack has been inadequate to date. Consequently, the Board is not prepared to approve the extension without a condition that specifies the Board's requirements of Agrium with respect to reclamation.

The Board requires Agrium to submit a conceptual reclamation plan of the gypsum stack for review by Alberta Environment by December 9, 2005. The Board directs that this plan will contain, at a minimum, a statistically defensible comprehensive characterization of the phosphogypsum stack material and the identification of the key factors that Agrium believes need to be investigated prior to finalizing a reclamation plan. The conceptual plan should also contain a timeline to which Agrium commits, setting out delivery dates for the research that Agrium believes needs to be accomplished in order to reclaim the stack within five years of the final additions of waste product to the stack. The Board directs Agrium to have another phosphogypsum producer that has successfully reclaimed a similar stack in North America, review Agrium's conceptual plan, prior to submission to Alberta Environment, and to submit the written comments from that party to Alberta Environment.

With respect to the balance of the rights of Agrium to maintain its operation and the rights of the surrounding residential neighbours, the Board believes that the project is in the public interest, but recommends Agrium, in keeping with its policy of continuous improvement, take all reasonable steps to improve communications with its residential neighbours and to work with all parties to seek a solution to the growing land use conflict that is developing within the Industrial Heartland.

## **APPENDIX A**

### **AGRIUM'S KEY COMMITMENTS**

## Appendix A: Agrium's Key Commitments

The commitments made by Agrium during the hearing that the Board believes are key to minimizing environmental impacts associated with this facility include:

- Incorporation of noise issues from Agrium's facility into its facility's program of continuous improvement.
- Continued response to noise complaints, including taking readings and providing results to residents.
- Restriction of gypsum stack construction activities from 7:00 am to 7:00 pm.
- Evaluation of methods to mitigate fluoride emissions from the gypsum stack. The first step in this process would be to determine all sources of fluoride emissions.
- Completion of gypsum stack pond water analyses for fluoride as well as annual hydrogen fluoride measurements to verify and validate the model.
- Completion of a PM monitoring program with sampling for two months/year that will be incorporated into the Fort Air partnership.
- Completion of silicon tetrafluoride measurements off the pond surface during the summer of 2004 using FTIR.
- Expansion and re-design of the vegetation survey during the summer of 2004 to improve the robustness of the program and to add forages and grasses to the sample sets. In addition, vegetation samples will also be analyzed from the current plots.
- Retention of a phytotoxicologist to work with Agrium on the vegetation survey.
- Continuation of the river benthic invertebrate monitoring program in 2006 and every five years thereafter. Completion of the river sediment pore water sampling program in 2004 and 2006.
- Completion of a sampling program for eight nests of groundwater monitoring wells around the proposed gypsum stack for both water levels and chemistry. A two year baseline comprehensive monitoring program will be followed by an indicator parameters program.

**APPENDIX B:**

**FORM OF APPROVAL**

## Appendix B: Form of Approval

### THE PROVINCE OF ALBERTA NATURAL RESOURCES CONSERVATION BOARD ACT NATURAL RESOURCES CONSERVATION BOARD

**IN THE MATTER** of an extension of an existing phosphogypsum storage area at its Redwater, Alberta nutrient product plant located sixty (60) kilometres northeast of the City of Edmonton

#### APPROVAL NO. NR-2004-01

**WHEREAS** the extension of an existing phosphogypsum storage area at its Redwater, Alberta nutrient product plant by Agrium Products Inc. (hereinafter called “Agrium”) is a reviewable project under s.4(f) of the *Natural Resources Conservation Board Act* being chapter N-3 of the Statutes of Alberta, 2000; and

**WHEREAS** the Natural Resources Conservation Board is prepared to grant approval to the application by Agrium, subject to the conditions herein contained, and the Lieutenant Governor in Council has given authorization, hereto attached.

**THEREFORE**, the Natural Resources Conservation Board hereby orders as follows:

1. The project of Agrium, for construction of the northern extension to the phosphogypsum storage area as described in Application No. 0301, from Agrium to the Board, including any descriptive material supporting the Application marked as exhibits at the hearing of the Natural Resources Conservation Board held from February 23, 2004 to March 12, 2004 including undertakings of the Applicant, is approved, subject to the terms and conditions herein contained.
2. Agrium shall undertake or commission studies to improve its understanding of the factors, including but not limited to moisture content and temperature, that determine the chemical composition and quantity of fluoride emissions from all parts of the existing phosphogypsum stack and shall develop a statistically credible procedure to estimate fluoride emissions for the current and extended phosphogypsum stacks. This work shall be conducted to the satisfaction of Alberta Environment and shall be completed on a timeline determined by Alberta Environment to assist them with establishing long-term licensing requirements. Agrium shall use the upper confidence limits of its emission estimates or another conservative assumption acceptable to Alberta Environment as input to its dispersion model and shall conduct screening level health and environmental risk assessments based on the new input. This work shall be conducted to the satisfaction of Alberta Environment and on a timeline determined by

Alberta Environment. If the revised assessments indicate that the predicted fluoride emissions pose a risk to the environment or to human health, Agrium shall develop and implement a mitigation plan to the satisfaction of Alberta Environment.

3. Agrium shall submit a conceptual reclamation plan of the phosphogypsum stack for review by Alberta Environment by December 9, 2005. The conceptual plan shall contain, at a minimum, a statistically defensible comprehensive characterization of the phosphogypsum stack material, shall identify the key factors that Agrium believes need to be investigated prior to finalizing a reclamation plan, and shall contain a timeline to which Agrium commits, setting out delivery dates for the research that Agrium believes needs to be accomplished in order to reclaim the stack within five years of the final additions of waste product to the stack. Agrium shall have another phosphogypsum producer that has successfully reclaimed a similar stack in North America, review Agrium's conceptual plan, prior to submission to Alberta Environment, and shall submit the written comments from that party to Alberta Environment.

Made at the City of Edmonton, in the Province of Alberta, this        day of        , 2004.

**NATURAL RESOURCES CONSERVATION BOARD**

Original signed by:

**William Young Kennedy**  
**Panel Chair**

**Sheila Leggett**  
**Member**

**Robert Powell**  
**Acting Member**





**APPENDIX C:**

**HEARING PARTICIPANTS**

## **Appendix C: Hearing Participants**

### **Hearing Meeting Participants Fort Saskatchewan February 23 – 28, March 11-12, 2004**

#### **Agrium Products Inc. (Agrium)**

- Richard Neufeld (counsel)
- Bernard Roth (counsel)
- Dr. Douglas Chambers
- Steve Ferner
- Jennifer Kirkaldy
- Dr. Joao Kupper
- Michelle Mostrom
- Dr. Connie Nichol
- David Novitsky
- Dr. Robert Rogers
- Darcy Walberg
- Alex Watson
- Dr. Anwar Wissa

#### **Alberta Justice Representing Alberta Environment and Alberta Health and Wellness (Alberta)**

- Darin Stepaniuk (counsel)
- Michelle Williamson (counsel)
- Justin Balko
- Randall Barrett
- Casey Chan
- Margaret Klebek
- Alex Mackenzie
- Richard Nutbrown
- Jeff Sansom
- Kem Singh

#### **Capital Health**

- Craig Boyer (counsel)
- Nelson Fok
- Bill Hohn
- Ludmilla Szmetan

#### **Ken Smulski**

- Ken Smulski
- Michael Fields
- Dr. David Ho
- Paul Machibroda

### **Northeast Strathcona County Residents Group (NSCRG)**

- Jennifer Klimek (counsel)
- Dr. James Baker
- Alysha Bartlett
- Tia Bartlett
- James Farquharson
- Heather Garon
- Veronica Goodwin
- Cheryl Henkelman
- Percival Henkelman
- Dr. Lennart Krook
- Dr. Hardy Limeback
- Brent Marquardt
- Cindy Marquardt
- Erich Marquardt
- Eve Marquardt
- Dr. Marvin Resnikoff
- Ward Sawatzky
- Dr. David Schindler
- Sharon Ziegeman

### **Sturgeon County Residents (SCR)**

- Jason Unger (counsel)
- Anne Brown
- Diana Gorgichuk
- Claude Lafond

### **Natural Resources Conservation Board**

- J.P. Mousseau (counsel)
- Dr. Jeremy Beach
- Steven Bilawchuk
- Kim Eastlick
- Jim Fujikawa
- Wayne MacKenzie
- Laura Roberts
- Susan Schlemko
- Rachel Stein
- Richard Stein
- Michelle Waritsky