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Date: 15 August 2023
Our Ref: 30108102
Subject: Phosphogypsum – Road Pilot Study – Radiological Risk Review – Update

Dear Mr. Nadaskay,

Through recent discussions with Mosaic, we understand that the Florida Department of Transportation (FDOT) has requested that Mosaic expand the size of its Pilot Test Road (Pilot Road) related to the use of phosphogypsum (PG) in the road construction on Mosaic's New Wales facility near Mulberry Florida. We understand that FDOT requested increasing the length of the Pilot Road sections and additionally, creating a section of PG blended with recycled asphalt pavement.

Arcadis has reviewed the updated proposal for the Pilot Road and has prepared this letter to document a review of predicted radiological risks, related to the proposed modifications.

In preparing this overview of potential radiological risks associated with the development of the proposed Pilot Road, Arcadis has considered our previous risk review of the Pilot Road as originally proposed (Arcadis 18 March 2022) and previously completed risk assessments related to PG use in roads and how these previous risk assessments relate to the proposed project.

In the following sections, each of the potentially relevant exposure pathways is reviewed and considered in context of the previously completed calculations. Comments on each pathway are provided for closer review, as they relate to the petition for the Pilot Road.

SUMMARY STATEMENT

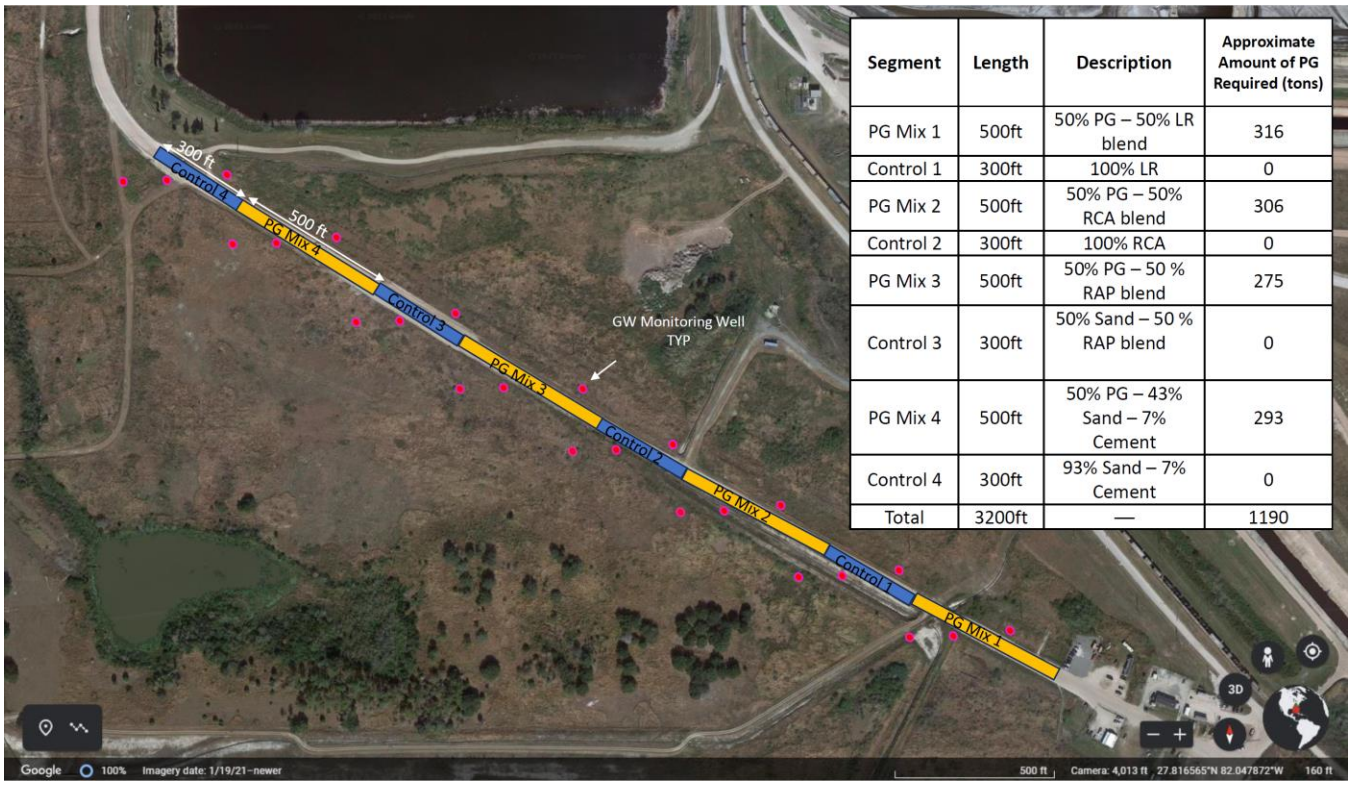
In summary, the anticipated doses and risks potentially arising from the Pilot Road project are predicted to be comparable to those predicted for the originally proposed Pilot Road and much smaller than those estimated from the previous PG risk assessments[1].

[1] EPA approved TFI's Petition to authorize the removal of PG for use in government road construction projects under certain conditions on October 20, 2020. See Notice of Approval of the Request for Other Use of Phosphogypsum by The Fertilizer Institute, 85 Fed. Reg. 66,550, 66,551 (Oct. 20, 2020). The approval was withdrawn, without prejudice, on July 7, 2021, for failure to provide specific information unrelated to the risk assessment. See Withdrawal of Approval for Use of Phosphogypsum in Road Construction, 86 Fed. Reg. 35,795 (Jul. 7, 2021).

Keith Nadaskay - Mosaic
15 August 2023

PROPOSED UPDATED ROAD DESIGN

After consideration of recommendations from the FDOT, Mosaic Fertilizer, LLC now plans to construct a 3,200-ft section of paved road at their New Wales Facility in Mulberry, Florida. This construction project will demonstrate further the beneficial use of PG as an ingredient in engineered road bases. Laboratory research conducted at the University of Florida over the past three years supports that PG, when appropriately blended with other aggregate or cementitious materials, can meet the performance standards required for engineered road base. Figure 1 illustrates the planned location of the Pilot Road.



Segment	Length	Description	Approximate Amount of PG Required (tons)
PG Mix 1	500ft	50% PG – 50% LR blend	316
Control 1	300ft	100% LR	0
PG Mix 2	500ft	50% PG – 50% RCA blend	306
Control 2	300ft	100% RCA	0
PG Mix 3	500ft	50% PG – 50 % RAP blend	275
Control 3	300ft	50% Sand – 50 % RAP blend	0
PG Mix 4	500ft	50% PG – 43% Sand – 7% Cement	293
Control 4	300ft	93% Sand – 7% Cement	0
Total	3200ft	—	1190

Figure 1. Aerial View of the Proposed Pilot Road (3,200 ft) with PG-aggregate Road Bases

The road will be constructed at the location of an existing road at the New Wales Facility but outside of the current PG stacking operations in an area of reclaimed mine land. The existing road materials will be removed during construction. Based on recommendations from FDOT, we understand that the lengths of the road test sections will increase to 500 feet and road control sections will be increased to 300 ft in length.

A contractor will construct four 500 ft test sections and a 300 ft control section for each, for a total of 3200 ft of Pilot Road length. PG will be incorporated into each of the four test sections. No PG will be used in the four control sections. The radioactivity (in particular, the Ra-226 content) of the local aggregates used in the Pilot Road will be measured. Road base containing PG will only be placed below an asphalt pavement layer and no PG will be used in the paving layer itself.

Roadway design is currently underway, but conceptually the road will be constructed following standard Florida Department of Transportation (FDOT) practices and include a 10-inch base layer and a 4-inch pavement layer.

Four types of road base mix designs will be tested. In Mix design 1, PG will be blended with limerock (LR) sourced from an FDOT approved aggregate supplier (for B01 aggregate). In Mix design 2, PG will be blended with recycled concrete aggregate (RCA) sourced from a FDOT approved aggregate supplier (for B12 aggregate). The sources of the LR and RCA aggregates will be aggregate suppliers in the Tampa, FL area. Samples of these materials have been obtained and are currently being tested as part of test mix design development. In Mix design 3, PG will be blended with recycled asphalt pavement (RAP). Mix design 4 will include PG (no more than 50%), sand, and Type I Portland cement.

The source of the PG will be a gypstack at the Mosaic New Wales facility (which was sampled as part of the TFI Petition.) The 2019 test data showed an average Radium-226 content of about 15 pCi/g. The PG to be used in the construction of the road will again be sampled for Radium-226 content. PG is anticipated to be incorporated into the mix designs in the range of 30% to 50% by mass.

IMPLEMENTATION OF THE PILOT ROAD TEST

Mosaic is working with the University of Florida to design the roadway, develop construction drawings, and monitor the performance of the Pilot Road. The mix designs are being developed based on previous testing, using the materials identified for this project, and following standard FDOT testing protocols. Prior to finalizing the design, test results will be discussed with FDOT, and the mix designs will be revised as necessary. Environmental testing and risk assessment includes measurements of total concentrations of PG constituents, leachable concentrations of PG constituents, fate-and-transport modeling, and an assessment of potential radiation doses to those potentially affected.

Once required approvals and permits have been obtained, Mosaic will hire a contractor to construct the Pilot Road. PG will be provided to the contractor in a staging area near the construction site.

As part of Pilot Road construction, groundwater monitoring wells will be installed. The monitoring well network is planned to locate groundwater well(s) upgradient and downgradient of the Pilot Road at suitable locations, in consideration of the updated Pilot Road design.

Environmental and worker monitoring proposed with the original Petition submission remains consistent:

- Baseline conditions will be established for the area of the Pilot Road considering:
  - Baseline water quality samples obtained from the groundwater monitoring wells will be analyzed for a suite of constituents, including radionuclides;
  - Soil samples will be collected from the area adjacent to the road (top 12 inches of soil) and analyzed for parameters typically associated with PG and stack operations including radionuclides; and,
  - Baseline gamma levels in the area of the test road.
- During construction monitoring includes:
  - Contractors will be equipped with personal gamma dosimeters (likely Optically Stimulated Luminescence (OSL)).
  - Passive radon detectors will be placed around the location of proposed Pilot Road, as well as three background stations away from the Mosaic site.
  - During mixing of PG, air monitoring including measurement of key radionuclides, will be performed proximate to the site of mixing/blending.

Based on our review, we conclude that the monitoring proposed for the original Pilot Road as outlined above remains appropriate.

RADIOLOGICAL EXPOSURE CALCULATIONS FOR PILOT ROAD

The 2019 risk assessment[2] performed in support of a TFI Petition for Re-use of PG as road construction considered use of PG as road base when mixed (at or less than 50%) with other materials such as soil, sand or aggregate.

As discussed in the 2019 risk assessment, a variety of potential exposure pathways were reviewed and those potentially resulting in a non-negligible dose were selected[3]. These included direct radiological exposure from the volumes of material with PG, and ingestion and inhalation of fugitive dust. Table 1 presents the receptors, exposure scenarios, and type of exposure.

Table 1. Exposures, Receptors and Complete Exposure Pathways

Exposure Scenario	Exposure	Exposure Pathway
Truck driver (PG to construction site)	Gamma radiation	Direct external exposure
Road Construction Worker	Gamma radiation & PG dust	Direct external exposure Inhalation /Incidental ingestion of dust
Utility worker	Gamma radiation & PG dust	Direct external exposure Inhalation /Incidental ingestion of dust
Road User (bicycle or auto)	Gamma radiation	Direct external exposure
Nearest Resident	Gamma radiation & PG dust	Direct external exposure Inhalation /Incidental ingestion of dust

As described in the 2019 risk assessment, all of the doses were found to be small and a small fraction of the dose from unavoidable natural background.

Our evaluation of the Pilot Road as currently proposed to accommodate the recommendations of the FDOT, as concluded for the originally proposed Pilot Road (see 18 March 2022 letter by Arcadis[4]), is of a size and scale that is a fraction of the road examined in detail in the 2019 TFI petition for PG use in roads. Consequently, any potential exposures dose and risk related to the use of PG in the Pilot Road would be substantially smaller than the exposures dose and risk estimated for the 2019 TFI petition.

CONCLUSIONS

This review considers the potential radiological doses arising from the proposed Pilot Road as updated based on the recommendations of the FDOT. Basd on our review, the proposed Pilot Road, is of a size and scale that is a fraction of the road examined in detail in the 2019 TFI petition for PG use in roads. Consequently any potential

[2] Arcadis 2019, *Radiological Risk Assessment in Support of Petition for Beneficial Use of Phosphogypsum*. Prepared for: The Fertilizer Institute. October.
[3] Various authors have reviewed the potential doses arising from the use of PG in road construction, among them, the EPA in their BID (EPA 1992). Exposure pathways other than those discussed in this report were shown by EPA to have doses and risks an order of magnitude or more below those discussed in this report.
[4] Arcadis 2022, *Phosphogypsum – Road Pilot Study – Radiological Risk Review*. Technical Letter to Mosaic. March 18.

exposures dose and risk related to the use of PG in the Pilot Road will be substantially smaller than the exposures dose and risk estimated for the 2019 TFI petition that EPA previously determined was acceptable.

The 2019 TFI petition showed that the total risk would be well below accepted risk criteria. Through this review and comparison, it can clearly be seen that the total risk associated with the use of PG in the Pilot Road can reasonably be expected to be well below the risk calculated for the 2019 TFI petition and by extension an even smaller fraction of the acceptable risk criterion.

Sincerely,

Arcadis Canada Inc.

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