



March 1, 2018

Mr. Bill Childress
Las Cruces District Manager
Bureau of Land Management
1800 Marquess Street
Las Cruces, New Mexico 88005

Re: American Magnesium Application for Plan of Operations Approval;
NMNM 136678; 3809 (L0310); American Magnesium's Response to
the Bureau of Land Management's Letter Dated December 8, 2017

Dear Mr. Childress:

American Magnesium is in receipt of your letter of December 8, 2017 requesting additional information from American Magnesium that would allow the Bureau of Land Management ("BLM") to consider American Magnesium's July 20, 2017 Amended Plan of Operations ("Plan") to be administratively complete under the BLM's surface management regulations, located at 43 C.F.R. Part 3809.401(b) and Part 3809.411(a). As set forth below, American Magnesium addresses each of the forty-one comments included in BLM's December 8, 2017 letter. In responding to certain comments, American Magnesium refers to new or revised materials that are enclosed with this letter. We look forward to discussing these responses, and any possible further clarifications or needed follow-up information, with your staff.

Responses to the BLM's December 8, 2017 comments are as follows:

1. **BLM Comment:** *Per 43 CFR 3809.401(b)(2)(i) maps must be at an appropriate scale showing drill sites, drill roads, access routes, support facilities, and structures, including temporary structures. Please enhance legibility of figures and display the items listed above. A map showing drill sites and roads was requested in the May 12, 2017 comment letter and was not included in the July 20, 2017 revised Plan.*

American Magnesium Response: Drill sites, drill roads, and access routes were provided in figures 2, 4, and 5 on pages 3-5 and 3-7 and 3-8 of the Plan, respectively. Figures 4 and 5 were 1:200 scale. We have enhanced the scale of figures 4 and 5 to improve

legibility and provide them as Enclosure 1 hereto. Planned temporary structures will be placed within the laydown area and will consist of mobile offices. The locations of the mobile offices within the laydown area as shown are preliminary sites and may be changed as the project progresses. No permanent structures are planned within the mining area. We address the expected manufacturing facility being planned for the Peru Industrial Park in response to BLM's comment 11 below.

2. **BLM Comment:** *Per 43 CFR 3809.401(b) (2) (ii) preliminary designs, cross sections, and operating plans for mining areas must be provided. Please provide a detailed plan for mining operations along with the appropriate cross sections.*

American Magnesium Response: Figure 5 at page 3-7, and enhanced at Enclosure 1, is the preliminary design showing the different phases of mining and drill locations. The design overlays topography. Figure 6 at page 3-8 shows a cross-section of the site. Section 2 is specific to the drilling equipment and drilling approach, and the operating plans therefor (see Sec. 2.5 at page 2-4) are descriptive.

3. **BLM Comment:** *Per 43 CFR 3809.401(b)(2)(iv) a rock characterization and handling plan must be included in your Plan. Please provide this information in your Plan.*

American Magnesium Response: American Magnesium is working on a Rock Characterization and Handling Plan and will submit that as soon as we are able to do so.

4. **BLM Comment:** *Per 43 CFR 3809.401(b)(2)(vi) spill contingency plans must be included in your Plan. On page 2-9 it states that a Spill Prevention Plan will be included as Appendix A which will be provided at a later date. This plan must be provided in order for your Plan to be complete.*

American Magnesium Response: A spill prevention plan that we propose be inserted with the Plan at Appendix A, page 7-1, is enclosed for the mining operations as Enclosure 2 hereto.

5. **BLM Comment:** *Per 43 CFR 3809.401(b)(2)(vii) a general schedule of operations from start to closure must be included in your Plan. Please update the Plan to include this information.*

American Magnesium Response: Section 2.16 on pg. 2-18 of the Plan is a "general schedule of operations from start to closure" that

sets forth the schedule in years. American Magnesium does not have specific or proposed dates for different phases, as those are unknowable at this time.

6. **BLM Comment:** *Per 43 CFR 3809.401(b)(2)(viii) a plan for all access routes must be included in your Plan. Please update your Plan to include a plan for maintaining access routes, figures that show where maintenance on access routes will take place, and where culverts will be installed.*

American Magnesium Response: Section 2.8 in the Plan describes all access routes, and those are shown in Figures 2 and 4 (including in the enhanced version of Figure 4 that is part of Enclosure 1 hereto). Section 2.8 (pages. 2-5 and 2-6) includes a plan for expanding and maintaining the access routes and roadways and discusses drainages and culverts. Once the access routes are confirmed, additional detail and survey information can be provided. American Magnesium is working on developing a complete plan of access, which would include a potential access route that would border the WSA. If American Magnesium chooses to include that route as a potential access route, any modification to the road would occur from a berm, outward from the WSA. See also the response to BLM Comment 15 below.

7. **BLM Comment:** *Per 43 CFR 3809.401(b)(3) a reclamation plan that meets the standards of 43 CFR 3809.420 must be included in your Plan. In a response to New Mexico Mining and Minerals Division (MMD) comment 2, it is stated that a reclamation plan will be provided at a later date. The BLM has not received this plan and must have a complete reclamation plan before your Plan will be considered complete.*

American Magnesium Response: A detailed reclamation plan can be found in Section 3.0 at page 3-1 of the Plan. Although American Magnesium likely will further delineate its reclamation plans as the Project is undertaken, we note that the Mining and Minerals Division, which you reference in your comment, has deemed American Magnesium's application for a minimal impact mining operations based largely on the Plan document to be deemed administratively complete. We respectfully submit that the Plan sufficiently states reclamation plans for BLM to be able to consider the Plan to be administratively complete as well. American Magnesium will supplement the Reclamation Plan as needed and will submit any revisions to the BLM.

8. **BLM Comment:** *Per 43 CFR 3809.4l(b)(3)(i) a drill-hole plugging plan must be provided. This information was requested in the May 12, 2017 comment letter and not provided in the July 20, 2017 revised Plan. Please include this information.*

American Magnesium Response: A drill hole plugging plan is not included in this submittal. As discussed during the meeting on February 7, 2017, drill cuttings will be used to temporarily plug the drill holes, which are planned to be used as blast holes at a later time in the project. Should an interruption in the project occur, or the plans change during implementation and the boreholes are no longer planned to be used as blast holes, the boreholes will be plugged and abandon In the unlikely event the boreholes are not used in the mining operations, they will be plugged with cement bentonite grout in accordance with New Mexico Office of the State Engineer requirements and a plugging plan of operations will be prepared and submitted in advance of plugging operations. .

9. **BLM Comment:** *BLM comment 2 response states that there will be both exploration activities and mining activities conducted under the Plan. However, there are no details outlining how the mining activities will occur. Please revise the Plan with additional detail on the mining activities.*

American Magnesium Response: The mining activities will essentially consist of traditional quarrying operations involving the blasting and methodical removal of the existing foothill comprising the dolomite deposit from the top of the deposit to approximately the contour of the valley floor. We respectfully submit that the Plan describes the quarrying operations to remove the dolomite ore in several parts of the Plan. In addition, revised and updated Figure 5 depicts the areas of phased mining that will occur (Enclosure 1).

10. **BLM Comment:** *BLM comment 5 response states that no drill pads will be constructed but then states that a 10-foot by 10-foot working footprint will be required. This sounds like a drill pad and listed in Table 1 is surface disturbance associated with drill pads. Please revise the Plan to correct these contradicting statements.*

American Magnesium Response: Due to the type of equipment used for drilling operations, drill pads per se will not be constructed. Nonetheless, since there will be some minimal surface disturbance from drilling operations, American Magnesium has treated the areas to be utilized during drilling, including the 10 x 10 areas where tarps will be placed during drilling, as disturbances in Table 1. Revised

Figure 5 (Enclosure 1) provides a depiction of the type of rig planned for use during project implementation.

11. **BLM Comment:** *BLM comment 6 response states the Peru Industrial Site might be the location for ore processing. Before the BLM can issue a decision on the Plan, a definitive location must be determined in order for the BLM to complete a National Environmental Policy Act analysis on the Plan.*

American Magnesium Response: American Magnesium, itself or through an affiliate, expects to construct a processing facility within the City of Deming's Peru Industrial Park to produce magnesium and magnesium products from the magnesium-rich dolomite ore that will be mined and transported from the quarry operations that are the primary subject of its plan of operations application. This is preferred over the alternative of shipping the ore to some other out-of-state or out-of-country magnesium facility for processing, and will create local jobs and economic development within an already established industrial park that is appropriately zoned and already supplied with useable infrastructure and space needs to accommodate the type of facility that is contemplated for processing the dolomite ore. Enclosure 1 contains a revised figure (Figure 2) showing the specific location of contemplated location of the facility that would be hereafter designed and built within the Peru Industrial Park. American Magnesium provides this information to be responsive to BLM's inquiry, but hereby reserves the right to assert any position it may have on the question of whether the processing facility is a "connected action" for purposes of NEPA or results in an impact significantly affecting the environment once BLM satisfies itself that American Magnesium's plan of operations application is administratively complete. Enclosure 1 contains the revised figure that depicts the Peru Industrial Park and the proposed area to be used for a processing facility.

12. **BLM Comment:** *BLM comment 7 response states that a Conceptual Feasibility of Magnesium Metal Complex near Deming, New Mexico report would be provided to give BLM details on how the ore will be processed. This report has not been provided to the BLM. The BLM cannot determine if your Plan will cause unnecessary and undue degradation to public land without information about how the ore will be processed.*

American Magnesium Response: The contemplated manufacturing process is detailed in the Conceptual Feasibility Study, which we include with this response as Enclosure 3. This document is a scoping study and the information provided in the

report is confidential. American Magnesium is requesting that the attached TRU Group report dated April 25, 2013 remain confidential.

13. **BLM Comment:** *BLM comment 8 response revised the Plan to include the proposed equipment but did not include equipment sizes as requested in the May 12, 2017 comment letter, nor were the locations of any equipment staging areas.*

American Magnesium Response: Locations of the equipment staging areas is to be the laydown area, as we attempted to suggest in Section 2.7 at page 2-5: "A laydown area for mining equipment will be developed within the footprint of the mining operations. The laydown and equipment staging area will be included within American Magnesium's disturbance calculations." The laydown area is shown in Figure 6, Enclosure 1. The exact equipment sizes and models are not known at this time, and proposed equipment may change. The table below is an early estimate of potential equipment.

Equipment Type (potential)
Air tool, quarry drill, track mounted, 6" diam
Motor grader, self-propelled, 40,000 lb
Smooth drum vibratory roller, 125 H.P.
Water truck, off highway, 10,000 gallon capacity
Dozer, crawler, torque converter, diesel 700 HP
Excavator diesel hydraulic crawler mounted 3.5 CY capacity
Excavator diesel hydraulic crawler mounted 4.5 CY capacity
Excavator diesel hydraulic crawler mounted 6 CY capacity
Excavator attachment, hydraulic hammer, 12,000 ft lbs
Excavator attachment, grapple
Front end loader, 4WD, art. frame, diesel, 4.00 - 4.50 CY 270 HP
Forklift, for rough terrain, 42' lift, 35' reach, 9000 lb., 110 H.P.

14. **BLM Comment:** *BLM comment 9 response states that quarrying is proposed in the Plan. The May 12, 2017 comment letter requested a reclamation plan, locations of ore stockpiles, and overburden stockpiles. Please revise the Plan to include this information.*

American Magnesium Response: Ore is not planned to be stockpiled, rather excavated and loaded for off-site processing. As discussed in response to comment 24 below, the only temporary storage that would occur would be if there was a delay in trucking. Overburden, if generated, will be stockpiled for future reclamation use in the laydown area. Any temporary storage of ore would be located immediately adjacent to the active excavation area, and any overburden set aside for reclamation would be stockpiled within the

laydown area. See our response to comment 7 above, which addresses the reclamation plan.

15. **BLM Comment:** *BLM comment 10 response did not revise the Plan to identify modification or maintenance of the road that is the boundary to the Florida Mountains Wilderness Study Area as requested in the May 12, 2017 comment letter. Please revise the Plan to include text and figures to explain, in detail, how this road will be maintained and modified.*

American Magnesium Response: There is a plan for road maintenance and construction in Section 2.6 at pages 2-5 to 2-7, although no specific mention of the road to Florida Mountain Wilderness. This road is proposed as alternate use and may not be used in the mining operations. Nonetheless, Enclosure 1 illustrates the boundary road.

16. **BLM Comment:** *BLM comment 11a response states that following drilling, all holes will be filled with rock chip cuttings until blasted. This is not an appropriate method of plugging drill holes. If the holes remain open and not plugged properly, each hole will be required to be covered under the financial guarantee.*

American Magnesium Response: American Magnesium questions the utility of formally plugging drill holes that it intends to repurpose during the quarrying phase of operations. Section 2.4 at page 2-2 states that the proposed verification drill holes shown in Figure 5 will be used as blast holes during active mining. Since groundwater is not planned to be encountered, there is no environmental impact to fill the holes with native material pending blasting. Grouting holes that will be re-entered is not cost efficient. In addition, the holes will be used as blasting sites and native fill would be temporary to prevent health and safety hazards. American Magnesium will plug the holes in accordance with the requirements of the Office of the State Engineer, who will necessarily need to issue permits to drill these exploratory drill holes.

17. **BLM Comment:** *MMD comment 6 response states that no waste rock material will be generated. The BLM does not believe this statement to be true, as there are no known mining operations that do not generate waste rock.*

American Magnesium Response: There is no discussion of generated waste rock in the Plan at this time because American Magnesium anticipates full utilization of the quarried dolomite deposit, and that any waste rock would be de minimus. All

indications are that the foothill in questions is a relatively uniformly magnesium-rich dolomite. As described in response to Comment 20, below, all dolomite will be processed for magnesium and cement, waste rock materials are not foreseen at this time. If any waste rock material is generated, it will likely be de minimus. The operation proposed is basically quarrying and the rock material will be blasted and hauled from the site. Quarrying operations typically do not generate a waste rock material, and this operation is not expected generate waste rock. As mentioned in our response to comment 3 above, we are working on a Rock Characterization and Handling Plan, which will be provided to BLM.

18. **BLM Comment:** *Table 1 does not show disturbance for the laydown yard that is mentioned on page 2-5 in section 2.7. Please revise the table to reflect this disturbance.*

American Magnesium Response: BLM is correct that Table 1 (pg. ii) does not specifically call out laydown disturbance, but the Plan does state in Section 2.7 at page 2-5 that "The laydown and equipment staging area will be included within American Magnesium's disturbance calculations," and that, in fact, has been done. To better reflect and delineate components of disturbance, including the combined laydown yard/equipment staging area, we include a revised Table 1 as Enclosure 6.

19. **BLM Comment:** *Table 1 does not show any disturbance related to the quarrying operation. Please revise this table to reflect the quarrying operation disturbance.*

American Magnesium Response: The revised Table 1 included as Enclosure 6 shows the expected disturbance related to quarrying at this time. Please note that it substantially overlaps areas of disturbance from drilling, and it would not be American Magnesium's intent for BLM to count the same areas of disturbance twice in determining appropriate financial assurance for the New Mexico Mining and Minerals Division and BLM, which also needs to take into account the kind of rolling reclamation that is permissible under the New Mexico Mining Act and the Mining Act Reclamation Program regulations adopted by the New Mexico Mining Commission under the 1993 Act. This can be another point of discussion in our upcoming meeting.

20. **BLM Comment:** *Page 2-1 states that the target deposit is dolomite, but the project is to mine magnesium. What ore type are you mining?*

American Magnesium Response: The site is a dolomite deposit. The quarrying operation described in the plan would be for the mining of dolomite. The dolomite contains magnesium, but magnesium per se would not be mined in the quarrying operation. Instead, magnesium would be separated out of the dolomite ore, leaving materials that would serve as appropriate ingredients for making cement, at the contemplated manufacturing facility to be sited at the Peru Industrial Park. We apologize if any parts of the Plan were worded in ways that confused BLM, and we hope this clarification improves your understanding of the Project.

21. **BLM Comment:** *Page 2-3 states that there will be overburden/topsoil and the amount will be determined through resource verification. The amount of overburden/topsoil and the location of an overburden/topsoil stockpile must be provided before a plan with quarrying/mining is considered complete.*

American Magnesium Response: BLM is correct that the amount and exact location of overburden/topsoil is not included in the Plan or figures at this time, as the exact amount is unknown and anticipated to be minimal. We do not interpret 43 CFR 3809.401(B)(3)(vi) as a requirement to precisely identify the amount or location of topsoil. That said, American Magnesium estimates that there is no measurable amount of overburden, but if it is encountered American Magnesium will measure it and let BLM know the amount.

22. **BLM Comment:** *Page 2-3 states that mining will occur from the top down and states that it will be similar to quarrying. More detail is needed to determine if mining operations will prevent unnecessary and undue degradation of public land. Please revise the Plan with greater detail on the mining operations.*

American Magnesium Response: The Plan provides a top down approach that incorporates blasting and excavation techniques that qualify under the New Mexico Mining and Minerals Divisions program as minimal impact mining. The drilling and blasting plan provided contains the available information on sequencing and blasting of the deposit. American Magnesium will evaluate operating hours and will attempt to not blast during evening and early morning hours. At this point in time, blasting schedules have not been fully developed and American Magnesium is willing to discuss blasting times and frequency as part of ongoing discussions. Revised Figure 5, Enclosure 1 depicts the overall phases of mining that will occur.

23. **BLM Comment:** *Page 2-4 states that primary crushing may be needed. What is the size and type of the crusher? Where will*

crushing occur onsite? Please revise the Plan to include this information and include a figure showing the location.

American Magnesium Response: Although the Plan mentions that primary crushing on-site may be an option that American Magnesium decides to employ in the future, because of the blasting operation necessary to quarry the dolomite deposit, it is not likely that it will ever be required. We therefore request that BLM disregard the Plan's discussion of that contingency in evaluating the plan. If primary crushing on-site is pursued in the future, American Magnesium will invoke appropriate permitting modifications or amendments at that time, and most likely only a mobile unit would be utilized.

24. **BLM Comment:** *Page 2-4 states that quarried materials may be temporarily stored onsite. Where will they be stored and how much material would be stored onsite?*

American Magnesium Response: The only temporary storage that would occur would be if there was a delay in trucking. Blasted material would be stored, temporarily right at the active excavation area and would not be transported within the site boundary pending off-site transport. The term temporary was used to indicate that it might be required to generate a stockpile immediately adjacent to where the quarrying is occurring while waiting for the trucks to arrive to the blast location for transport. The maximum amount of ore that would need to be stored at any one time in this fashion while awaiting the arrival of a truck is estimated to be 15 cubic yards of material.

25. **BLM Comment:** *Page 2-5, section 2.7 mentions a laydown yard. What are the dimensions of the laydown yard? Where will this yard be located within the project area? Please revise the text and include a figure showing the layout of the laydown yard and location of the yard.*

American Magnesium Response: The location and dimension of the laydown area is included in figure 5, which we have enhanced for legibility purposes and included as part of Enclosure 1.

26. **BLM Comment:** *Page 2-5 states there will be an office trailer and portable sanitation facilities but on page 2-7 it states that there will be no facilities onsite, then states that there may be a logging/core trailer, a 5,000-gallon water tank, two temporary storage facilities for explosives, a storage silo, and a job trailer for employees. Please revise the Plan to eliminate contradictory statements.*

American Magnesium Response: Where American Magnesium stated in the Plan that there would be no onsite facilities, it was intending to mean that there would be no structures that would be permanent as opposed to temporary or mobile types of units. We have identified where any such temporary, mobile facilities would be located, if they are used in the operations, in Enclosure 1, revised figures.

27. **BLM Comment:** *Page 2-6 states that overland travel will be required to access drill sites. How much overland travel? Also, due to the topography of the site and outcropping of bedrock, road construction would be expected to access drill sites. Please display all drill sites on a map.*

American Magnesium Response: All planned drill sites and the planned access or overland travel routes are identified on the enhanced figures provided as part of Enclosure 1. Overland travel is listed in table 1 of the Plan in terms of acres, and a proposed route is given in terms of miles (top of page 2-6) on page 2-6 (bottom of paragraph 2). The Plan states: "A modest amount of overland travel is planned to access certain drill pad locations and to conduct blasting operations. Overland travel will be limited and will only be conducted when needed, and areas affected thereby will be counted as part of the disturbance footprint."

28. **BLM Comment:** *Page 2-6 states that if blasting is necessary, a blasting plan would be provided to MMD. This plan must be provided to the BLM. Also, it is expected that blasting would occur during mining operations. This plan will need to be provided before the Plan would be considered complete.*

American Magnesium Response: Section 2.5 on page 2-4 states: "AmMg plans to conduct blasting, under an approved blasting plan. This plan will be submitted independently by a licensed and permitted blasting contractor." We would like to discuss the timing requirements for submission of the blasting plan with BLM at the upcoming meeting, after which time we will arrange for submission of the Plan.

29. **BLM Comment:** *Page 2-7 states that there will be fencing onsite. Please show on a map the location of fencing.*

American Magnesium Response: Only the boundary of the laydown area is planned to be fenced. Fencing would be around the perimeter of the proposed 22,600 square foot area depicted as the solid black line on revised Proposed Laydown Figure in Enclosure 1.

30. **BLM Comment:** *Page 2-8 states that the New Mexico Environmental Department would be notified of any spills. The BLM must also be notified of any spills as the project is on public land.*

American Magnesium Response: The Plan will be revised to also include BLM.

31. **BLM Comment:** *Page 2-9 states that water will be brought to the project area via a 5,000-gallon water tank. Where is this water coming from?*

American Magnesium Response: American Magnesium will purchase water from the City of Deming from a municipal source. No wells will be drilled. Negotiations for purchase of commercial water are ongoing.

32. **BLM Comment:** *Sections 2. 15, 2.15. 1, 2.15.2, 2. 15.3, Table 3, 2.15.5, Table 4, 2.15.8, 2.15.8.1, Table 5, Table 6, Table 7, 2.15.8.2, and paragraphs 1-3 of 2. 15.4, are not considered environmental protection measures and these sections are not germane to the Plan. Please remove this information.*

American Magnesium Response: We are not aware of a requirement that a Plan of Operations contain information limited to environmental protection measures. However the requested sections will be removed from the Plan.

33. **BLM Comment:** *Figure 3 is not clear on what it is trying to depict. What is the project boundary?*

American Magnesium Response: The project area is limited to the claim boundaries, as depicted in the revised Proposed Road Alignment Figure in Enclosure 1.

34. **BLM Comment:** *Figure 4 is not clear on what it is trying to depict. Is the proposed alternate route on the map the main access route into the claim block? This is not an existing route, how do you proposed to construct this route and how do you propose to cross the arroyo?*

American Magnesium Response: A revised Figure is enclosed herewith as Enclosure 1. The proposed alternate route is still under consideration. Any arroyo crossing required will be fully evaluated and any subsequent crossing would be properly engineered in accordance with applicable anticipated load. Arroyo flow would not be impacted and if determined necessary, the required permits would be obtain prior to construction.

35. **BLM Comment:** *Figure 5 is not clear on what it is trying to depict. There is no legend on this map. Are the white dots drill sites? How are you accessing the drill sites?*

American Magnesium Response: The map is the drilling locations. The white dots indicate the number of drilling localities in phase 1 and 2. Section 2.4 pg. 2-2 discusses how the drill sites will be accessed. It more so describes how resource verification will be performed with indication that the mobile drilling rig will move from drill site to drill site. A revised Figure 5 is enclosed herewith as Enclosure 1.

36. **BLM Comment:** *Figure 6 is not clear on what it is trying to depict. What is the purpose of this figure?*

American Magnesium Response: Figure 6 on pg. 3-9 is a 1:300 scale map showing surface topography. The map shows a cross sectional profile of the proposed site.

37. **BLM Comment:** *Page 4- I states that there will be diversions, including existing diversions to divert water away from the disturbed areas. How will these diversions be constructed? Where are these diversions located? How will these diversion structures be maintained?*

American Magnesium Response: Section 2.8 pg 2-6 states "Culverts may be required in various areas along the proposed access road. These areas will be reviewed with BLM, and culverts will be installed as required by BLM." All future crossing and culverts will be designed to meet or exceed project traffic and truck loads. A road maintenance plan will be developed when all routes are confirmed.

38. **BLM Comment:** *Page 4-1 states that Best Management Practices (BMP) will be used to limit erosion. Please list the BMPs.*

American Magnesium Response: Pg. 4-1 states "the use of BMPs including regrading, seeding and mulching, silt fences, straw bale dams, diversion ditches with energy dissipaters, and rock check dams at appropriate locations during construction and operation."

39. **BLM Comment:** *Page 5-2, section 5.2.3 states that there will be no provisions for removal of equipment, supplies, and structures but this contradicts several statements earlier in the Plan that equipment,*

supplies, and structures will be onsite. What will these provisions be?

American Magnesium Response: Section 2.7 pg 2-5 states "No construction of permanent structures for mining operations or ancillary facilities will be required" Section 2.9 and 2.9.1 on page 2-7 discusses temporary structures and their use at the site "Intermodal containers may be used to store project equipment and supplies at the site." Section 5.2.3 does state "Not applicable" for provisions for removing the temporary structures.

40. **BLM Comment:** *Page 5-2, section 5.2.4 states that sumps will be fenced until dried then backfilled. Other than page 5-2, section 5.2.4, there is no mention of sumps. If sumps will be created and used, please revise the Plan in the appropriate sections to include sump information.*

American Magnesium Response: Page 5-4 section 5.2.4 does state that "sumps will be fenced until dried then backfilled" This reference will be removed, as no sumps are planned.

41. **BLM Comment:** *Section 5.0 Interim Management Plan only states what the Plan will be during the exploration/resource verification stage of the Plan. Revise the Plan to include an interim management plan for the mining/quarrying operations.*

American Magnesium Response: The Plan will be revised to reflect mining operations.

American Magnesium looks forward to continuing to work with BLM on this project. Please email Mr. David Tognoni, PE, managing member of American Magnesium, at dgtognoni@gmail.com if you request additional information related to this submittal.

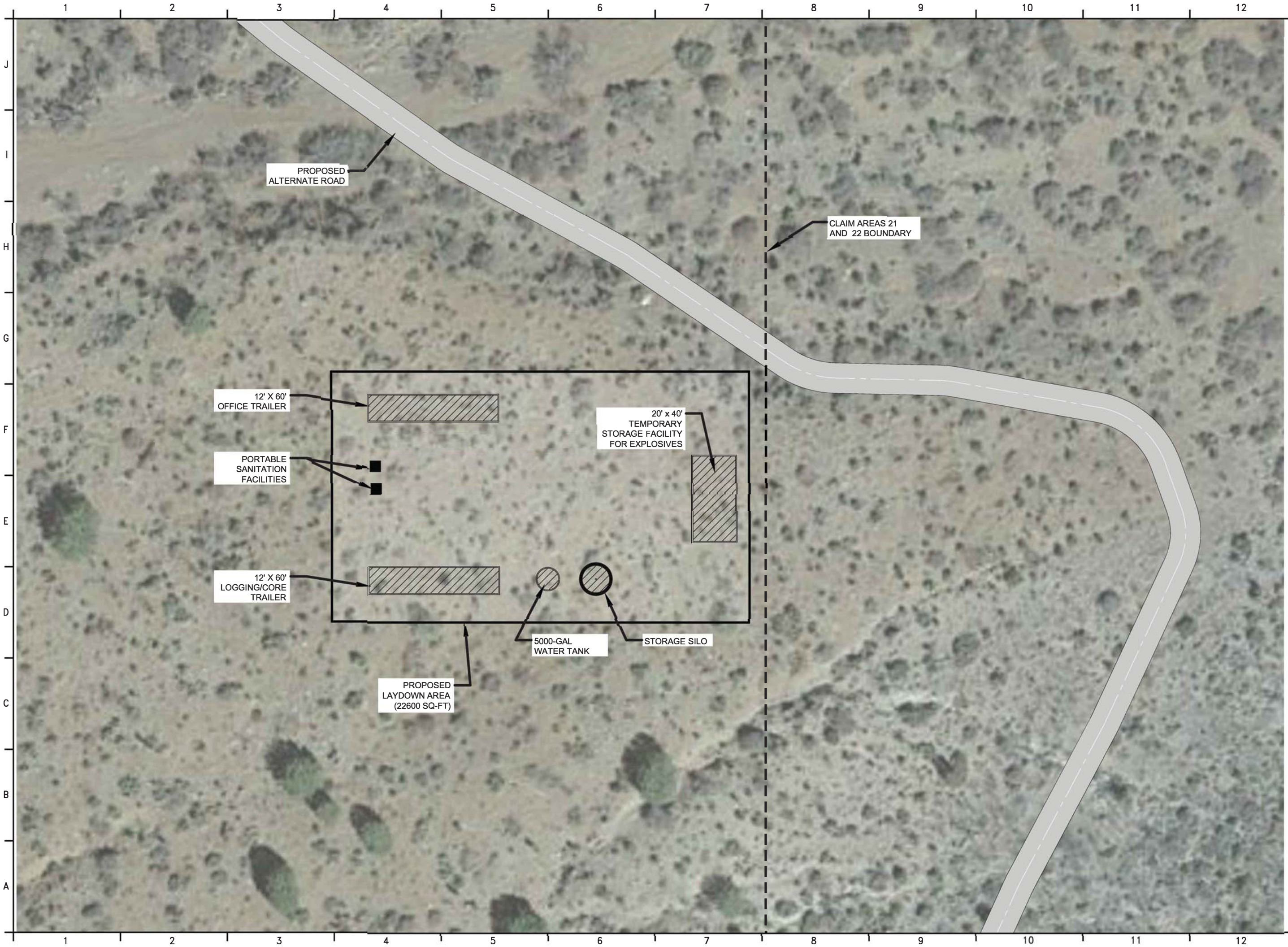
American Magnesium

Kind Regards,

A handwritten signature in black ink, appearing to be 'D. Tognoni', written over a horizontal line.

David Tognoni, PE
Managing Member

Enclosure 1
Revised Figures



PROPOSED
ALTERNATE ROAD

CLAIM AREAS 21
AND 22 BOUNDARY

12' X 60'
OFFICE TRAILER

PORTABLE
SANITATION
FACILITIES

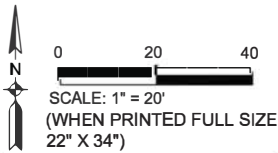
12' X 60'
LOGGING/CORE
TRAILER

20' x 40'
TEMPORARY
STORAGE FACILITY
FOR EXPLOSIVES

5000-GAL
WATER TANK

STORAGE SILO

PROPOSED
LAYDOWN AREA
(22600 SQ-FT)



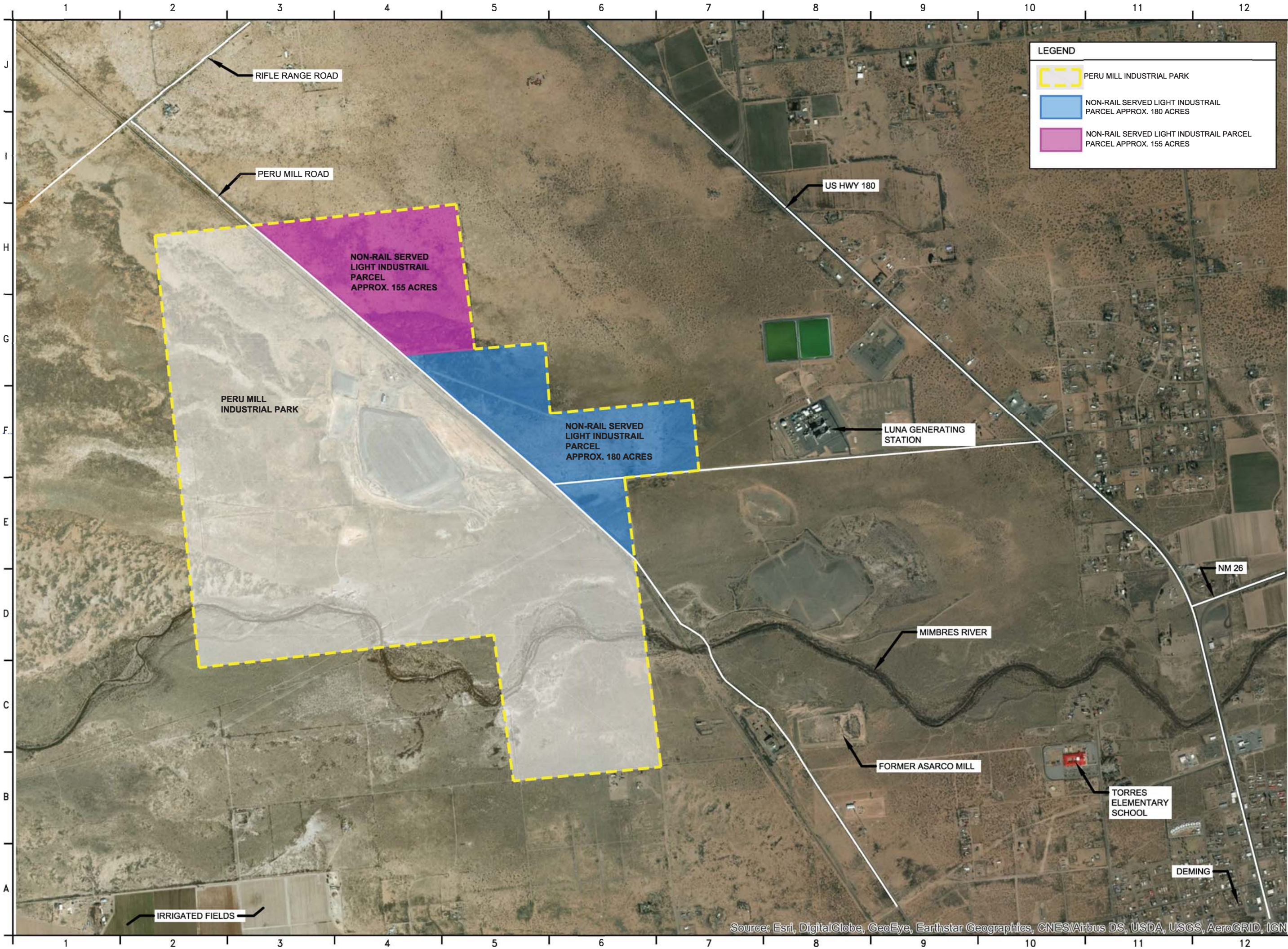
PROJECT:
**AMERICAN
MAGNESIUM**

REVISIONS			
NO.	DATE	BY	APPROVED

DESIGNED BY:	
DRAWN BY:	
CHECKED BY:	
APPROVED BY:	
DATE:	

SHEET TITLE:
**PROPOSED
LAYDOWN
AREA**

SHEET NUMBER:	REV. #
SHEET	OF SHEETS



LEGEND

PERU MILL INDUSTRIAL PARK

NON-RAIL SERVED LIGHT INDUSTRIAL PARCEL APPROX. 180 ACRES

NON-RAIL SERVED LIGHT INDUSTRIAL PARCEL APPROX. 155 ACRES

N

08001600

SCALE: 1" = 800'
(WHEN PRINTED FULL SIZE
22" X 34")

PROJECT:

AMERICAN
MAGNESIUM

REVISIONS			
NO.	DATE	BY	APPROVED

DESIGNED BY:	
DRAWN BY:	
CHECKED BY:	
APPROVED BY:	
DATE:	

SHEET TITLE:

INDUSTRIAL
CENTER PARK
SITE MAP

SHEET NUMBER:	REV. #
SHEET	OF SHEETS



PROPOSED
LAYDOWN AREA
(22600 SQ-FT)

PHASE 3 DELINEATION
MINING

4WD DIRT ROAD B016

PHASE 1 DELINEATION
MINING
(15 DRILLING LOCATIONS)

PHASE 2 DELINEATION
MINING
(29 DRILLING LOCATIONS)

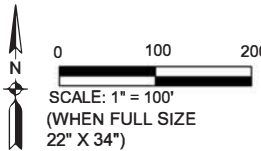
MAHONEY PARK

FLORIDA MOUNTAINS

4WD DIRT ROAD B013

LEGEND

- PROPOSED BORE HOLE-DRILLING LOCATION
- PHASE 1 MINING
- PHASE 2 MINING
- PHASE 3 MINING



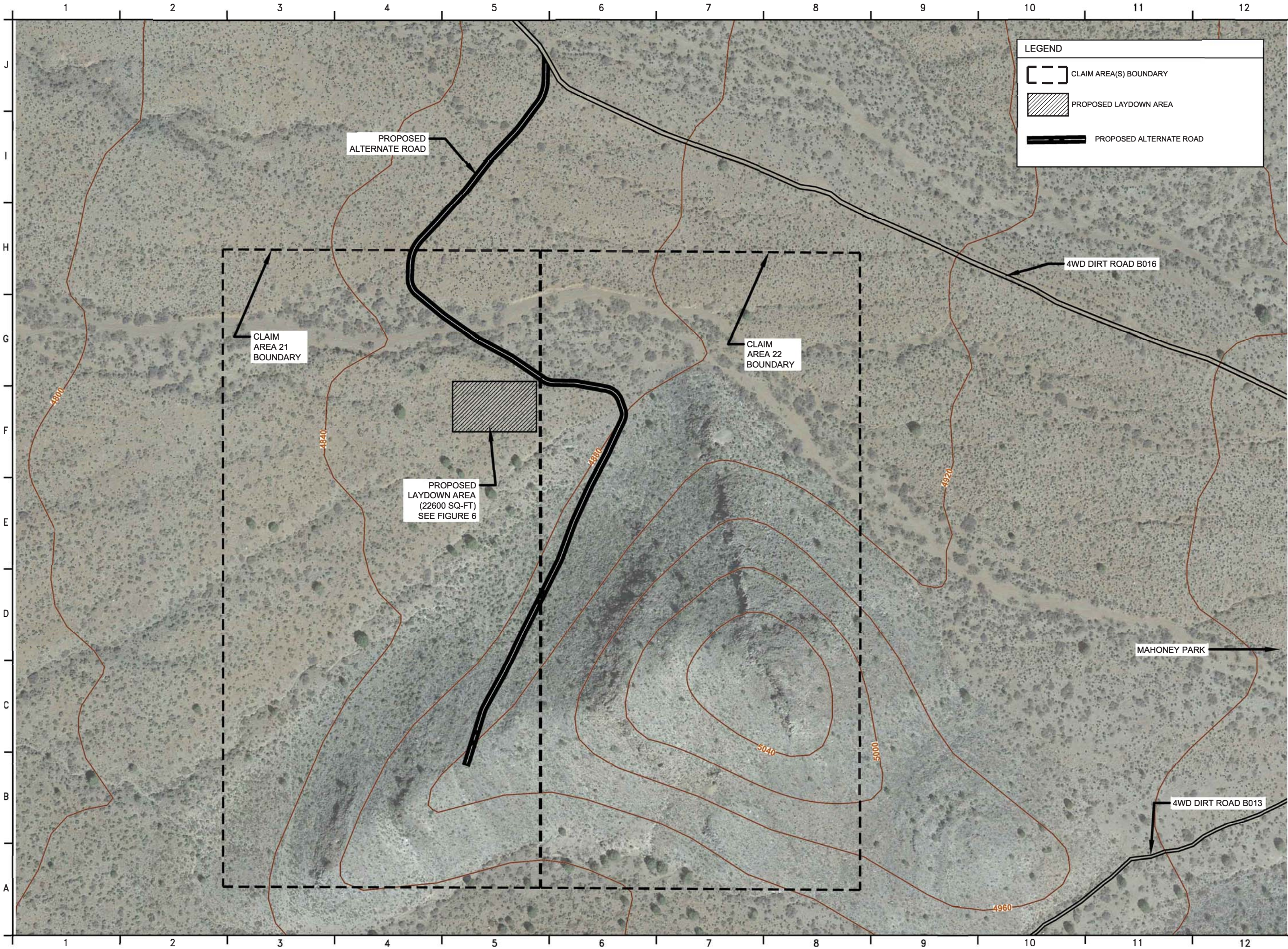
PROJECT:
**AMERICAN
MAGNESIUM
-PROPOSED
MINING
PHASED
APPROACH**

REVISIONS			
NO.	DATE	BY	APPROVED

DESIGNED BY:	
DRAWN BY:	
CHECKED BY:	
APPROVED BY:	
DATE:	

SHEET TITLE:
**PROPOSED
DRILLING
LOCATIONS
100' GRID**

SHEET NUMBER:	REV. #
SHEET OF	SHEETS



LEGEND

CLAIM AREA(S) BOUNDARY

PROPOSED LAYDOWN AREA

N

0100200

SCALE: 1" = 100'
(WHEN PRINTED FULL SIZE
22" X 34")

PROJECT:

AMERICAN
MAGNESIUM-
PROPOSED
ALTERNATE
ROAD

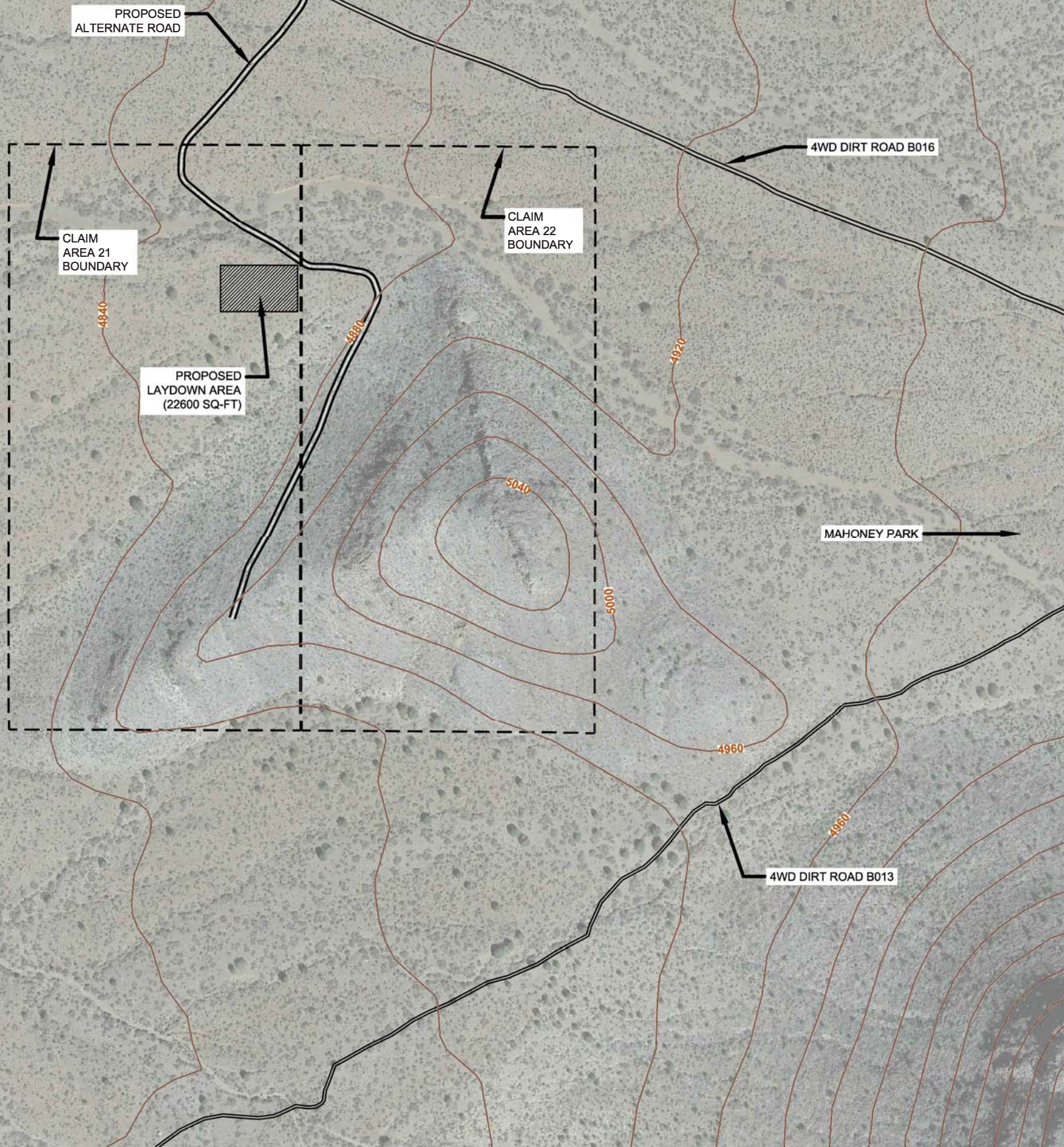
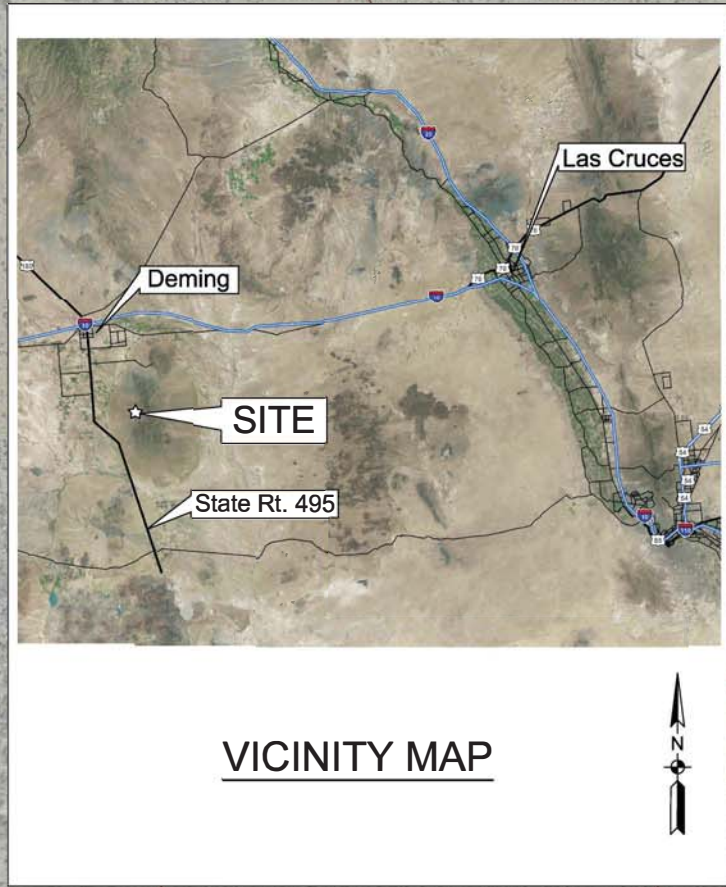
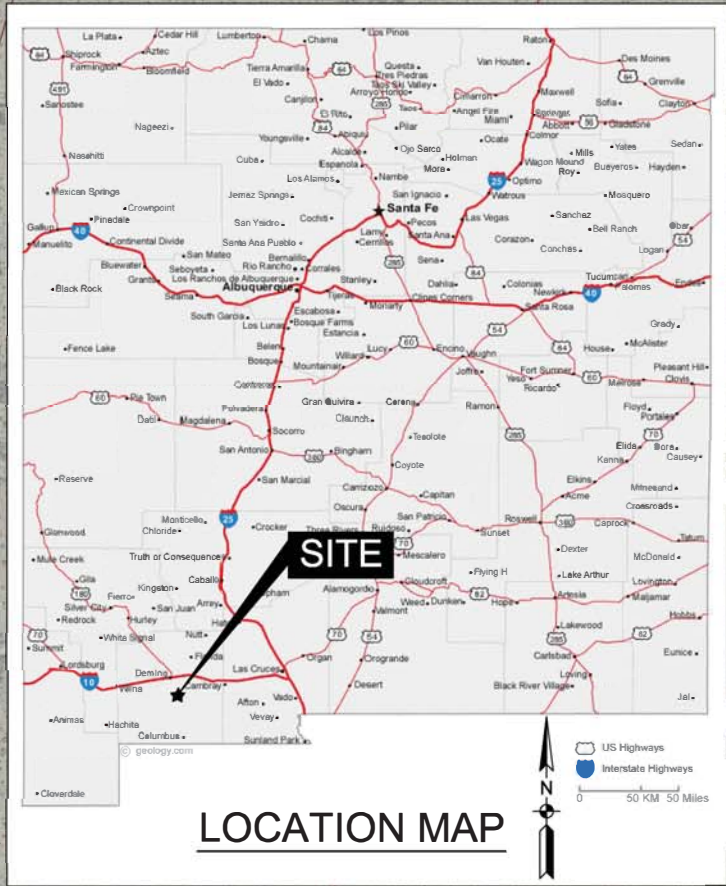
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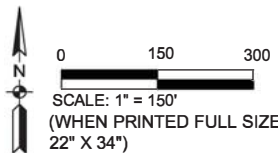
PROPOSED
ROAD
ALIGNMENT

SHEET NUMBER:	REV. #
C-5	
SHEET 5 OF 5 SHEETS	



LEGEND

- CLAIM BOUNDARY
- ROADWAY
- PROPOSED LAYDOWN AREA



PROJECT:

**AMERICAN
MAGNESIUM-
SPILL PREVENTION,
CONTROL, AND
COUNTERMEASURES
PLAN**

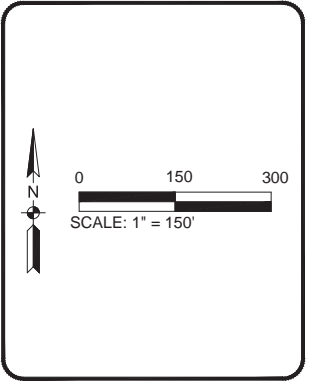
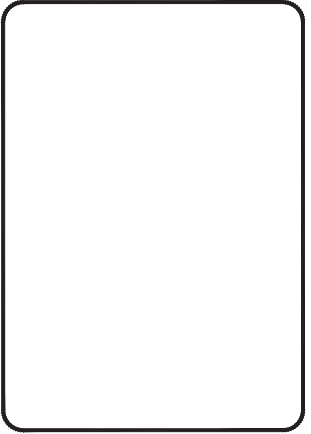
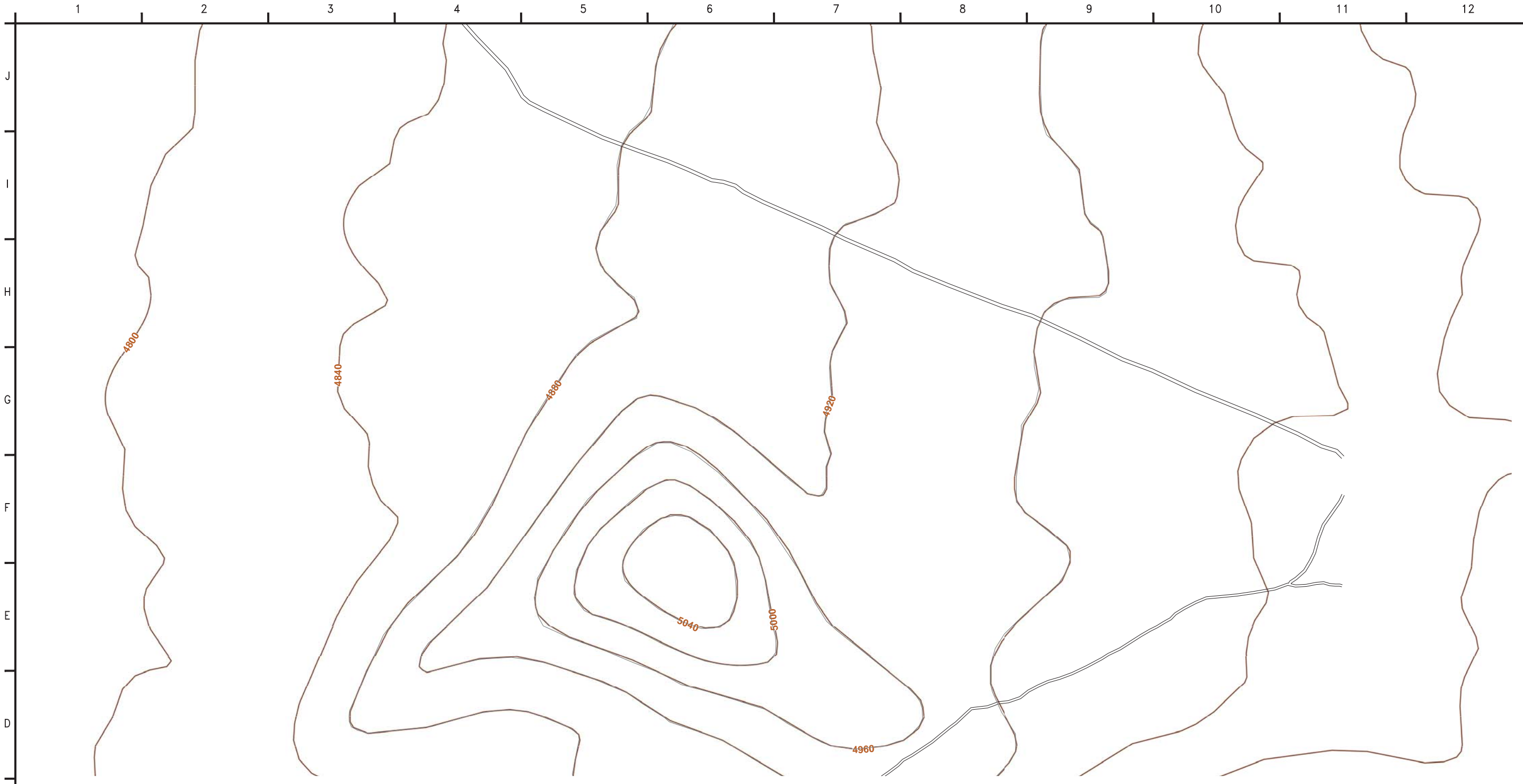
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SITE MAP

SHEET NUMBER:	REV. #
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SHEET 1 OF 1 SHEETS	



PROJECT:

**AMERICAN
MAGNESIUM**

REVISIONS			
NO.	DATE	BY	APPROVED

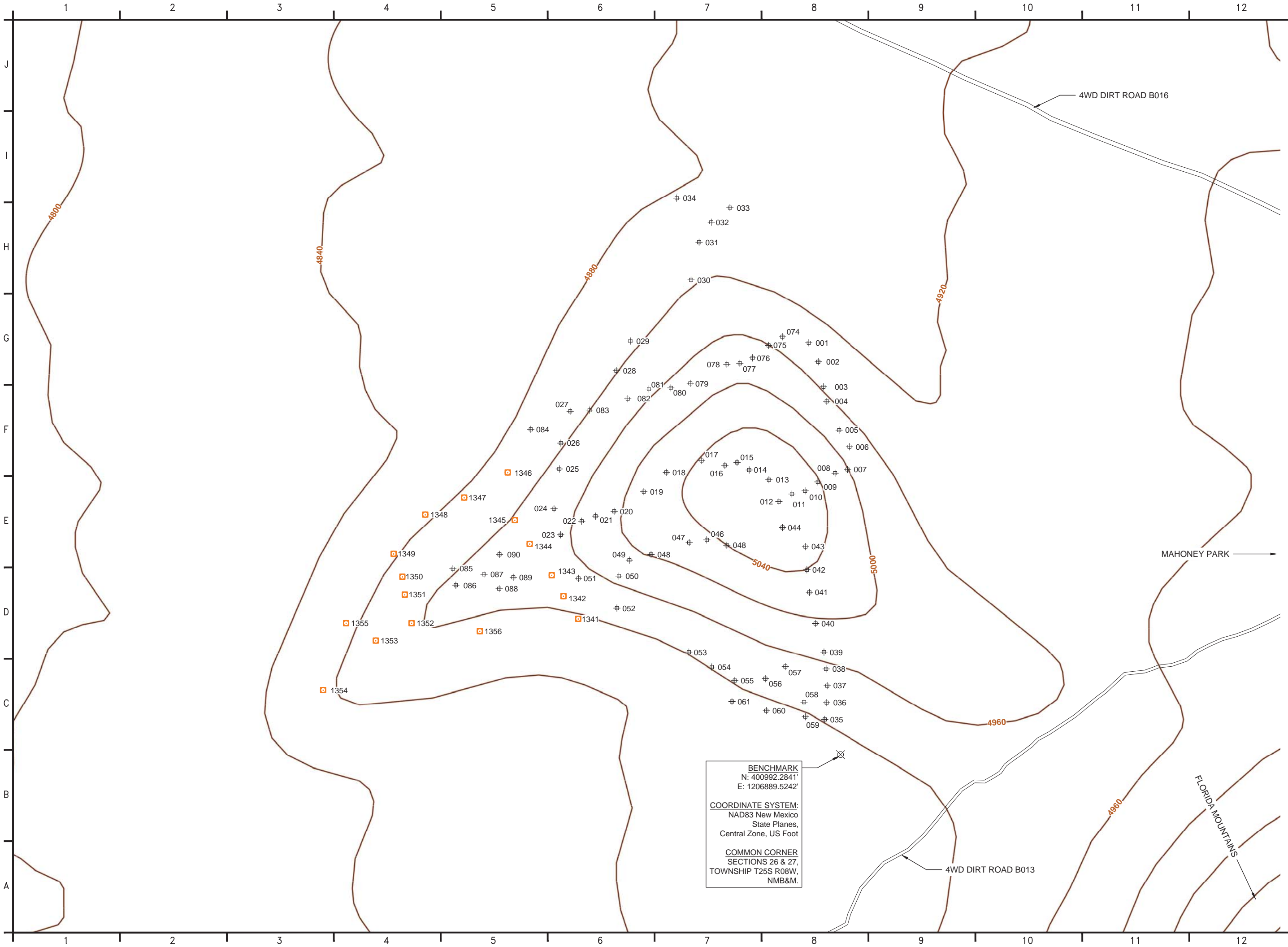
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SHEET TITLE:

**SURFACE
PROFILE**

SHEET NUMBER:	REV. #
C-4	
SHEET 4 OF 4 SHEETS	





LEGEND

2015 SAMPLING LOCATIONS

2013 SAMPLING LOCATIONS

0100200

SCALE: 1" = 100'

(WHEN PRINTED FULL SIZE 22" X 34")

PROJECT:

**AMERICAN
MAGNESIUM-
SAMPLING
LOCATIONS
2013-2015**

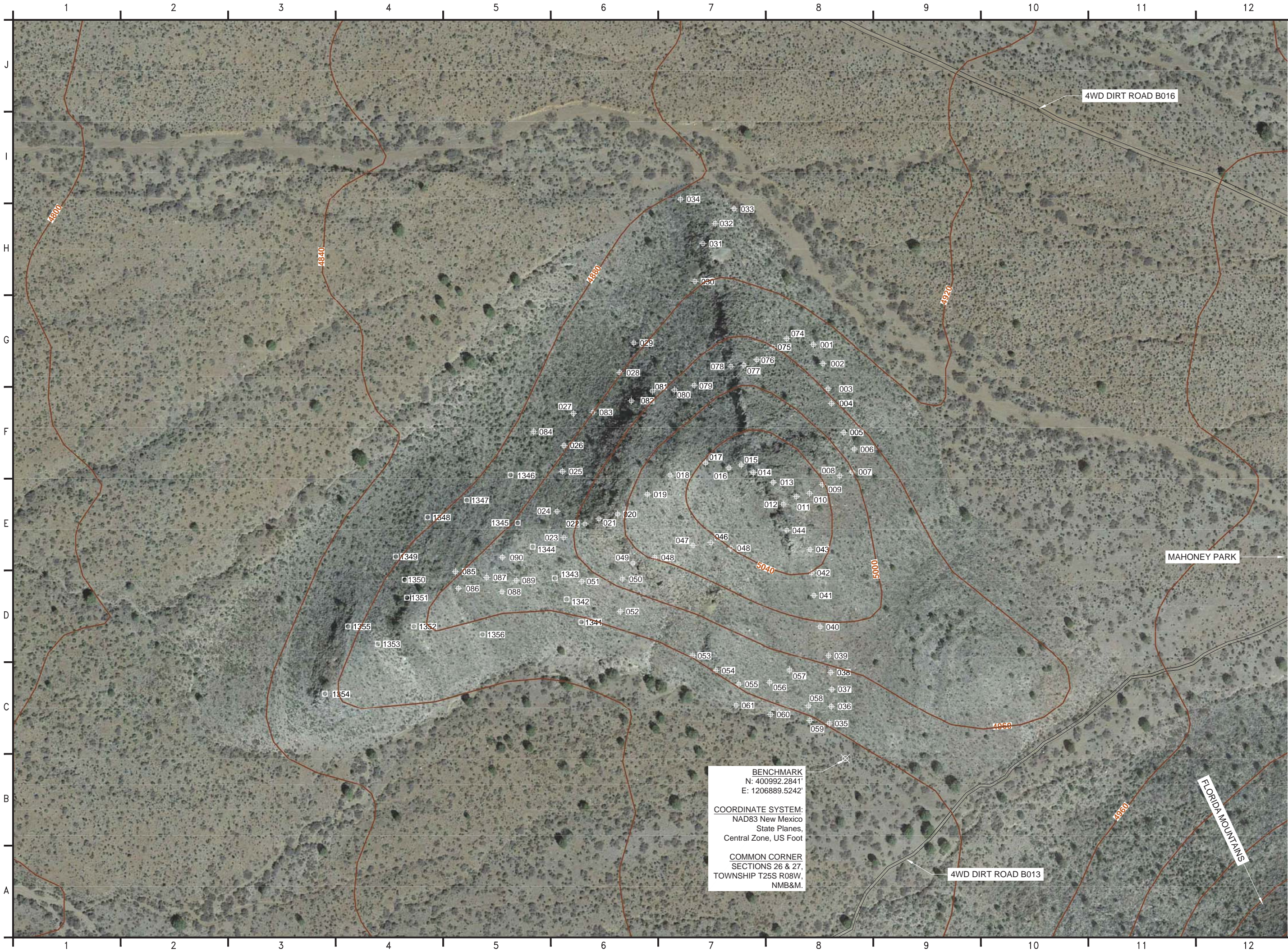
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**SAMPLING
LOCATIONS
TOPO MAP**

SHEET NUMBER:	REV. #
C-2	
SHEET 2 OF 4 SHEETS	



BENCHMARK
N: 400992.2841'
E: 1206889.5242'

COORDINATE SYSTEM:
NAD83 New Mexico
State Planes,
Central Zone, US Foot

COMMON CORNER
SECTIONS 26 & 27,
TOWNSHIP T25S R08W,
NMB&M.

LEGEND

- ⊕ 2015 SAMPLING LOCATIONS
- 2013 SAMPLING LOCATIONS

N

0 100 200

SCALE: 1" = 100'
(WHEN PRINTED FULL SIZE
22" X 34")

PROJECT:

**AMERICAN
MAGNESIUM-
SAMPLING
LOCATIONS
2013-2015**

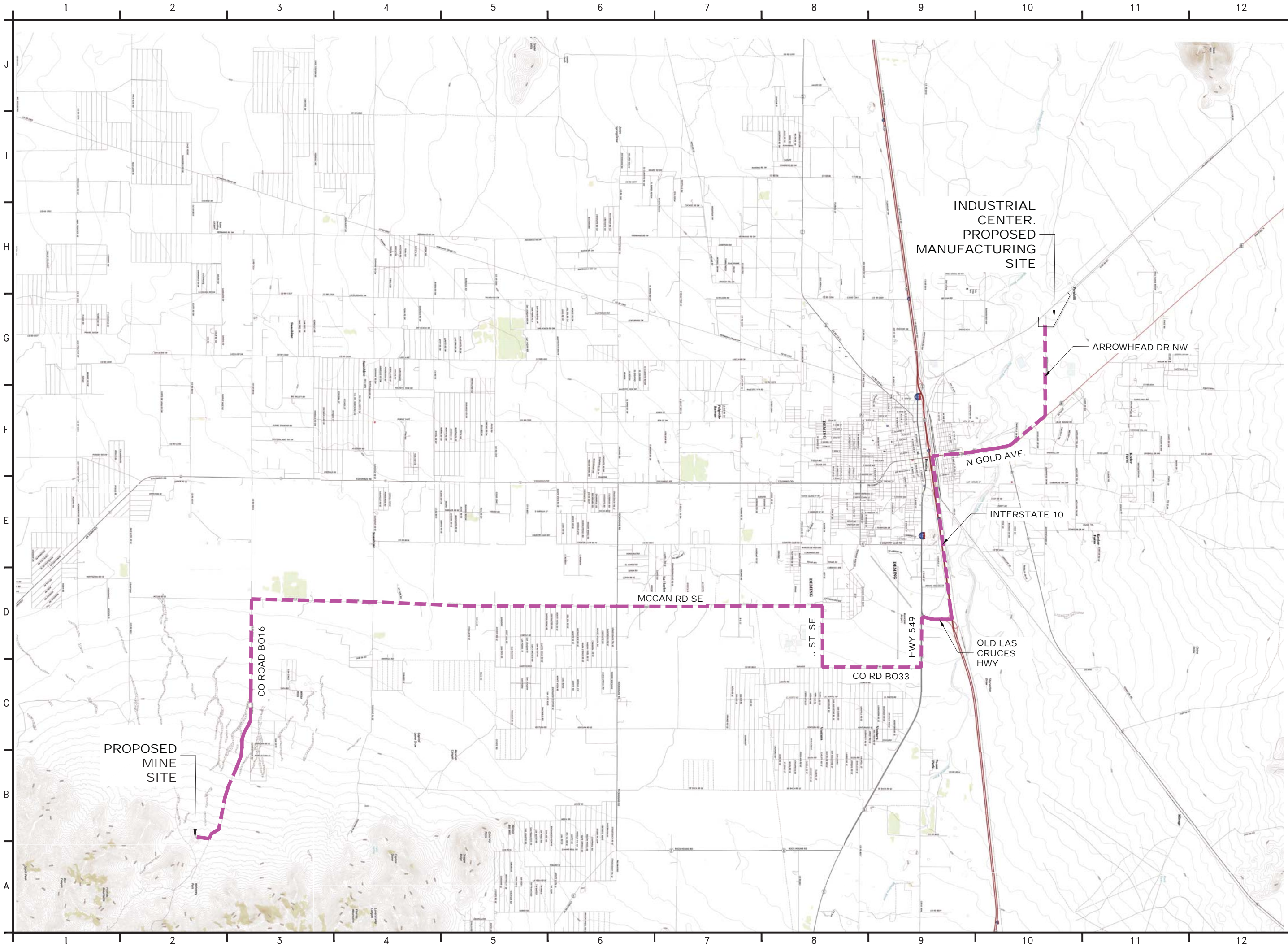
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SHEET TITLE:

**SAMPLING
LOCATIONS**

SHEET NUMBER:	REV. #
C-1	
SHEET 1 OF 4 SHEETS	



LEGEND

ROUTE FROM MINE SITE TO MANUFACTURING SITE



PROJECT:

AMERICAN MAGNESIUM-MINE SITE TO MANUFACTURING SITE

ROUTE MAP

REVISIONS			
NO.	DATE	BY	APPROVED

DESIGNED BY:	
DRAWN BY:	
CHECKED BY:	
APPROVED BY:	
DATE:	

SHEET TITLE:

ROUTE MAP

MINE SITE TO MANUFACTURING SITE

SHEET NUMBER:	REV. #
C-6	
SHEET 6 OF 6 SHEETS	

Enclosure 2
Spill Prevention Plan

DRAFT

SPILL PREVENTION, CONTROL, AND COUNTERMEASURE PLAN

*For Magnesium Mining
Deming, New Mexico*

February 2018

Prepared for:



**U.S. Department of the Interior
Bureau of Land Management**
Las Cruces Field Office
1800 Marquess Street
Las Cruces, New Mexico 88005

Prepared and Submitted by:



American Magnesium LLC
104 Rinconada
PO Box 684
Elephant Butte, NM 87935



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Appendix B. Safety Data Sheets
Appendix C. Equipment Inspection Forms



Professional Engineer Certification [40 CFR 112.3(d)]

Certification: I hereby certify that I have examined the facility and, being familiar with the provisions of 40 CFR Part 112, attest that this SPCC Plan has been prepared in accordance with good engineering practices.

Engineer: David Tognoni

Registration Number: XXXXX

State: New Mexico

Date of Plan Certification: XXXXX

Dan Kwiecinski, PE

Date

Registered Professional Engineer Seal

SPCC Management Approval [40 CFR 112.7]

I hereby certify that the necessary resources to implement this SPCC have been committed.

David Tognoni, PE;
America Magnesium LLC Managing Partner

Date



List of Acronyms

AmMg	American Magnesium LLC
AST	aboveground storage tank
BLM	Bureau of Land Management, Las Cruces Office
CFR	Code of Federal Regulations
EMNRD	New Mexico Energy, Minerals, and Natural Resources Department
MND	Mining and Minerals Division
MSHA	Mining Safety and Health Administration
NMDOT	New Mexico Department of Transportation
Project	American Magnesium Mining Project near Deming, New Mexico
Project Area	Sections 26 & 27, Township 25 South, Range 8 West, NMB&M, in Little Florida Mountains Mining District, Luna County, New Mexico
RC	dual-tube, reverse-circulation drilling method
SO	Safety Officer
SPCC	Spill Prevention, Control, and Countermeasure Plan
UST	underground storage tank
U.S. EPA	U.S. Environmental Protection Agency



1. Introduction

This Spill Prevention, Control, and Countermeasure Plan (SPCC) is submitted to the Bureau of Land Management, Las Cruces Office (BLM), and the New Mexico Energy, Minerals and Natural Resources Department (EMNRD) Mining and Minerals Division (MMD) by American Magnesium for the Mining Project (Project) located near Deming, New Mexico. The Project is administered by American Magnesium, LLC (AmMg), a New Mexico limited liability company. This SPCC was prepared and will be implemented as required by the U.S. Environmental Protection Agency (U.S. EPA) Regulation contained in Title 40, Code of Federal Regulations, Part 112 (40 CFR 112).

This SPCC describes the reporting requirements and response actions that would take place in the event of a spill, release, or other upset condition, as well as procedures for cleanup and disposal. This SPCC will be posted and distributed to key site personnel and will be used as a guide in the training of employees. This SPCC also addresses mitigation of potential spills associated with project facilities as well as activities of on-site contractors. The SPCC shall be reviewed and updated at a minimum of every 3 years, and whenever major changes are made in the management of the materials addressed in the plan. Inspection and maintenance schedules and procedures for equipment at the Project Area would be set forth in sections of the plan addressing hazardous materials and petroleum products. In addition, the implementation of a health and safety manual and hazard communication program would provide employees with education and awareness of hazardous materials management; thereby further minimizing the potential for spills at the mine area.

This SPCC addresses general requirements for handling spills and discharges of hazardous or controlled materials during activities for the Project. The development, implementation and use of this SPCC are essential to ensure that spills and leaks can be quickly contained and cleaned up. As a general rule, the approach to spill cleanup is to first contain the spill by securing the spill source and deploying spill containment materials, including sorbent pillows, socks, sheets, and granules. Small spills are responded to by the operator involved in the spill. Clean up of residues managed as hazardous or solid waste will be disposed of accordingly.



2. Facility Information [40 CFR 112.7(a)]

Facility Name: American Magnesium LLC (AmMg)

Mailing Address: 104 Rinconada
PO Box 684
Elephant Butte, NM 87935-0684

Street Address: XXXXX

Owner: David Tognoni, PE
104 Rinconada
PO Box 684
Elephant Butte, NM 87935-0684

Facility Contact: David Tognoni, PE

Location: 32°5'0.61"N, 107°39'10.90"W (approximated)

2.1 Location

The Project Area is located on public land administered by the BLM in part or all of Sections 26 & 27, Township 25 South, Range 8 West, NMB&M, in Little Florida Mountains Mining District, Luna County, New Mexico. (Project Area). The Project Area includes approximately 43.8 acres. Project disturbance and bonding will occur in phases. There are approximately 8.6 miles of existing road that will be utilized for Project access. A Site map of the Project Area is included as **Appendix A**.

2.2 Project Description and Onsite Equipment

The Project Area will include drill sites, the excavation and removal of dolomite resources, and necessary road improvements. The Project Area will include a total of 44 acres for the purpose of resource verification, mining operations, and reclamation activities.

For the initial phase of the Project, dual-tube, reverse-circulation (RC) air rotary drilling rigs and diamond-bit core rigs will be used for drilling operations and exploration of dolomite resources. One reverse circulation rig and one core drilling rig will be used in the Project Area for mine development. Each rig will include the following support vehicles:

- One pipe truck;
- One booster truck;
- One 3,000-gallon water truck;
- One all-terrain support vehicle; and,
- One auxiliary air compressor.

The Project Area includes primitive road which will be improved with a bulldozer using cut-fill balance methods. One D7 dozer will be used for rehabilitation of the existing access roads and for resource verification road construction. One tracked excavator hoe will be required to assist in the rehabilitation of existing roads, for new road construction, and for drill pad construction.

During mine operations including quarrying the dolomite rock and crushing of the material for transport off-site, operational equipment required for use at the Project Area will expand to include the following.

- Up to 10 haul trucks;
- One 3,000-gallon water truck;
- Two all-terrain support vehicles;
- Storage igloo for blasting storage;



- Excavator;
- Primary crusher, if needed;
- Grader;
- Backhoe; and,
- Broadcast seeder for reclamation activities.

2.3 Contact Information

The American Magnesium Site Supervisor (to be determined), will be responsible for overall spill prevention and response during the Project. All Project personnel will be responsible for following spill prevention procedures and notifying the Supervisor in the event of a spill or discharge. Key contacts with knowledge of the Project spill prevention and response procedures are provided below in **Table 1**.

Table 1. Project Contact Information

Name	Title	Telephone	Email Address
David Tognoni, PE	AmMg Managing Partner	Mobile: 575.741.1527	dqtognoni@gmail.com
David Tognoni, PE	AmMg	Mobile: 575.741.1527	dqtognoni@gmail.com
TBD	AmMg	Work: TBD Mobile: TBD	TBD

2.4 Past Spill Experience

There are no historical or existing spills at the site. If spills occur during the activities in the Project Area **Table 2** below will be updated in a revised SPCC.

Table 2. Past Spill Experience

Date of Occurrence	Description of Spill	Corrective Actions Taken	Plan for Preventing Recurrence
Not Applicable	Not Applicable	Not Applicable	Not Applicable



3. Potential Equipment Failures [40 CFR 112.7(b)]

Hazardous materials are chemicals (such as paints, oils, and fuels), biological agents (such as disease-causing materials), or physical agents (such as radioactive materials) that are dangerous to humans, animals or the environment.

The anticipated total oil storage capacity at the Project Area is 700 gallons. Hazardous materials used at the Project Area will include diesel fuel, gasoline, and lubricating grease. Approximately 500 gallons of diesel fuel will be stored in fuel delivery systems on vehicles and drill rigs. Approximately 100 gallons of gasoline will be stored in fuel delivery systems for light vehicles. Approximately 100 pounds of lubricating grease will be stored on the drill rigs or transported by drill trucks. All containers of hazardous substances will be labeled and handled in accordance with requirements of the New Mexico Department of Transportation (NMDOT) and Mining Safety and Health Administration (MSHA).

The physical and chemical properties for diesel fuel, gasoline, and other petroleum products are included in their respective Safety Data Sheets (SDS) that will be maintained on site at all times in accordance with MSHA's Hazard Communication for the Mining Industry (30 CFR Part 47). The anticipated SDSs required for use at the Project Area are included as **Appendix B** and include the following:

- Marathon Petroleum No. 2 Ultra low Sulfur Diesel (SDS ID No. 0290Mar019);
- Marathon Petroleum Gasoline All Grades (SDS ID No. 0127Mar19);
- Marathon Petroleum Multipower-3 Motor Oil (SDS ID No. 0162Mar019);
- Marathon Petroleum Maratrac Grease (SDS ID No. 0196Mar019); and,
- Prestone Antifreeze/Coolant (SDS ID No. SDS 501).



4. Containment and Diversionary Structures [40 CFR 112.7(c)]

Spill response materials of sufficient quantity to prevent a typical discharge will be maintained onsite. In accordance with 40 CFR 112.7(c)(1)(vii) sorbent materials will provide sufficient containment for this Project Area and anticipated activities. Oil absorbent boom, sorbent materials, and other spill response materials will be maintained onsite and within vicinity to daily work activities. The spill response materials anticipated for use during this project will include the following:

- (quantity) empty 55-gallon drums for potentially contaminated material storage;
- (quantity) oil absorbent socks;
- (quantity) oil absorbent pads;
- (quantity) Oil-Dry® or equivalent absorbent material;
- (quantity) Nitrile gloves;
- (quantity) Neoprene gloves;
- (quantity) Vinyl or PVC overboots;
- (quantity) non-sparking shovels; and,
- (quantity) brooms.

These materials will be stored in the onsite mobile trailer area and accessible by onsite personnel and replaced as needed throughout the duration of the Project. The spill response materials will be checked monthly during the duration of the Project and replenished as needed.



5. Potential Spill Volumes and Rates [40 CFR 112.7(d)]

Fuel spills from diesel and gasoline storage required by onsite equipment fall into two main categories: “minor incidental” and “major incidental” spills. Minor incidental spills result from incidents such as careless operator handling of transfer equipment during fueling, broken hydraulic lines, or engines that leak oil. Examples of a major incidental spill include breach of the fuel storage tank, rupture of a vehicle fuel tanks from collision, or an unattended open valve. **Table 3** and **Table 4**, below, present typical volumes and discharge rates for fuel spills caused by common equipment failures and operator mistakes.

Table 3. Potential Minor Incidental Failures

Major Incidental			
Potential Failure	Spill Direction	Volume Released	Discharge Rate
Operational oil and grease	Spotting	Up to several ounces	Spotting
Refueling of small motors, generators, etc.		Up to several gallons	Instantaneous
Broken hydraulic line on onsite equipment		Up to several gallons	Instantaneous
Leaking engine or onsite vehicle		Up to several gallons	Gradual to Instantaneous
Refueling of onsite vehicles		Up to 50 gallons	Gradual to Instantaneous

Table 4. Potential Major Incidental Failures

Major Incidental			
Potential Failure	Spill Direction	Volume Released	Discharge Rate
Breach of fuel storage tank		Up to 150 gallons	Instantaneous
Vehicle Collision		Up to 100 gallons	Instantaneous
Refueling of large equipment such as drilling rigs, front loaders, excavators, etc.		Up to 100 gallons	Up to 10 gallons per minute

5.1 Demonstration of Practicability

AmMg have determined that the use of additional containment and diversionary structures outside of the procedures described within this SPCC, NMDOT-approved storage containers, and appropriately stocked spill kits would be impractical during this phase of activities at the Project Area.

In accordance with 40 CFR 112.7(d)(2), AmMg commits to providing manpower, equipment, and materials required to expeditiously control and remove any quantity of oil spilled during the implementation of this project.



6. Inspections and Record Keeping [40 CFR 112.7(e)]

6.1 Routine Daily Inspections

Documentation of inspections will be maintained at all times. Daily visual inspections will be conducted for both onsite equipment and the complete project site prior to operation, and will include visual monitoring for the following:

- Signs of fuel or oil leakage from onsite vehicles and equipment;
- Staining and discoloration of site soils;
- Excessive ponding of stormwater; and,
- The presence of visible accumulation of petroleum hydrocarbons.

Daily tailgate inspection forms and daily equipment inspection forms are included as **Appendix C**; whenever possible manufacturer equipment inspection forms will be used.

Equipment safety inspections will be completed prior to the daily use of onsite equipment. The inspections will be completed by the equipment operator and verified by the Site Supervisor or designee. Equipment safety inspection forms will be maintained onsite during the duration of the project.

6.2 Annual Inspections

An inspection of the Project Area will be conducted annually by appropriate responsible personnel to verify that:

- The SPCC is maintained;
- The description of the onsite chemicals and equipment is accurate;
- Applicable SDSs are maintained onsite;
- Site maps are current and reflect accurate onsite conditions; and,
- Controls to reduce the potential for spills identified in this plan are being implemented.

6.3 Record Keeping

This SPCC will be maintained at the Project Area, where personnel will be able to quickly access and use the information to respond to spills. Emergency telephone numbers and any other relevant numbers will be kept readily available to all site personnel. Training records of onsite personnel and documentation of any spills or maintenance conducted at the Project Area will be maintained onsite.

If spills occur at the Project Area, details of the spills will be recorded and maintained onsite. In the event of a potential spill, the following information will be recorded:

- Description of the material spilled (including the quantity and manifest number, if any);
- Exact time and location of spill, including a description of the area involved;
- Containment and cleanup procedures;
- Summary of any communications with government officials, including NMED;
- Reason for spill;
- Corrective action to prevent future spills; and,
- Plan for preventing Recurrence.



7. Personnel Training and Spill Control Procedures [40 CFR 112.7(f)]

7.1 Personnel Training

In addition to the required posted information, all project personnel will be briefed about spill control procedures prior to mobilization to the Project Area, at the initial site briefing, and through daily tailgate safety meetings.

Onsite personnel shall, at a minimum, be trained in the operation and maintenance of onsite equipment in a manner sufficient to prevent discharges, discharge procedure protocols, applicable pollution control laws, rules and regulations, and general contents of this SPCC in accordance with 40 CFR 112.7(f)(1). Personnel responsible for handling spills and potentially hazardous wastes will have received both the initial 40-hour and annual 8-hour refresher training in Hazardous Waste Operations and Emergency Response (HAZWOPER) in accordance with OSHA Standard 29 CFR 1920.120(e). This training is included as part of the initial training received by all field personnel. Training records and certificates will be kept at the mobile trailer area. Foster Wheeler Site Supervisor will be responsible for ensuring the effectiveness of this SPCC and will be accountable for discharge prevention [40 CFR 112.7(f)(2)]. The Site Supervisor will report minor incidental failures to the Project Manager within one day (24 hours) and major incidental failures within one hour.

Upon completion of the annual site inspection and review of the SPCC, any discharges, or recently developed precautionary measures, the revised SPCC will be reviewed with onsite personnel by the Project Manager or Site Supervisor [40 CFR 112.7(f)(3)].

7.2 Spill Control Procedures

Fuels and oils will be stored in containers on support or crew trucks for fueling of equipment. Container storage includes auxiliary fuel tanks (100 gallons or less) and containers (5 gallons or less) on support vehicles. Containers will not be stored where a leak or spill could enter a stormwater conveyance or arroyo. No storage of containers will occur outdoors. This will preclude exposure to precipitation and extremes in temperature. All materials will be stored on support vehicles or within equipment reservoirs.

Site personnel will monitor fuel storage, delivery and construction equipment for leaks. Any leaks will be immediately addressed and repaired. Any leaks and leak repair procedures will be documented according to Section 6.3 of this SPCC.

All spills or leaks, regardless of their quantity, will be reported to New Mexico Environment Department (NMED) at the following numbers:

- For emergencies, call 505-827-9329 twenty-four hours a day.
- For non-emergencies, call 866-428-6535 (voice mail, twenty-four hours a day).
- For non-emergencies, and to reach an on-duty NMED staff member during normal business hours, call 505-476-6000.

During spill cleanup operations, the Site Supervisor will be responsible for all spill containment and cleanup activities. If a spill occurs on-site, AmMg will respond and immediately contain the contaminated material and place it in a secure container, work area, or truck. The cause of any spill will be determined and corrective action will be taken. Complete details of the cause of the spill and how it was responded to will be documented.

Should a spill occur off-site, the delivery driver will immediately contact the Site Supervisor as well as the responsible local and/or state emergency response agencies so that a response may be made to mitigate the spill. Action will be taken immediately to contain and recover the spilled material. The spill will be contained so that removal equipment can clean up the spill. If a spill occurs on soil, the area will be over excavated to clean soil, to verify that all spilled material is removed. If a spill occurs on concrete or



pavement, brooms, sorbent materials or vacuums may be used to ensure that all spilled material is recovered.

AmMg and its subcontractors will oversee the disposal of any recovered product, contaminated soil, contaminated materials and equipment, decontamination solutions, sorbents, and spent chemicals collected during a response to a discharge incident. A licensed transportation/disposal company will be contracted to dispose of waste according to applicable local and state regulatory guidelines.



8. Security [40 CFR 112.7(g)]

AmMg will construct chain-link fences in the proposed laydown area to provide a higher level of security for potential sources of spills and for onsite equipment. These areas will remain locked during non-operational hours. Within this area, a mobile trailer area will be maintained. Spill response materials and small equipment will be stored in this location when not in use.

Fuel used during the Project will remain in mobile fuel delivery systems and maintained on light vehicles. Light vehicles will not remain onsite during non-operational hours.

All petroleum products, kerosene, and reagents used for blasting activities will be stored in aboveground tanks within a secondary containment area capable of holding 110 percent of the volume of the largest vessel in the area.

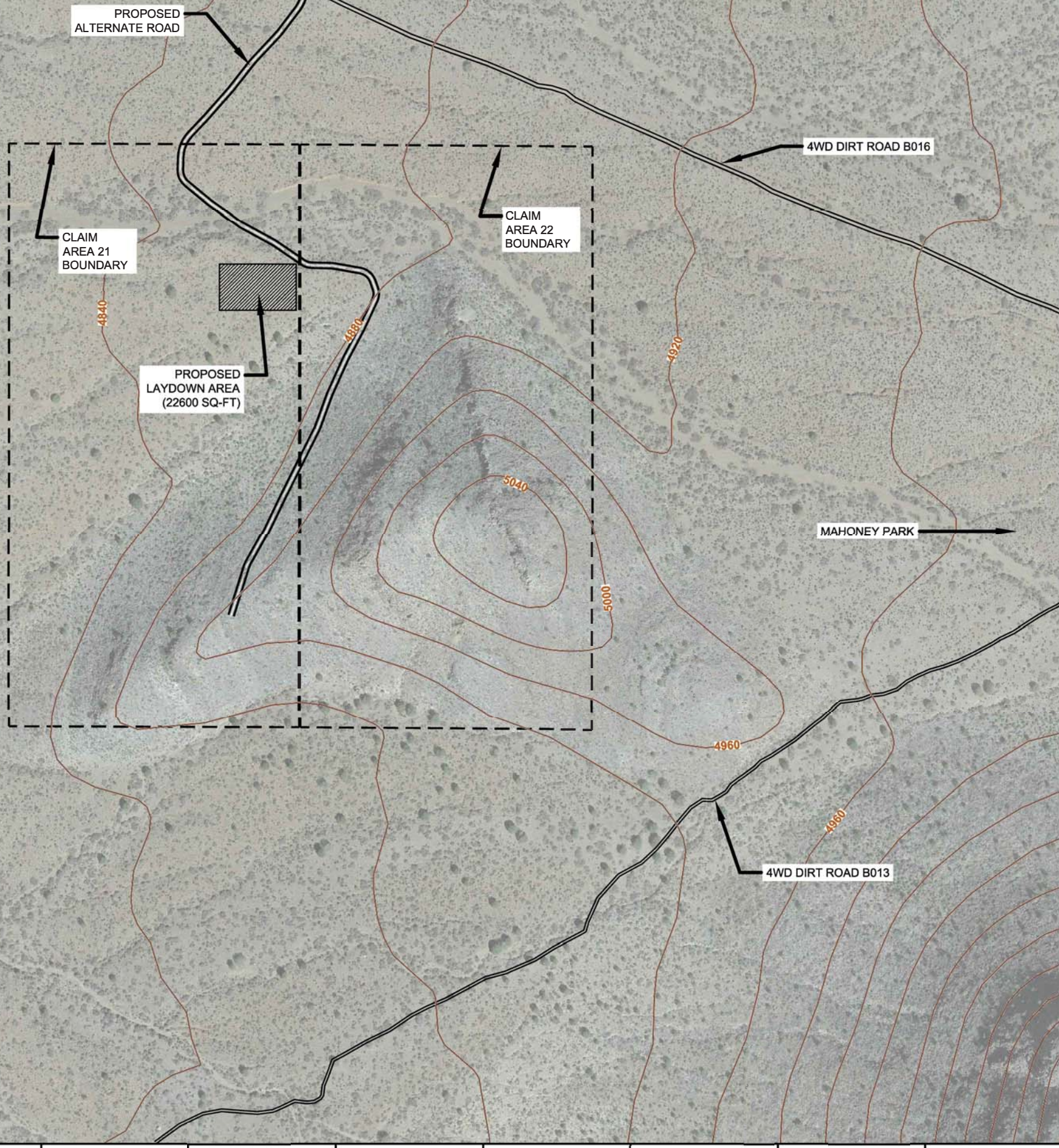
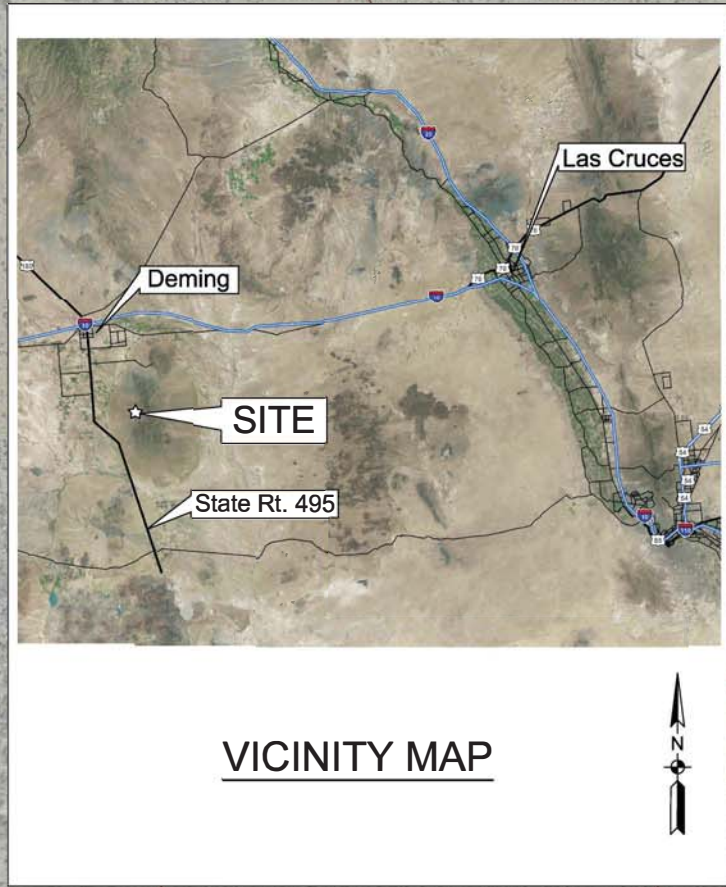
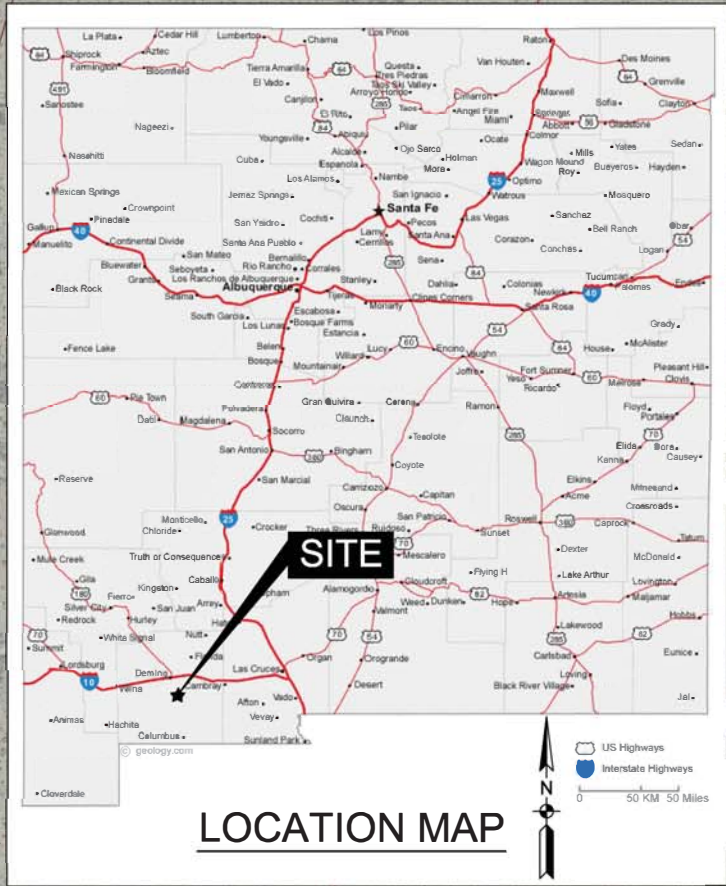


APPENDICES



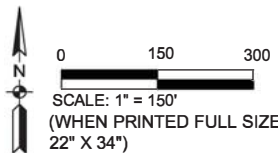
Appendix A

Site Map



LEGEND

- CLAIM BOUNDARY
- ROADWAY
- PROPOSED LAYDOWN AREA



PROJECT:

**AMERICAN
MAGNESIUM-
SPILL PREVENTION,
CONTROL, AND
COUNTERMEASURES
PLAN**

REVISIONS			
NO.	DATE	BY	APPROVED

DESIGNED BY:	
DRAWN BY:	
CHECKED BY:	
APPROVED BY:	
DATE:	

SHEET TITLE:

SITE MAP

SHEET NUMBER:	REV. #
1	
SHEET 1 OF 1 SHEETS	



Appendix B

Safety Data Sheets



SAFETY DATA SHEET

SDS ID NO.: 0290MAR019
Revision Date 06/01/2016

1. IDENTIFICATION

Product Name: Marathon Petroleum No. 2 Ultra Low Sulfur Diesel

Synonym: #2 Diesel; No. 2 Ultra Low Sulfur Diesel 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 15 ppm Sulfur Max with Polar Plus; No. 2 Diesel, Motor Vehicle Use, Undyed; No. 2 Diesel, Motor Vehicle Use, Undyed, with Polar Plus; ULSD No. 2 Diesel 15 ppm Sulfur Max; ULSD No. 2 Diesel 15 ppm Sulfur Max with Polar Plus; No. 2 MV 15 Diesel; No. 2 MV 15 Diesel with Polar Plus; No. 2 Ultra Low Sulfur Diesel Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 Dyed 15 ppm Sulfur Max; Ultra Low Sulfur Diesel No. 2 Dyed 15 ppm Sulfur Max with Polar Plus; No. 2 Diesel, Tax Exempt-Motor Vehicle Use, Dyed; No. 2 Diesel, Tax Exempt-Motor Vehicle Use, Dyed, with Polar Plus; ULSD No. 2 Diesel Dyed 15 ppm Sulfur Max; ULSD No. 2 Diesel Dyed 15 ppm Sulfur Max, with Polar Plus; No. 2 MV 15 Diesel Dyed; #2 MV 15 CFI Diesel; #2 MV 15 CFI Diesel Dyed; No. 2 Low Sulfur Diesel (TxLED); No. 2 MV 15 Diesel Dyed, with Polar Plus; No. 2 NRLM 15 Diesel Dyed; No.2 NRLM Diesel Dyed; No. 2 MV 500 ppm TxLED; No.2 Low Emission Low Sulfur Diesel; No. 2 Low Sulfur Diesel (TxLED) 500 ppm Sulfur Max; No. 2 Heating Oil 5000 NMA Unmarked; NEMA No. 2 Heating Oil; Heating Oil, No. 2 Low Sulfur 5000 ppm; No. 2 Ultra Low Sulfur Diesel Dyed with <6% Renewable Diesel Fuel; Ultra Low Sulfur No. 2 Diesel Dyed with <6% Renewable Diesel Fuel; No. 2 Diesel Dyed with <6% Renewable Diesel Fuel 15 ppm Sulfur Max; No. 2 Ultra Low Sulfur Diesel with <6% Renewable Diesel Fuel; Ultra Low Sulfur No. 2 Diesel with <6% Renewable Diesel Fuel; No. 2 Diesel with <6% Renewable Diesel Fuel 15 ppm Sulfur Max; Garyville Export Diesel; Export Diesel, Garyville; Diesel Fuel, Export Garyville; #2 Motor Vehicle ULSD 15 ppm with 0-5% Renewable Diesel; Marathon No. 2 ULSD with 0-5% Renewable Fuel with R100; Marathon No. 2 ULSD with 0-5% Renewable Fuel with R99; No. 2 Heating Oil 2000 ppm Sulfur Max, Clear (Undyed) Unmarked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Clear (Undyed) Unmarked; ULS Heating Oil 15 ppm Clear (Undyed) Unmarked; ULS HO 15 ppm CLR; Ultra-Low Sulfur Heating Oil (<= 15ppm, Undyed); No. 2 Heating Oil 2000 ppm Sulfur Max, Dyed Unmarked; No. 2 Heating Oil 2000 ppm Sulfur Max, Dyed Marked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Dyed Unmarked; Ultra Low Sulfur Heating Oil 15 ppm Sulfur Max, Dyed Marked; 15 ppm Sulfur Heating Oil Grade 67; 15 PPM Heating Oil; 15 PPM Dyed Heating Oil; 0291MAR019; 0306MAR019; 0308MAR019; 0334MAR019; 0335MAR019; 0336MAR019; 0337MAR019; 0340MAR019;

Product Code: 0290MAR019
Chemical Family: Complex Hydrocarbon Substance

Recommended Use: Fuel.
Restrictions on Use: All others.

Manufacturer, Importer, or Responsible Party Name and Address:
MARATHON CANADA MARKETING, Ltd.
Canadian Address Here

SDS information: 1-419-421-3070

Emergency Telephone: 1-877-627-5463

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 3
Acute toxicity - Inhalation (Dusts/Mists)	Category 4
Skin corrosion/irritation	Category 2
Carcinogenicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Specific target organ toxicity (repeated exposure)	Category 2
Aspiration toxicity	Category 1
Acute aquatic toxicity	Category 2
Chronic aquatic toxicity	Category 2

Hazards Not Otherwise Classified (HNOC)

Static accumulating flammable liquid

Label elements

EMERGENCY OVERVIEW

Danger

FLAMMABLE LIQUID AND VAPOR

May accumulate electrostatic charge and ignite or explode

May be fatal if swallowed and enters airways

Harmful if inhaled

Causes skin irritation

May cause respiratory irritation

May cause drowsiness or dizziness

Suspected of causing cancer

May cause damage to organs (thymus, liver, bone marrow) through prolonged or repeated exposure

Toxic to aquatic life with long lasting effects



Appearance Yellow to Red Liquid

Physical State Liquid

Odor Hydrocarbon

Precautionary Statements - Prevention

Obtain special instructions before use

Do not handle until all safety precautions have been read and understood

Keep away from heat/sparks/open flames/hot surfaces. - No smoking

Keep container tightly closed

Ground/bond container and receiving equipment

Use only non-sparking tools.

Use explosion-proof electrical/ventilating/lighting/equipment

Take precautionary measures against static discharge

Do not breathe mist/vapors/spray

Use only outdoors or in a well-ventilated area

Wear protective gloves/protective clothing/eye protection/face protection

Wash hands and any possibly exposed skin thoroughly after handling
Avoid release to the environment

Precautionary Statements - Response

IF exposed or concerned: Get medical attention
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
If skin irritation occurs: Get medical attention
Wash contaminated clothing before reuse
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor if you feel unwell
IF SWALLOWED: Immediately call a POISON CENTER or doctor
Do NOT induce vomiting
In case of fire: Use water spray, fog or regular foam for extinction
Collect spillage

Precautionary Statements - Storage

Store in a well-ventilated place. Keep container tightly closed
Keep cool
Store locked up

Precautionary Statements - Disposal

Dispose of contents/container at an approved waste disposal plant

3. COMPOSITION/INFORMATION ON INGREDIENTS

No. 2 Ultra Low Sulfur Diesel is a complex mixture of paraffins, cycloparaffins, olefins and aromatic hydrocarbon chain lengths predominantly in the range of eleven to twenty carbons. May contain up to 5% Renewable Diesel. May contain small amounts of dye and other additives (<0.15%) which are not considered hazardous at the concentration(s) used. May contain a trace amount of benzene (<0.01%). Contains a trace amount of sulfur (<0.0015%)

Composition Information:

Name	CAS Number	% Concentration
No. 2 Diesel Fuel	68476-34-6	50-100
Kerosine (petroleum)	8008-20-6	0-50
Alkanes, C10-C20 branched and linear	928771-01-1	0-5
Naphthalene	91-20-3	0.3-2.6

All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

4. FIRST AID MEASURES

First Aid Measures

General Advice: In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation: Remove to fresh air. If not breathing, institute rescue breathing. If breathing is difficult, ensure airway is clear, give oxygen and continue to monitor. If heart has stopped, immediately begin cardiopulmonary resuscitation (CPR). Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Skin Contact: Immediately wash exposed skin with plenty of soap and water while removing contaminated clothing and shoes. May be absorbed through the skin in harmful amounts. Get medical attention if irritation persists. Any injection injury from high pressure equipment should be evaluated immediately by a physician as potentially serious (See NOTES TO PHYSICIAN).

Place contaminated clothing in closed container until cleaned or discarded. If clothing is to be laundered, inform the person performing the operation of contaminant's hazardous properties. Destroy contaminated, non-chemical resistant footwear.

Eye Contact:	Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while flushing. Get medical attention if irritation persists.
Ingestion:	Do not induce vomiting because of danger of aspirating liquid into lungs, causing serious damage and chemical pneumonitis. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects:	Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking. Prolonged or repeated exposure may cause adverse effects to the thymus, liver, and bone marrow.
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Indication of any immediate medical attention and special treatment needed

Notes To Physician:	<p>INHALATION: This material (or a component) sensitizes the myocardium to the effects of sympathomimetic amines. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in individuals exposed to this material. Administration of sympathomimetic drugs should be avoided.</p> <p>SKIN: Leaks or accidents involving high-pressure equipment may inject a stream of material through the skin and initially produce an injury that may not appear serious. Only a small puncture wound may appear on the skin surface but, without proper treatment and depending on the nature, original pressure, volume, and location of the injected material, can compromise blood supply to an affected body part. Prompt surgical debridement of the wound may be necessary to prevent irreversible loss of function and/or the affected body part. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES.</p> <p>INGESTION: This material represents a significant aspiration and chemical pneumonitis hazard. Induction of emesis is not recommended.</p>
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5. FIRE-FIGHTING MEASURES

Suitable extinguishing media

For small fires, Class B fire extinguishing media such as CO₂, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.

Unsuitable extinguishing media

Do not use straight water streams to avoid spreading fire.

Specific hazards arising from the chemical

This product has been determined to be a flammable liquid per the OSHA Hazard Communication Standard and should be handled accordingly. May accumulate electrostatic charge and ignite or explode. Vapors may travel along the ground or be moved by ventilation and ignited by many sources such as pilot lights, sparks, electric motors, static discharge, or other ignition sources at locations distant from material handling. Flashback can occur along vapor trail. For additional fire related information, see NFPA 30 or the Emergency Response Guidebook 128.

Hazardous combustion products

Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data

Sensitivity to Mechanical Impact No.

Sensitivity to Static Discharge Yes.

Special protective equipment and precautions for firefighters

Firefighters should wear full protective clothing and positive-pressure self-contained breathing apparatus (SCBA) with a full face-piece, as appropriate. Avoid using straight water streams. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Avoid excessive water spray application. Keep surrounding area cool with water spray from a distance and prevent further ignition of combustible material. Keep run-off water out of sewers and water sources.

Additional firefighting tactics

FIRES INVOLVING TANKS OR CAR/TRAILER LOADS: Fight fire from maximum distance or use unmanned hose holders or monitor nozzles. Cool containers with flooding quantities of water until well after the fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

EVACUATION: Consider initial downwind evacuation for at least 1000 feet. If tank, rail car or tank truck is involved in a fire, ISOLATE for 5280 feet (1 mile) in all directions; also, consider initial evacuation of 5280 feet (1 mile) in all directions.

NFPA Health 1 Flammability 2 Instability 0 Special Hazard -

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Eliminate all ignition sources. All contaminated surfaces will be slippery.
Protective equipment:	Use personal protection measures as recommended in Section 8.
Emergency procedures:	Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.
Environmental precautions:	Avoid release to the environment. Avoid subsoil penetration.
Methods and materials for containment:	Contain liquid with sand or soil. Prevent spilled material from entering storm drains, sewers, and open waterways.
Methods and materials for cleaning up:	Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids. Recover and return free product to proper containers. When recovering free liquids ensure all equipment is grounded and bonded. Use only non-sparking tools.

7. HANDLING AND STORAGE

Safe Handling Precautions:	<p>NEVER SIPHON THIS PRODUCT BY MOUTH. Use appropriate grounding and bonding practices. Static accumulating flammable liquid. Bonding and grounding may be insufficient to eliminate the hazard from static electricity. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. Vapors may travel along the ground or be moved by ventilation. Flashback may occur along vapor trails. No smoking. Use only non-sparking tools. Avoid breathing fumes, gas, or vapors. Use only with adequate ventilation. Avoid repeated and prolonged skin contact. Use personal protection measures as recommended in Section 8. Exercise good personal hygiene including removal of soiled clothing and prompt washing with soap and water. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements.</p> <p>Hydrocarbons are basically non-conductors of electricity and can become electrostatically charged during mixing, filtering, pumping at high flow rates or loading and transfer operations. If this charge reaches a sufficiently high level, sparks can form that may ignite the vapors of flammable liquids. Sudden release of hot organic chemical vapors or mists</p>
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from process equipment operating under elevated temperature and pressure, or sudden ingress of air into vacuum equipment may result in ignition of vapors or mists without the presence of obvious ignition sources. Nozzle spouts must be kept in contact with the containers or tank during the entire filling operation.

Portable containers should never be filled while in or on a motor vehicle or marine craft. Containers should be placed on the ground. Static electric discharge can ignite fuel vapors when filling non-grounded containers or vehicles on trailers. The nozzle spout must be kept in contact with the container before and during the entire filling operation. Use only approved containers.

A buildup of static electricity can occur upon re-entry into a vehicle during fueling especially in cold or dry climate conditions. The charge is generated by the action of dissimilar fabrics (i.e., clothing and upholstery) rubbing across each other as a person enters/exits the vehicle. A flash fire can result from this discharge if sufficient flammable vapors are present. Therefore, do not get back in your vehicle while refueling.

Cellular phones and other electronic devices may have the potential to emit electrical charges (sparks). Sparks in potentially explosive atmospheres (including fueling areas such as gas stations) could cause an explosion if sufficient flammable vapors are present. Therefore, turn off cellular phones and other electronic devices when working in potentially explosive atmospheres or keep devices inside your vehicle during refueling.

High-pressure injection of any material through the skin is a serious medical emergency even though the small entrance wound at the injection site may not initially appear serious. These injection injuries can occur from high-pressure equipment such as paint spray or grease or guns, fuel injectors, or pinhole leaks in hoses or hydraulic lines and should all be considered serious. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES (See First Aid Section 4).

Storage Conditions:

Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area. Do not store near an open flame, heat or other sources of ignition.

Incompatible Materials

Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	ACGIH TLV	OSHA PELs:	OSHA - Vacated PELs	NIOSH IDLH
No. 2 Diesel Fuel 68476-34-6	100 mg/m ³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Kerosine (petroleum) 8008-20-6	200 mg/m ³ TWA Skin - potential significant contribution to overall exposure by the cutaneous route	-	-	-
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	-	-
Naphthalene 91-20-3	10 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm TWA: 50 mg/m ³	10 ppm TWA 50 mg/m ³ TWA 15 ppm STEL 75 mg/m ³ STEL	250 ppm

Notes:

The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.

Engineering measures:

Local or general exhaust required in an enclosed area or with inadequate ventilation. Use mechanical ventilation equipment that is explosion-proof.

Personal protective equipment

Eye protection:	Use goggles or face-shield if the potential for splashing exists.
Skin and body protection:	Wear neoprene, nitrile or PVA gloves to prevent skin contact. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times.
Respiratory protection:	Use a NIOSH approved organic vapor chemical cartridge or supplied air respirators when there is the potential for airborne exposures to exceed permissible exposure limits or if excessive vapors are generated. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.
Hygiene measures:	Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES**Information on basic physical and chemical properties**

Physical State	Liquid
Appearance	Yellow to Red Liquid
Color	Yellow to Red
Odor	Hydrocarbon
Odor Threshold	No data available.

Property	Values (Method)
Melting Point / Freezing Point	No data available.
Initial Boiling Point / Boiling Range	154-366 °C / 310-691 °F (ASTM D86)
Flash Point	58-76 °C / 136-168 °F (ASTM D93)
Evaporation Rate	No data available.
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%):	
Upper Flammability Limit:	No data available.
Lower Flammability Limit:	No data available.
Explosion limits:	No data available.
Vapor Pressure	No data available.
Vapor Density	No data available.
Specific Gravity / Relative Density	0.82-0.86
Water Solubility	No data available.
Solubility in other solvents	No data available.
Partition Coefficient	No data available.
Decomposition temperature	No data available.
pH:	Not applicable
Autoignition Temperature	No data available.
Kinematic Viscosity	1.90-3.32 cSt @ 40°C (ASTM D445)
Dynamic Viscosity	No data available.
Explosive Properties	No data available.
VOC Content (%)	No data available.
Density	No data available.
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

Reactivity	The product is non-reactive under normal conditions.
Chemical stability	The material is stable at 70°F (21°C), 760 mmHg pressure.
Possibility of hazardous reactions	None under normal processing.

Hazardous polymerization

Will not occur.

Conditions to avoid

Excessive heat, sources of ignition, open flame.

Incompatible Materials

Strong oxidizing agents.

Hazardous decomposition products

None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION**Potential short-term adverse effects from overexposures****Inhalation**

Harmful if inhaled. May cause irritation of respiratory tract. May cause drowsiness or dizziness. Breathing high concentrations of this material in a confined space or by intentional abuse can cause irregular heartbeats which can cause death.

Eye contact

Exposure to vapor or contact with liquid may cause mild eye irritation, including tearing, stinging, and redness.

Skin contact

Irritating to skin. Effects may become more serious with repeated or prolonged contact. May be absorbed through the skin in harmful amounts.

Ingestion

May be fatal if swallowed or vomited and enters airways. May cause irritation of the mouth, throat and gastrointestinal tract.

Acute toxicological data

Name	Oral LD50	Dermal LD50	Inhalation LC50
No. 2 Diesel Fuel 68476-34-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	>1 - <5 mg/L (Rat) 4 h
Kerosine (petroleum) 8008-20-6	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.28 mg/L (Rat) 4 h
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	>1 - <5 mg/l (Rat) 4 h
Naphthalene 91-20-3	490 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 340 mg/m ³ (Rat) 1 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

MIDDLE DISTILLATES, PETROLEUM: Long-term repeated (lifetime) skin exposure to similar materials has been reported to result in an increase in skin tumors in laboratory rodents. The relevance of these findings to humans is not clear at this time. Altered mental state, drowsiness, peripheral motor neuropathy, irreversible brain damage (so-called Petrol Sniffer's Encephalopathy), delirium, seizures, and sudden death have been reported from repeated overexposure to some hydrocarbon solvents, naphthas, and gasoline.

MIDDLE DISTILLATES WITH CRACKED STOCKS: Light cracked distillates have been shown to be carcinogenic in animal tests and have tested positive with in vitro genotoxicity tests. Repeated dermal exposures to high concentrations in test animals resulted in reduced litter size and litter weight, and increased fetal resorptions at maternally toxic doses. Dermal exposure to high concentrations resulted in severe skin irritation with weight loss and some mortality. Inhalation exposure to high concentrations resulted in respiratory tract irritation, lung changes/infiltration/accumulation, and reduction in lung function.

ISOPARAFFINS: Studies in laboratory animals have shown that long-term exposure to similar materials (isoparaaffins) can cause kidney damage and kidney cancer in male laboratory rats. However, in-depth research indicates that these findings are unique to the male rat, and that these effects are not relevant to humans.

NAPHTHALENE: Severe jaundice, neurotoxicity (kernicterus) and fatalities have been reported in young children and infants as a result of hemolytic anemia from overexposure to naphthalene. Persons with glucose 6-phosphate dehydrogenase (G6PD) deficiency are more prone to the hemolytic effects of naphthalene. Adverse effects on the kidney have been reported in persons overexposed to naphthalene but these effects are believed to be a consequence of hemolytic anemia, and not a direct effect. Hemolytic anemia has been observed in laboratory animals exposed to naphthalene. Laboratory rodents exposed to naphthalene vapor for 2 years (lifetime studies) developed non-neoplastic and neoplastic tumors and inflammatory lesions of the nasal and respiratory tract. Cataracts and other adverse effects on the eye have been observed in laboratory animals exposed to high levels of naphthalene. Findings from a large number of bacterial and mammalian cell mutation assays have been negative. A few studies have shown chromosomal effects (elevated levels of Sister Chromatid Exchange or chromosomal aberrations) in vitro. Naphthalene has been classified as Possibly Carcinogenic to Humans (2B) by IARC, based on findings from studies in laboratory animals.

DIESEL EXHAUST: The combustion of diesel fuels produces gases including carbon monoxide, carbon dioxide, oxides of nitrogen and/or sulfur, and hydrocarbons that can be irritating and hazardous with overexposure. Long-term occupational overexposure to diesel exhaust and diesel exhaust particulate matter has been associated with an increased risk of respiratory disease, including lung cancer, and is characterized as a "known human carcinogen" by the International Agency for Research on Cancer (IARC), as "a reasonably anticipated human carcinogen" by the National Toxicology Program, and as "likely to be carcinogenic to humans" by the EPA, based upon animal and occupational exposure studies. However, uncertainty exists with these classifications because of deficiencies in the supporting occupational exposure/epidemiology studies, including reliable exposure estimates. Lifetime animal inhalation studies with pulmonary overloading exposure concentrations of diesel exhaust emissions have produced tumors and other adverse health effects. However, in more recent long-term animal inhalation studies of diesel exhaust emissions, no increase in tumor incidence and in fact a substantial reduction in adverse health effects along with significant reductions in the levels of hazardous material emissions were observed and are associated with fuel composition alterations coupled with new technology diesel engines.

Adverse effects related to the physical, chemical and toxicological characteristics

Signs and Symptoms	Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking. Prolonged or repeated exposure may cause damage to organs.
Skin corrosion/irritation	Causes skin irritation.
Serious eye damage/eye irritation	None known.
Sensitization	None known.
Mutagenic effects	None known.
Carcinogenicity	Suspected of causing cancer.

Cancer designations are listed in the table below

Name	ACGIH (Class)	IARC (Class)	NTP	OSHA
No. 2 Diesel Fuel 68476-34-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Kerosine (petroleum) 8008-20-6	Confirmed animal carcinogen (A3)	Not Classifiable (3)	Not Listed	Not Listed
Alkanes, C10-C20 branched and linear 928771-01-1	Not Listed	Not Listed	Not Listed	Not Listed

Naphthalene 91-20-3	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Reasonably anticipated to be a human carcinogen	Not Listed
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Reproductive toxicity None known.

Specific Target Organ Toxicity (STOT) - single exposure Respiratory system. Central nervous system.

Specific Target Organ Toxicity (STOT) - repeated exposure Thymus. Liver. Bone marrow.

Aspiration hazard May be fatal if swallowed or vomited and enters airways.

12. ECOLOGICAL INFORMATION

Ecotoxicity This product should be considered toxic to aquatic organisms, with the potential to cause long lasting adverse effects in the aquatic environment.

Name	Algae/aquatic plants	Fish	Toxicity to Microorganisms	Crustacea
No. 2 Diesel Fuel 68476-34-6	-	96-hr LC50 = 35 mg/l Fathead minnow (flow-through)	-	48-hr EL50 = 6.4 mg/l Daphnia magna
Kerosine (petroleum) 8008-20-6	72-hr EL50 = 5.0-11 mg/l Algae	96-hr LL50 = 18-25 mg/l Fish	-	48-hr EL50 = 1.4-21 mg/l Invertebrates
Alkanes, C10-C20 branched and linear 928771-01-1	-	-	-	-
Naphthalene 91-20-3	-	96-hr LC50 = 0.91-2.82 mg/l Rainbow trout (static) 96-hr LC50 = 1.99 mg/l Fathead minnow (static)	-	48-hr LC50 = 1.6 mg/l Daphnia magna

Persistence and degradability Expected to be inherently biodegradable.

Bioaccumulation Has the potential to bioaccumulate.

Mobility in soil May partition into air, soil and water.

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues

This material may be a flammable liquid waste.

Safe Handling of Wastes

Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required. Use appropriate grounding and bonding practices. Use only non-sparking tools. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. No smoking.

Disposal of Wastes / Methods of Disposal

The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal

Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper Shipping Name: Fuel Oil, No. 2
UN/Identification No: NA 1993
Class: 3
Packing Group: III

TDG (Canada):

UN Proper Shipping Name: Diesel Fuel
UN/Identification No: UN 1202
Transport Hazard Class(es): 3
Packing Group: III

15. REGULATORY INFORMATION

US Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b): This product and/or its components are listed on the TSCA Chemical Inventory.

EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product does not contain any component(s) included on EPA's Extremely Hazardous Substance (EHS) List.

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
No. 2 Diesel Fuel	NA
Kerosine (petroleum)	NA
Alkanes, C10-C20 branched and linear	NA
Naphthalene	NA

SARA Section 304: This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	Hazardous Substances RQs
No. 2 Diesel Fuel	NA
Kerosine (petroleum)	NA
Alkanes, C10-C20 branched and linear	NA
Naphthalene	100 lb final RQ 45.4 kg final RQ

SARA Section 311/312: The following EPA hazard categories apply to this product:

Acute Health Hazard
Fire Hazard
Chronic Health Hazard

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

Name	CERCLA/SARA 313 Emission reporting:
No. 2 Diesel Fuel	None
Kerosine (petroleum)	None
Alkanes, C10-C20 branched and linear	None
Naphthalene	0.1 % de minimis concentration

State and Community Right-To-Know Regulations:

The following component(s) of this material are identified on the regulatory lists below:

No. 2 Diesel Fuel

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 2444
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 2444 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Kerosine (petroleum)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1091
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	SN 1091 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Alkanes, C10-C20 branched and linear	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Naphthalene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Carcinogen, initial date 4/19/02

New Jersey Right-To-Know:	SN 1322 SN 3758
Pennsylvania Right-To-Know:	Environmental hazard Present (particulate)
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Carcinogen
New Jersey - Environmental Hazardous Substances List:	SN 1322 TPQ: 500 lb (Reportable at the de minimis quantity of >0.1%)
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	100 lb RQ (air); 1 lb RQ (land/water)

Canada DSL/NDL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all of the information required by those regulations.

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
No. 2 Diesel Fuel	B3,D2A,D2B	0.1%
Kerosine (petroleum)	B3,D2B	1%
Alkanes, C10-C20 branched and linear	B3,D2A,D2B	0.1%
Naphthalene	B4,D2A	0.1%



Note: Not applicable.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety

Issue Date 10/31/2016

Revision Notes

Revision Date 06/01/2016

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.



SAFETY DATA SHEET

SDS ID NO.: 0127MAR019
Revision Date 06/01/2016

1. IDENTIFICATION

Product Name: Marathon Petroleum Gasoline - All Grades

Synonym: Gasoline; Regular Unleaded Gasoline; Conventional Regular Unleaded Gasoline; Mid Grade Unleaded Gasoline; Conventional Mid Grade Unleaded Gasoline; Premium Unleaded Gasoline; Conventional Premium Unleaded Gasoline; Sub-Octane Gasoline; Regular RBOB; Super RBOB; Premium RBOB; RBOB; Reformulated Blend Stock For Oxygenated Blending; 84 Octane Gasoline; CBOB; Premium CBOB; Conventional Blend Stock for Oxygenate Blending; Recreational Gasoline; Recreational Gasoline; Recreational Unleaded Gasoline; 89 Recreational Gasoline; Brand 89 Recreational Gasoline; 7.0 Max RVP 89 Recreational Gasoline; BR 7.0 Max RVP 89 Recreational Gasoline; 90 Recreational Gasoline; 90 Marina Gasoline; Brand 91 Recreational Gasoline; 91 Recreational Gasoline; 91 Marina Gasoline; 90 Octane Midgrade Gasoline with No Ethanol; 0125MAR019; 0126MAR019; 0134MAR019; 0313MAR019; 0314MAR019

Product Code: 0127MAR019

Chemical Family: Complex Hydrocarbon Substance

Recommended Use: Fuel.

Restrictions on Use: All others.

Manufacturer, Importer, or Responsible Party Name and Address:

MARATHON PETROLEUM COMPANY LP
539 South Main Street
Findlay, OH 45840

SDS information: 1-419-421-3070

Emergency Telephone: 1-877-627-5463

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Flammable liquids	Category 1
Skin corrosion/irritation	Category 2
Germ cell mutagenicity	Category 1B
Carcinogenicity	Category 1B
Reproductive toxicity	Category 2
Specific target organ toxicity (single exposure)	Category 3
Aspiration toxicity	Category 1
Acute aquatic toxicity	Category 2
Chronic aquatic toxicity	Category 2

Hazards Not Otherwise Classified (HNOC)

Static accumulating flammable liquid

Label elements

EMERGENCY OVERVIEW

Danger

EXTREMELY FLAMMABLE LIQUID AND VAPOR

May accumulate electrostatic charge and ignite or explode

May be fatal if swallowed and enters airways

Causes skin irritation

May cause respiratory irritation

May cause drowsiness or dizziness

May cause genetic defects

May cause cancer

Suspected of damaging fertility or the unborn child

Toxic to aquatic life with long lasting effects



Appearance Clear yellow liquid

Physical State Liquid

Odor Hydrocarbon

Precautionary Statements - Prevention

Obtain special instructions before use

Do not handle until all safety precautions have been read and understood

Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking

Keep container tightly closed

Ground/bond container and receiving equipment

Use explosion-proof electrical/ventilating/lighting/equipment

Use only non-sparking tools.

Take action to prevent static discharges

Avoid breathing mist/vapors/spray

Use only outdoors or in a well-ventilated area

Wear protective gloves/protective clothing/eye protection/face protection

Wash hands and any possibly exposed skin thoroughly after handling

Avoid release to the environment

Precautionary Statements - Response

IF exposed or concerned: Get medical attention

IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower

If skin irritation occurs: Get medical attention

Wash contaminated clothing before reuse

IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing

Call a POISON CENTER or doctor if you feel unwell

IF SWALLOWED: Immediately call a POISON CENTER or doctor

Do NOT induce vomiting

In case of fire: Use water spray, fog or regular foam for extinction

Collect spillage

Precautionary Statements - Storage

Store in a well-ventilated place. Keep container tightly closed

Keep cool

Store locked up

Precautionary Statements - Disposal

Dispose of contents/container at an approved waste disposal plant

3. COMPOSITION/INFORMATION ON INGREDIENTS

Gasoline is a complex combination of hydrocarbons consisting of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons having molecular chains ranging in length from four to ten carbons. May contain small amounts of dye and other additives (>0.02%) which are not considered hazardous at the concentrations used.

Composition Information:

Name	CAS Number	% Concentration
Gasoline	86290-81-5	100
Heptane (mixed isomers)	142-82-5	2.5-26
Butane (mixed isomers)	106-97-8	0.5-19
Pentane (mixed isomers)	78-78-4	6.5-19
Hexane Isomers (other than n-Hexane)	107-83-5	2-12
Toluene	108-88-3	3-9.5
Xylene (mixed isomers)	1330-20-7	3.5-9.5
n-Hexane	110-54-3	0.1-4.5
Cumene	98-82-8	0-4
1,2,4 Trimethylbenzene	95-63-6	1-4
Ethylbenzene	100-41-4	0.5-2.5
Benzene	71-43-2	0.1-1.5
Cyclohexane	110-82-7	0-1.5
Octane	111-65-9	0-1.5
1,2,3-Trimethylbenzene	526-73-8	0-1
Naphthalene	91-20-3	0.1-0.5

All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

4. FIRST AID MEASURES**First Aid Measures****General Advice:**

In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation:

Remove to fresh air. If not breathing, institute rescue breathing. If breathing is difficult, ensure airway is clear, give oxygen and continue to monitor. If heart has stopped, immediately begin cardiopulmonary resuscitation (CPR). Keep affected person warm and at rest. If symptoms occur get medical attention.

Skin Contact:

Immediately wash exposed skin with plenty of soap and water while removing contaminated clothing and shoes. May be absorbed through the skin in harmful amounts. Get medical attention if irritation persists. Any injection injury from high pressure equipment should be evaluated immediately by a physician as potentially serious (See NOTES TO PHYSICIAN).

Place contaminated clothing in closed container until cleaned or discarded. If clothing is to be laundered, inform the person performing the operation of contaminant's hazardous properties. Destroy contaminated, non-chemical resistant footwear.

Eye Contact:

Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while flushing. Get medical attention if irritation persists.

Ingestion:

Do not induce vomiting because of danger of aspirating liquid into lungs, causing serious damage and chemical pneumonitis. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected

person warm and at rest. GET IMMEDIATE MEDICAL ATTENTION.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects: Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking.

Indication of any immediate medical attention and special treatment needed

Notes To Physician:

INHALATION: This material (or a component) sensitizes the myocardium to the effects of sympathomimetic amines. Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in individuals exposed to this material. Administration of sympathomimetic drugs should be avoided.

SKIN: Leaks or accidents involving high-pressure equipment may inject a stream of material through the skin and initially produce an injury that may not appear serious. Only a small puncture wound may appear on the skin surface but, without proper treatment and depending on the nature, original pressure, volume, and location of the injected material, can compromise blood supply to an affected body part. Prompt surgical debridement of the wound may be necessary to prevent irreversible loss of function and/or the affected body part. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES.

INGESTION: This material represents a significant aspiration and chemical pneumonitis hazard. Induction of emesis is not recommended.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media

For small fires, Class B fire extinguishing media such as CO₂, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.

Unsuitable extinguishing media

Do not use straight water streams to avoid spreading fire.

Specific hazards arising from the chemical

This product has been determined to be an extremely flammable liquid per the OSHA Hazard Communication Standard and should be handled accordingly. May accumulate electrostatic charge and ignite or explode. Vapors may travel along the ground or be moved by ventilation and ignited by many sources such as pilot lights, sparks, electric motors, static discharge, or other ignition sources at locations distant from material handling. Flashback can occur along vapor trail. For additional fire related information, see NFPA 30 or the Emergency Response Guidebook 128.

Hazardous combustion products

Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data

Sensitivity to Mechanical Impact No.
Sensitivity to Static Discharge Yes.

Special protective equipment and precautions for firefighters

Firefighters should wear full protective clothing and positive-pressure self-contained breathing apparatus (SCBA) with a full face-piece, as appropriate. Avoid using straight water streams. Water may be ineffective in extinguishing low flash point fires, but can be used to cool exposed surfaces. Avoid excessive water spray application. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Keep run-off water out of sewers and water sources.

Additional firefighting tactics

FIRES INVOLVING TANKS OR CAR/TRAILER LOADS: Fight fire from maximum distance or use unmanned hose holders or

monitor nozzles. Cool containers with flooding quantities of water until well after the fire is out. Do not direct water at source of leak or safety devices; icing may occur. Withdraw immediately in case of rising sound from venting safety devices or discoloration of tank. ALWAYS stay away from tanks engulfed in fire. For massive fire, use unmanned hose holders or monitor nozzles; if this is impossible, withdraw from area and let fire burn.

EVACUATION: Consider initial downwind evacuation for at least 1000 feet. If tank, rail car or tank truck is involved in a fire, ISOLATE for 5280 feet (1 mile) in all directions; also, consider initial evacuation of 5280 feet (1 mile) in all directions.

NFPA Health 1 Flammability 3 Instability 0 Special Hazard -

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Keep public away. Isolate and evacuate area. Shut off source if safe to do so. Eliminate all ignition sources.
Protective equipment:	Use personal protection measures as recommended in Section 8.
Emergency procedures:	Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.
Environmental precautions:	Avoid release to the environment. Avoid subsoil penetration. Ethanol in gasoline phase separates in contact with water. Monitor downstream for dissolved ethanol or other appropriate indicators.
Methods and materials for containment:	Contain liquid with sand or soil. Prevent spilled material from entering storm drains, sewers, and open waterways.
Methods and materials for cleaning up:	Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids. Recover and return free product to proper containers. When recovering free liquids ensure all equipment is grounded and bonded. Use only non-sparking tools.

7. HANDLING AND STORAGE

Safe Handling Precautions:	<p>NEVER SIPHON THIS PRODUCT BY MOUTH. Use appropriate grounding and bonding practices. Static accumulating flammable liquid. Bonding and grounding may be insufficient to eliminate the hazard from static electricity. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. Vapors may travel along the ground or be moved by ventilation. Flashback may occur along vapor trails. No smoking. Use only non-sparking tools. Avoid contact with skin, eyes and clothing. Avoid breathing fumes, gas, or vapors. Use only with adequate ventilation. Avoid repeated and prolonged skin contact. Use personal protection measures as recommended in Section 8. Exercise good personal hygiene including removal of soiled clothing and prompt washing with soap and water. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements.</p> <p>Hydrocarbons are basically non-conductors of electricity and can become electrostatically charged during mixing, filtering, pumping at high flow rates or loading and transfer operations. If this charge reaches a sufficiently high level, sparks can form that may ignite the vapors of flammable liquids. Sudden release of hot organic chemical vapors or mists from process equipment operating under elevated temperature and pressure, or sudden ingress of air into vacuum equipment may result in ignition of vapors or mists without the presence of obvious ignition sources. Nozzle spouts must be kept in contact with the containers or tank during the entire filling operation.</p> <p>Portable containers should never be filled while in or on a motor vehicle or marine craft. Containers should be placed on the ground. Static electric discharge can ignite fuel vapors when filling non-grounded containers or vehicles on trailers. The nozzle spout must be kept in contact with the container before and during the entire filling operation. Use only</p>
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approved containers.

A buildup of static electricity can occur upon re-entry into a vehicle during fueling especially in cold or dry climate conditions. The charge is generated by the action of dissimilar fabrics (i.e., clothing and upholstery) rubbing across each other as a person enters/exits the vehicle. A flash fire can result from this discharge if sufficient flammable vapors are present. Therefore, do not get back in your vehicle while refueling.

Cellular phones and other electronic devices may have the potential to emit electrical charges (sparks). Sparks in potentially explosive atmospheres (including fueling areas such as gas stations) could cause an explosion if sufficient flammable vapors are present. Therefore, turn off cellular phones and other electronic devices when working in potentially explosive atmospheres or keep devices inside your vehicle during refueling.

High-pressure injection of any material through the skin is a serious medical emergency even though the small entrance wound at the injection site may not initially appear serious. These injection injuries can occur from high-pressure equipment such as paint spray or grease or guns, fuel injectors, or pinhole leaks in hoses or hydraulic lines and should all be considered serious. High pressure injection injuries may be SERIOUS SURGICAL EMERGENCIES (See First Aid Section 4).

Storage Conditions:

Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area. Do not store near an open flame, heat or other sources of ignition.

Incompatible Materials

Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	ACGIH TLV	OSHA PELs:	OSHA - Vacated PELs	NIOSH IDLH
Gasoline 86290-81-5	300 ppm TWA 500 ppm STEL	-	300 ppm TWA 900 mg/m ³ TWA 500 ppm STEL 1500 mg/m ³ STEL	-
Heptane (mixed isomers) 142-82-5	400 ppm TWA 500 ppm STEL	TWA: 500 ppm TWA: 2000 mg/m ³	400 ppm TWA 1600 mg/m ³ TWA 500 ppm STEL 2000 mg/m ³ STEL	750 ppm
Butane (mixed isomers) 106-97-8	1000 ppm STEL	-	800 ppm TWA 1900 mg/m ³ TWA	-
Pentane (mixed isomers) 78-78-4	1000 ppm TWA	-	-	-
Hexane Isomers (other than n-Hexane) 107-83-5	500 ppm TWA 1000 ppm STEL	-	500 ppm TWA 1800 mg/m ³ TWA 1000 ppm STEL 3600 mg/m ³ STEL	-
Toluene 108-88-3	20 ppm TWA	TWA: 200 ppm Ceiling: 300 ppm	100 ppm TWA 375 mg/m ³ TWA 150 ppm STEL 560 mg/m ³ STEL	500 ppm
Xylene (mixed isomers) 1330-20-7	100 ppm TWA 150 ppm STEL	TWA: 100 ppm TWA: 435 mg/m ³	100 ppm TWA 435 mg/m ³ TWA 150 ppm STEL 655 mg/m ³ STEL	900 ppm
n-Hexane 110-54-3	50 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 500 ppm TWA: 1800 mg/m ³	50 ppm TWA 180 mg/m ³ TWA	1100 ppm
Cumene 98-82-8	50 ppm TWA	TWA: 50 ppm TWA: 245 mg/m ³ Skin	50 ppm TWA 245 mg/m ³ TWA Limit applies to skin	900 ppm
1,2,4 Trimethylbenzene	25 ppm TWA	-	25 ppm TWA	-

95-63-6			125 mg/m ³ TWA	
Ethylbenzene 100-41-4	20 ppm TWA	TWA: 100 ppm TWA: 435 mg/m ³	100 ppm TWA 435 mg/m ³ TWA 125 ppm STEL 545 mg/m ³ STEL	800 ppm
Benzene 71-43-2	0.5 ppm TWA 2.5 ppm STEL Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm (applies to industry segments exempt from the benzene standard) TWA: 1 ppm STEL: 5 ppm (see 29 CFR 1910.1028)	25 ppm Ceiling 1 ppm TWA 5 ppm STEL	500 ppm
Cyclohexane 110-82-7	100 ppm TWA	TWA: 300 ppm TWA: 1050 mg/m ³	300 ppm TWA 1050 mg/m ³ TWA	1300 ppm
Octane 111-65-9	300 ppm TWA	TWA: 500 ppm TWA: 2350 mg/m ³	300 ppm TWA 1450 mg/m ³ TWA 375 ppm STEL 1800 mg/m ³ STEL	1000 ppm
1,2,3-Trimethylbenzene 526-73-8	25 ppm TWA	-	25 ppm TWA 125 mg/m ³ TWA	-
Naphthalene 91-20-3	10 ppm TWA Skin - potential significant contribution to overall exposure by the cutaneous route	TWA: 10 ppm TWA: 50 mg/m ³	10 ppm TWA 50 mg/m ³ TWA 15 ppm STEL 75 mg/m ³ STEL	250 ppm

Notes: The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.

Engineering measures: Local or general exhaust required in an enclosed area or when there is inadequate ventilation. Use mechanical ventilation equipment that is explosion-proof.

Personal protective equipment

Eye protection: Use goggles or face-shield if the potential for splashing exists.

Skin and body protection: Use nitrile rubber, Viton® or PVA gloves for repeated or prolonged skin exposure. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times.

Respiratory protection: Use a NIOSH approved organic vapor chemical cartridge or supplied air respirators when there is the potential for airborne exposures to exceed permissible exposure limits or if excessive vapors are generated. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.

Hygiene measures: Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical State Liquid
Appearance Clear yellow liquid
Color Yellow
Odor Hydrocarbon
Odor Threshold No data available.

Property **Values (Method)**
Melting Point / Freezing Point No data available.
Initial Boiling Point / Boiling Range 24-210 °C / 75-410 °F (ASTM D86)

Flash Point	-43 °C / -45 °F
Evaporation Rate	No data available.
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%):	
Upper Flammability Limit:	7.6
Lower Flammability Limit:	1.4
Explosion limits:	No data available.
Vapor Pressure	5.5-15 psi (ASTM D4814)
Vapor Density	3-4
Specific Gravity / Relative Density	0.70-0.76
Water Solubility	No data available.
Solubility in other solvents	No data available.
Partition Coefficient	2.13-4.5
Decomposition temperature	No data available.
pH:	Not applicable
Autoignition Temperature	280 °C / 536 °F
Kinematic Viscosity	No data available.
Dynamic Viscosity	No data available.
Explosive Properties	No data available.
VOC Content (%)	100%
Density	No data available.
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

<u>Reactivity</u>	The product is non-reactive under normal conditions.
<u>Chemical stability</u>	The material is stable at 70°F (21°C), 760 mmHg pressure.
<u>Possibility of hazardous reactions</u>	None under normal processing.
<u>Hazardous polymerization</u>	Will not occur.
<u>Conditions to avoid</u>	Excessive heat, sources of ignition, open flame.
<u>Incompatible Materials</u>	Strong oxidizing agents.
<u>Hazardous decomposition products</u>	None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION

Potential short-term adverse effects from overexposures

Inhalation	May cause irritation of respiratory tract. May cause drowsiness or dizziness. Breathing high concentrations of this material in a confined space or by intentional abuse can cause irregular heartbeats which can cause death.
Eye contact	Exposure to vapor or contact with liquid may cause mild eye irritation, including tearing, stinging, and redness.
Skin contact	Irritating to skin. Effects may become more serious with repeated or prolonged contact. May be absorbed through the skin in harmful amounts.
Ingestion	May be fatal if swallowed or vomited and enters airways. May cause irritation of the mouth, throat and gastrointestinal tract.

Acute toxicological data

Name	Oral LD50	Dermal LD50	Inhalation LC50
Gasoline	14000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.2 mg/L (Rat) 4 h

86290-81-5			
Heptane (mixed isomers) 142-82-5	-	3000 mg/kg (Rabbit)	103 g/m ³ (Rat) 4 h
Butane (mixed isomers) 106-97-8	-	-	658 mg/L (Rat) 4 h
Pentane (mixed isomers) 78-78-4	-	-	450 mg/L (Mouse) 2 h
Hexane Isomers (other than n-Hexane) 107-83-5	> 5000 mg/kg (Rat)	-	-
Toluene 108-88-3	> 2000 mg/kg (Rat)	8390 mg/kg (Rabbit)	12.5 mg/L (Rat) 4 h
Xylene (mixed isomers) 1330-20-7	> 2000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 5.04 mg/L (Rat) 4 h
n-Hexane 110-54-3	15000 mg/kg (Rat)	3000 mg/kg (Rabbit)	48000 ppm (Rat) 4 h
Cumene 98-82-8	> 2000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 20 mg/L (Rat) 6 h
1,2,4 Trimethylbenzene 95-63-6	3280 mg/kg (Rat)	> 3160 mg/kg (Rabbit)	18,000 mg/m ³ (Rat) 4 h
Ethylbenzene 100-41-4	> 2000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	17.2 mg/L (Rat) 4 h
Benzene 71-43-2	> 2000 mg/kg (Rat)	> 5000 mg/kg (Rabbit)	> 20 mg/l (Rat) 4 h
Cyclohexane 110-82-7	> 5000 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	13.9 mg/L (Rat) 4 h
Octane 111-65-9	-	-	118 g/m ³ (Rat) 4 h
1,2,3-Trimethylbenzene 526-73-8	-	-	-
Naphthalene 91-20-3	490 mg/kg (Rat)	> 2000 mg/kg (Rabbit)	> 340 mg/m ³ (Rat) 1 h

Delayed and immediate effects as well as chronic effects from short and long-term exposure

NAPHTHAS: In a large epidemiological study on over 15,000 employees at several petroleum refineries and amongst residents located near these refineries, no increased risk of kidney cancer was observed in association with gasoline exposures (a similar material). In a similar study, no increased risk of kidney cancer was observed among petroleum refinery workers, but there was a slight trend in the incidence of kidney cancers among service station employees, especially after a 30-year latency period. Altered mental state, drowsiness, peripheral motor neuropathy, irreversible brain damage (so-called Petrol Sniffer's Encephalopathy), delirium, seizures, and sudden death have been reported from repeated overexposure to some hydrocarbon solvents, naphthas, and gasoline.

ISOPARAFFINS: Studies in laboratory animals have shown that long-term exposure to similar materials (isoparaaffins) can cause kidney damage and kidney cancer in male laboratory rats. However, in-depth research indicates that these findings are unique to the male rat, and that these effects are not relevant to humans.

C9 AROMATIC HYDROCARBONS: A developmental inhalation study was conducted in laboratory mice. Increased implantation losses, reduced fetal weights, delayed ossification and an increased incidence of cleft palate were observed at the highest exposure level (1,500 ppm). This exposure level was extremely toxic to pregnant female mice (44% mortality). Reduced fetal body weights were also observed at 500 ppm. A multi-generation reproduction inhalation study was conducted in laboratory rats. Reductions in pup weights, pup weight gain, litter size, and pup survival were observed at 1,500 ppm, an exposure level at which significant maternal toxicity was observed. Reduced pup weight gain was also observed at 500 ppm.

PENTANES: Studies of pentane isomers in laboratory animals indicate exposure to extremely high levels (roughly 10 vol.%) may induce cardiac arrhythmias (irregular heartbeats) which may be serious or fatal.

BUTANES: Studies in laboratory animals indicate exposure to extremely high levels of butanes (1-10 or higher vol.% in air) may cause cardiac arrhythmias (irregular heartbeats) which may be serious or fatal.

TOLUENE: Case studies of persons abusing toluene suggest isolated incidences of adverse effects on the fetus including birth defects. Abuse of toluene at high concentrations (e.g., glue sniffing and solvent abuse) has been associated with adverse effects on the liver, kidney and nervous system, and can cause CNS depression, cardiac arrhythmias, and death. Studies of workers indicate longterm exposure may be related to impaired color vision and hearing. Some studies of workers suggest longterm exposure may be related to neurobehavioral and cognitive changes. Some of these effects have been observed in laboratory animals following repeated exposure to high levels of toluene. Several studies of workers suggest longterm exposure may be related to small increases in spontaneous abortions and changes in some gonadotropic hormones. However, the weight of evidence does not indicate toluene is a reproductive hazard to humans. Studies in laboratory animals indicate some changes in reproductive organs following high levels of exposure, but no significant effects on mating performance or reproduction were observed. Case studies of persons abusing toluene suggest isolated incidences of adverse effects on the fetus including birth defects. Findings in laboratory animals have been largely negative. Positive findings include small increases in minor skeletal and visceral malformations and developmental delays following very high levels of maternal exposure. Studies of workers indicate long-term exposure may be related to effects on the liver, kidney and blood, but these appear to be limited to changes in serum enzymes and decreased leukocyte counts. Adverse effects on the liver, kidney, thymus and nervous system were observed in animal studies following very high levels of exposure. The relevance of these findings to humans is not clear at this time.

XYLENES, ALL ISOMERS: Overexposure to xylene may cause upper respiratory tract irritation, headache, cyanosis, blood serum changes, nervous system damage and narcosis. Effects may be increased by the use of alcoholic beverages. Evidence of liver and kidney impairment were reported in workers recovering from a gross overexposure. Effects from Prolonged or Repeated Exposure: Impaired neurological function was reported in workers exposed to solvents including xylene. Studies in laboratory animals have shown evidence of impaired hearing following high levels of exposure. Studies in laboratory animals suggest some changes in reproductive organs following high levels of exposure but no significant effects on reproduction were observed. Studies in laboratory animals indicate skeletal and visceral malformations, developmental delays, and increased fetal resorptions following extremely high levels of maternal exposure with evidence of maternal toxicity. The relevance of these observations to humans is not clear at this time. Adverse effects on the liver, kidney, bone marrow (changes in blood cell parameters) were observed in laboratory animals following high levels of exposure. The relevance of these observations to humans is not clear at this time.

1,2,4-TRIMETHYLBENZENE: The following information pertains to a mixture of C9 aromatic hydrocarbons, over 40% of which was composed of 1,2,4-trimethylbenzene. A developmental inhalation study was conducted in laboratory mice. Increased implantation losses, reduced fetal weights, delayed ossification and an increased incidence of cleft palate were observed at the highest exposure level (1,500 ppm). This exposure level was extremely toxic to pregnant female mice (44% mortality). Reduced fetal body weights were also observed at 500 ppm. A multi-generation reproduction inhalation study was conducted in laboratory rats. Reductions in pup weights, pup weight gain, litter size, and pup survival were observed at 1,500 ppm, an exposure level at which significant maternal toxicity was observed. Reduced pup weight gain was also observed at 500 ppm. Embryotoxicity has been reported in studies of laboratory animals. Adverse effects included increased implantation losses, reduced fetal weights, delayed ossification and an increased incidence of cleft palate.<n><n>

N-HEXANE: Long-term or repeated exposure to n-hexane can cause peripheral nerve damage. Initial symptoms are numbness of the fingers and toes. Also, motor weakness can occur in the digits, but may also involve muscles of the arms, thighs and forearms. The

onset of these symptoms may be delayed for several months to a year after the beginning of exposure. Testicular atrophy and partial to full loss of the germ cell line were observed in sub-chronic high-dose inhalation studies of laboratory rodents. These effects appeared irreversible. Rodent reproduction studies have shown evidence of reduced fetal weight but no frank malformations.

CUMENE: Overexposure to cumene may cause upper respiratory tract irritation and CNS depression. Studies in laboratory animals indicate evidence of respiratory tract hyperplasia, and adverse effects on the liver, kidney and adrenal glands following high level exposure. The relevance of these findings to humans is not clear at this time. Findings from lifetime laboratory rodent inhalation studies were as follows: In F344/N rats: an increased incidence of renal carcinomas and adenomas, respiratory epithelial adenomas, and interstitial cell adenomas of the testes. In B6C3F1 mice: an increased incidence of carcinomas and adenomas of the bronchi and lung, liver neoplasms, hemangiosarcomas of the spleen, and adenomas of the thyroid.

ETHYLBENZENE: Findings from a 2-year inhalation study in rodents conducted by NTP were as follows: Effects were observed only at the highest exposure level (750 ppm). At this level the incidence of renal tumors was elevated in male rats (tubular carcinomas) and female rats (tubular adenomas). The incidence of tumors was also elevated in male mice (alveolar and bronchiolar carcinomas) and female mice (hepatocellular carcinomas). IARC has classified ethyl benzene as "possibly carcinogenic to humans" (Group 2B). Studies in laboratory animals indicate some evidence of post-implantation deaths following high levels of maternal exposure. The relevance of these findings to humans is not clear at this time. Studies in laboratory animals indicate limited evidence of renal malformations, resorptions, and developmental delays following high levels of maternal exposure with evidence of maternal toxicity. The relevance of these findings to humans is not clear at this time. Studies in laboratory animals have demonstrated evidence of ototoxicity (hearing loss) following exposure levels as low as 300 ppm for 5 days. Studies in laboratory animals indicate some evidence of adverse effects on the liver, kidney, thyroid, and pituitary gland.

BENZENE: Studies of workers exposed to benzene show clear evidence that overexposure can cause cancer and other diseases of the blood forming organs including Acute Myelogenous Leukemia (AML), and Aplastic Anemia (AA), an often fatal disease. Some studies suggest overexposure to benzene may also be associated with Myelodysplastic Syndrome (MDS). Findings from a case control study of workers exposed to benzene was reported during the 2009 Benzene Symposium in Munich included an increase in Acute Myeloid Leukemias and Non-Hodgkins Lymphoid Neoplasms (NHLN) of the subtype follicular lymphoma (FL) in some occupational categories. Some studies of workers exposed to benzene have shown an association with increased rates of chromosome aberrations in circulating lymphocytes. One study of women workers exposed to benzene suggested a weak association with irregular menstruation. However, other studies of workers exposed to benzene have not demonstrated clear evidence of an effect on fertility or reproductive outcome in humans. Benzene can cross the placenta and affect the developing fetus. Cases of AA have been reported in the offspring of persons severely overexposed to benzene. Studies in laboratory animals indicate that prolonged, repeated exposure to high levels of benzene vapor can cause bone marrow suppression and cancer in multiple organ systems. Studies in laboratory animals show evidence of adverse effects on male reproductive organs following high levels of exposure but no significant effects on reproduction have been observed. Embryotoxicity has been reported in studies of laboratory animals but effects were limited to reduced fetal weight and minor skeletal variations. Benzene has been classified as a proven human carcinogen by OSHA and a Group 1 (Carcinogenic to Humans) material by IARC. The current proposed IARC classification for benzene is summarized as follows: Sufficient evidence for Acute Myeloid Leukemia; limited evidence for Acute Lymphatic Leukemia, Chronic Lymphatic Leukemia, Non-Hodgkin Lymphoma, and Multiple Myeloma.

NAPHTHALENE: Severe jaundice, neurotoxicity (kernicterus) and fatalities have been reported in young children and infants as a result of hemolytic anemia from overexposure to naphthalene. Persons with glucose 6-phosphate dehydrogenase (G6PD) deficiency are more prone to the hemolytic effects of naphthalene. Adverse effects on the kidney have

been reported in persons overexposed to naphthalene but these effects are believed to be a consequence of hemolytic anemia, and not a direct effect. Hemolytic anemia has been observed in laboratory animals exposed to naphthalene. Laboratory rodents exposed to naphthalene vapor for 2 years (lifetime studies) developed non-neoplastic and neoplastic tumors and inflammatory lesions of the nasal and respiratory tract. Cataracts and other adverse effects on the eye have been observed in laboratory animals exposed to high levels of naphthalene. Findings from a large number of bacterial and mammalian cell mutation assays have been negative. A few studies have shown chromosomal effects (elevated levels of Sister Chromatid Exchange or chromosomal aberrations) in vitro. Naphthalene has been classified as Possibly Carcinogenic to Humans (2B) by IARC, based on findings from studies in laboratory animals.

CARBON MONOXIDE: is a chemical asphyxiant with no warning properties (such as odor). At 400-500 ppm for 1 hour headache and dyspnea may occur. If activity is increased, symptoms of overexposure may include nausea, irritability, increased respiration, tinnitus, sweating, chest pain, confusion, impaired judgement, dizziness, weakness, drowsiness, ataxia, irregular heart beat, cyanosis and pallor. Levels in excess of 1000 ppm can result in collapse, loss of consciousness, respiratory failure and death. Extremely high concentrations (12,800 ppm) can cause immediate unconsciousness and death in 1-3 minutes. Repeated anoxia can lead to central nervous system damage and peripheral neuropathy, with loss of sensation in the fingers, amnesia, and mental deterioration and possible congestive heart failure. Damage may also occur to the fetus, lung, liver, kidney, spleen, cardiovascular system and other organs.

WHOLLY-VAPORIZED UNLEADED GASOLINE: Lifetime exposure to wholly vaporized unleaded gasoline produced an increased incidence of liver tumors in female mice exposed to the highest exposure concentration (2056 ppm) and α -2 urinary globulin-mediated kidney tumors in male rats. No exposure-related tumors were observed in male mice or female rats. The male-specific rat kidney tumors are not considered relevant to human health. Mice receiving lifetime repeated skin application of various petroleum naphthas exhibited an irritation-dependent increased incidence of skin tumors. Additional studies suggest that these tumors occur through a mechanism that may not be relevant to human health. Epidemiological data from over 18,000 petroleum marketing and distribution workers showed no increased risk of leukemia, multiple myeloma, or kidney cancer resulting from gasoline exposure. Unleaded gasoline has been identified as possibly carcinogenic to humans (2B) by the International Agency for Research on Cancer (IARC).

COMBUSTION ENGINE EXHAUST: Chronic inhalation studies of gasoline engine exhaust in mice, rats and hamsters did not produce any carcinogenic effects. Condensates/extracts of gasoline engine exhaust produced an increase in tumors compared to controls when testing by skin painting, subcutaneous injection, intratracheal instillation or implantation into the lungs. Gasoline exhaust has been classified as possibly carcinogenic to humans (2B) by the International Agency for Research on Cancer (IARC).

Adverse effects related to the physical, chemical and toxicological characteristics

Signs and Symptoms

Irritating to the skin and mucous membranes. Symptoms may include redness, itching, and inflammation. May cause nausea, vomiting, diarrhea, and signs of nervous system depression: headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue. Aspiration hazard. May cause coughing, chest pains, shortness of breath, pulmonary edema and/or chemical pneumonitis. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking.

Sensitization

Not expected to be a skin or respiratory sensitizer.

Mutagenic effects

May cause genetic defects.

Carcinogenicity

May cause cancer.

Cancer designations are listed in the table below

Name	ACGIH	IARC	NTP	OSHA
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	(Class)	(Class)		
Gasoline 86290-81-5	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Not Listed	Not Listed
Heptane (mixed isomers) 142-82-5	Not Listed	Not Listed	Not Listed	Not Listed
Butane (mixed isomers) 106-97-8	Not Listed	Not Listed	Not Listed	Not Listed
Pentane (mixed isomers) 78-78-4	Not Listed	Not Listed	Not Listed	Not Listed
Hexane Isomers (other than n-Hexane) 107-83-5	Not Listed	Not Listed	Not Listed	Not Listed
Toluene 108-88-3	Not Classifiable (A4)	Not Classifiable (3)	Not Listed	Not Listed
Xylene (mixed isomers) 1330-20-7	Not classifiable (A4)	Not classifiable (3)	Not Listed	Not Listed
n-Hexane 110-54-3	Not Listed	Not Listed	Not Listed	Not Listed
Cumene 98-82-8	Not listed	Possible human carcinogen (2B)	Reasonably anticipated to be a human carcinogen	Not listed
1,2,4 Trimethylbenzene 95-63-6	Not Listed	Not Listed	Not Listed	Not Listed
Ethylbenzene 100-41-4	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Not Listed	Not Listed
Benzene 71-43-2	Confirmed human carcinogen (A1)	Carcinogenic to humans (1)	Known to be human carcinogen	Known carcinogen
Cyclohexane 110-82-7	Not Listed	Not Listed	Not Listed	Not Listed
Octane 111-65-9	Not Listed	Not Listed	Not Listed	Not Listed
1,2,3-Trimethylbenzene 526-73-8	Not Listed	Not Listed	Not Listed	Not Listed
Naphthalene 91-20-3	Confirmed animal carcinogen (A3)	Possible human carcinogen (2B)	Reasonably anticipated to be a human carcinogen	Not Listed

Reproductive toxicity Suspected of damaging fertility or the unborn child.

Specific Target Organ Toxicity (STOT) - single exposure Respiratory system. Central nervous system.

Specific Target Organ Toxicity (STOT) - repeated exposure Not classified.

Aspiration hazard May be fatal if swallowed or vomited and enters airways.

12. ECOLOGICAL INFORMATION

Ecotoxicity This product should be considered toxic to aquatic organisms, with the potential to cause long lasting adverse effects in the aquatic environment.

Name	Algae/aquatic plants	Fish	Toxicity to Microorganisms	Crustacea
Gasoline 86290-81-5	72-hr EC50 = 56 mg/l Algae	96-hr LC50 = 11 mg/l Rainbow trout (static)	-	48-hr LC50 = 7.6 mg/l Daphnia magna
Heptane (mixed isomers) 142-82-5	-	96-hr LC50 = 375 mg/L Tilapia	-	-
Butane (mixed isomers) 106-97-8	-	-	-	-
Pentane (mixed isomers) 78-78-4	-	96-hr LC50 = 3.1 mg/L Rainbow trout	-	48-hr EC50 = >1 - <10 mg/L Daphnia magna
Hexane Isomers (other than n-Hexane) 107-83-5	-	-	-	-
Toluene	72-hr EC50 = 12.5 mg/l	96-hr LC50 ≤ 10 mg/l	-	48-hr EC50 = 5.46-9.83 mg/l

108-88-3	Algae	Rainbow trout		Daphnia magna 48-hr EC50 = 11.5 mg/l Daphnia magna (Static)
Xylene (mixed isomers) 1330-20-7	72-hr EC50 = 11 mg/l Algae	96-hr LC50 = 8 mg/l Rainbow trout	-	48-hr LC50 = 3.82 mg/l Daphnia magna
n-Hexane 110-54-3	-	96-hr LC50 = 2.5 mg/l Fathead minnow	-	-
Cumene 98-82-8	72-hr EC50 = 2.6 mg/l Algae	96-hr LC50 = 6.04-6.61 mg/l Fathead minnow (Flow-through) 96-hr LC50 = 2.7 mg/l Rainbow trout (semi-static)	-	48-hr EC50 = 7.9-14.1 mg/l Daphnia magna (static)
1,2,4 Trimethylbenzene 95-63-6	-	96-hr LC50 = 7.19-8.28 mg/l Fathead minnow (flow-through)	-	48-hr EC50 = 6.14 mg/L Daphnia magna
Ethylbenzene 100-41-4	72-hr EC50 = 1.7-7.6 mg/l Algae	96-hr LC50 = 4 mg/L Rainbow trout	-	48-hr EC50 = 1-4 mg/L Daphnia magna
Benzene 71-43-2	72-hr EC50 = 29 mg/l Algae	96-hr LC50 = 5.3 mg/l Rainbow trout (flow-through)	-	48-hr EC50 = 8.76-15.6 mg/l Daphnia magna (Static)
Cyclohexane 110-82-7	72-hr EC50 = 500 mg/l Algae	96-hr LC50 = 3.96-5.18 mg/l Fathead minnow	-	48-hr EC50 = 1.7-3.5 mg/L Bay shrimp
Octane 111-65-9	-	-	-	48-hr LC50 = 0.38 mg/l Daphnia magna
1,2,3-Trimethylbenzene 526-73-8	-	96-hr LC50 = 7.72 mg/l Fathead Minnow (flow-through)	-	-
Naphthalene 91-20-3	-	96-hr LC50 = 0.91-2.82 mg/l Rainbow trout (static) 96-hr LC50 = 1.99 mg/l Fathead minnow (static)	-	48-hr LC50 = 1.6 mg/l Daphnia magna

Persistence and degradability

Expected to be inherently biodegradable. The presence of ethanol in this product may impede the biodegradation of benzene, toluene, ethylbenzene and xylene in groundwater, resulting in elongated plumes of these constituents.

Bioaccumulation

Has the potential to bioaccumulate.

Mobility in soil

May partition into air, soil and water.

Other adverse effects

No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues

This material may be a flammable liquid waste.

Safe Handling of Wastes

Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required. Use appropriate grounding and bonding practices. Use only non-sparking tools. Do not expose to heat, open flames, strong oxidizers or other sources of ignition. No smoking.

Disposal of Wastes / Methods of Disposal

The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal

Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper Shipping Name:	Gasoline
UN/Identification No:	UN 1203
Class:	3
Packing Group:	II

TDG (Canada):

UN Proper Shipping Name:	Gasoline
UN/Identification No:	UN 1203
Transport Hazard Class(es):	3
Packing Group:	II

15. REGULATORY INFORMATION**US Federal Regulatory Information:**

US TSCA Chemical Inventory Section 8(b):

This product and/or its components are listed on the TSCA Chemical Inventory.

EPA Superfund Amendment & Reauthorization Act (SARA):**SARA Section 302:**

This product does not contain any component(s) included on EPA's Extremely Hazardous Substance (EHS) List.

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
Gasoline	NA
Heptane (mixed isomers)	NA
Butane (mixed isomers)	NA
Pentane (mixed isomers)	NA
Hexane Isomers (other than n-Hexane)	NA
Toluene	NA
Xylene (mixed isomers)	NA
n-Hexane	NA
Cumene	NA
1,2,4 Trimethylbenzene	NA
Ethylbenzene	NA
Benzene	NA
Cyclohexane	NA
Octane	NA
1,2,3-Trimethylbenzene	NA
Naphthalene	NA

SARA Section 304:

This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	Hazardous Substances RQs
Gasoline	NA
Heptane (mixed isomers)	NA
Butane (mixed isomers)	NA
Pentane (mixed isomers)	NA
Hexane Isomers (other than n-Hexane)	NA
Toluene	1000 lb final RQ 454 kg final RQ
Xylene (mixed isomers)	100
n-Hexane	5000
Cumene	5000
1,2,4 Trimethylbenzene	NA
Ethylbenzene	1000

Benzene	10
Cyclohexane	1000
Octane	NA
1,2,3-Trimethylbenzene	NA
Naphthalene	100 lb final RQ 45.4 kg final RQ

SARA Section 311/312: The following EPA hazard categories apply to this product:

Acute Health Hazard
Chronic Health Hazard
Fire Hazard

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

Name	CERCLA/SARA 313 Emission reporting:
Gasoline	None
Heptane (mixed isomers)	None
Butane (mixed isomers)	None
Pentane (mixed isomers)	None
Hexane Isomers (other than n-Hexane)	None
Toluene	1.0 % de minimis concentration
Xylene (mixed isomers)	1.0 % de minimis concentration
n-Hexane	1.0 % de minimis concentration
Cumene	1.0 % de minimis concentration
1,2,4 Trimethylbenzene	1.0 % de minimis concentration
Ethylbenzene	0.1 % de minimis concentration
Benzene	0.1 % de minimis concentration
Cyclohexane	1.0 % de minimis concentration
Octane	None
1,2,3-Trimethylbenzene	None
Naphthalene	0.1 % de minimis concentration

State and Community Right-To-Know Regulations:

The following component(s) of this material are identified on the regulatory lists below:

Gasoline

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 0957
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Carcinogen; Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 0957 TPQ: 10000 lb (Under N.J.A.C. 7:1G, environmental hazardous substances in mixtures such as gasoline or new and used petroleum oil may be reported under these categories)
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Heptane (mixed isomers)	
Louisiana Right-To-Know:	Not Listed

California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1339
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Butane (mixed isomers)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 0273
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - fourth degree
New Jersey - Environmental Hazardous Substances List:	SN 0273 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Pentane (mixed isomers)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1064
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - fourth degree
New Jersey - Environmental Hazardous Substances List:	SN 1064 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Hexane Isomers (other than n-Hexane)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1285
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present

Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Toluene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Developmental toxicity, initial date 1/1/91 Female reproductive toxicity, initial date 8/7/09 SN 1866
New Jersey Right-To-Know:	SN 1866
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic (skin); Flammable (skin)
Michigan Critical Materials Register List:	100 lb Annual usage threshold
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree; Teratogen
New Jersey - Environmental Hazardous Substances List:	SN 1866 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1000 lb RQ (air); 1 lb RQ (land/water)
Xylene (mixed isomers)	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 2014
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic (skin); Flammable (skin)
Michigan Critical Materials Register List:	100 lb Annual usage threshold all isomers
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 2014 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1000 lb RQ (air); 1 lb RQ (land/water)
n-Hexane	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1340
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed

Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 1340 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1 lb RQ (air); 1 lb RQ (land/water)
Cumene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Carcinogen, initial date 4/6/10
New Jersey Right-To-Know:	SN 0542
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic (skin); Flammable (skin)
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 0542 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	5000 lb RQ (air); 1 lb RQ (land/water)
1,2,4 Trimethylbenzene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1929
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed
Ethylbenzene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Carcinogen, initial date 6/11/04
New Jersey Right-To-Know:	SN 0851
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed

New Jersey - Special Hazardous Substances:	Carcinogen; flammable - Third degree
New Jersey - Environmental Hazardous Substances List:	SN 0851 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1000 lb RQ (air); 1 lb RQ (land/water)
Benzene	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Carcinogen, initial date 2/27/87
	Developmental toxicity, initial date 12/26/97
	Male reproductive toxicity, initial date 12/26/97
New Jersey Right-To-Know:	SN 0197
Pennsylvania Right-To-Know:	Environmental hazard; Special hazardous substance
Massachusetts Right-To Know:	Carcinogen; Extraordinarily hazardous
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic (skin); Flammable (skin); Carcinogen (skin)
Michigan Critical Materials Register List:	100 lb Annual usage threshold
Massachusetts Extraordinarily Hazardous Substances:	Carcinogen; Extraordinarily hazardous
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Present
New Jersey - Special Hazardous Substances:	Carcinogen; Flammable - third degree; Mutagen
New Jersey - Environmental Hazardous Substances List:	SN 0197 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	10 lb RQ (air); 1 lb RQ (land/water)
Cyclohexane	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 0565
Pennsylvania Right-To-Know:	Environmental hazard
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous Substances List:	SN 0565 TPQ: 500 lb
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	1000 lb RQ (air); 1 lb RQ (land/water)
Octane	
Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	SN 1434
Pennsylvania Right-To-Know:	Present
Massachusetts Right-To Know:	Present
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Toxic; Flammable
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Flammable - third degree
New Jersey - Environmental Hazardous	Not Listed

Substances List:		
Illinois - Toxic Air Contaminants:		Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:		Not Listed
1,2,3-Trimethylbenzene		
Louisiana Right-To-Know:		Not Listed
California Proposition 65:		Not Listed
New Jersey Right-To-Know:		SN 1929
Pennsylvania Right-To-Know:		Present
Massachusetts Right-To Know:		Present
Florida Substance List:		Not Listed
Rhode Island Right-To-Know:		Toxic
Michigan Critical Materials Register List:		Not Listed
Massachusetts Extraordinarily Hazardous Substances:		Not Listed
California - Regulated Carcinogens:		Not Listed
Pennsylvania RTK - Special Hazardous Substances:		Not Listed
New Jersey - Special Hazardous Substances:		Not Listed
New Jersey - Environmental Hazardous Substances List:		Not Listed
Illinois - Toxic Air Contaminants:		Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:		Not Listed
Naphthalene		
Louisiana Right-To-Know:		Not Listed
California Proposition 65:		Carcinogen, initial date 4/19/02
New Jersey Right-To-Know:		SN 1322 SN 3758
Pennsylvania Right-To-Know:		Environmental hazard Present (particulate)
Massachusetts Right-To Know:		Present
Florida Substance List:		Not Listed
Rhode Island Right-To-Know:		Toxic; Flammable
Michigan Critical Materials Register List:		Not Listed
Massachusetts Extraordinarily Hazardous Substances:		Not Listed
California - Regulated Carcinogens:		Not Listed
Pennsylvania RTK - Special Hazardous Substances:		Not Listed
New Jersey - Special Hazardous Substances:		Carcinogen
New Jersey - Environmental Hazardous Substances List:		SN 1322 TPQ: 500 lb (Reportable at the de minimis quantity of >0.1%)
Illinois - Toxic Air Contaminants:		Present
New York - Reporting of Releases Part 597 - List of Hazardous Substances:		100 lb RQ (air); 1 lb RQ (land/water)

Canada DSL/NDL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all of the information required by those regulations.

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
Gasoline	B2,D2A,D2B	0.1%
Heptane (mixed isomers)	B2,D2B	1%
Butane (mixed isomers)	A,B1	1%
Pentane (mixed isomers)	B2	1%
Hexane Isomers (other than n-Hexane)	B2	1%
Toluene	B2,D2A,D2B	0.1%
Xylene (mixed isomers)	B2,D2A,D2B	m-, o-isomers 1.0%; p-isomer 0.1%
n-Hexane	B2,D2A,D2B	1%

Cumene	B2,D2A	0.1%
1,2,4 Trimethylbenzene	B3,D2B	1%
Ethylbenzene	B2,D2A,D2B	0.1%
Benzene	B2,D2A,D2B	0.1%
Cyclohexane	B2,D2B	1%
Octane	B2,D2B	1%
1,2,3-Trimethylbenzene	B3	1%
Naphthalene	B4,D2A	0.1%



Note: Not applicable.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety

Revision Notes

Revision Date 06/01/2016

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.



SAFETY DATA SHEET

SDS ID NO.: 0162MAR019
Revision Date 05/22/2015

1. IDENTIFICATION

Product Name: Marathon Petroleum Multipower-3 15W-40 Motor Oil
Synonym: Multipower-3 15W-40 Motor Oil; Multipower-3 15W-40 Heavy Duty Motor Oil
Product Code: 0162MAR019
Chemical Family: Motor/Lube Oil
Recommended Use: Engine Oil.
Restrictions on Use: All others.

Manufacturer, Importer, or Responsible Party Name and Address:
MARATHON PETROLEUM COMPANY LP
539 South Main Street
Findlay, OH 45840

SDS information: 1-419-421-3070

Emergency Telephone: 1-877-627-5463

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status

This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Serious eye damage/eye irritation

Category 2A

Hazards Not Otherwise Classified (HNOC)

Not applicable.

Label elements

EMERGENCY OVERVIEW

Warning

Causes serious eye irritation



Appearance Brown Liquid

Physical State Liquid

Odor Petroleum

Precautionary Statements - Prevention

Wash hands and any possibly exposed skin thoroughly after handling
Wear eye/face protection

Precautionary Statements - Response

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical attention

Precautionary Statements - Storage

Not applicable.

Precautionary Statements - Disposal

Not applicable.

Additional Information

Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Motor oil is a complex mixture of highly refined lubricating oil base stocks and additives.

Composition Information:

Name	CAS Number	% Concentration
Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts	113706-15-3	1-5
Dinonyl diphenylamine	36878-20-3	1-5
Butene, homopolymer	9003-29-6	1-5
Amines, polyethylenepoly-, reaction products with succinic anhydride polyisobutenyl derivs.	84605-20-9	1-5

All concentrations are percent by weight unless material is a gas. Gas concentrations are in percent by volume.

4. FIRST AID MEASURES

First Aid Measures

General Advice:

In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).

Inhalation:

Remove to fresh air and keep at rest in a position comfortable for breathing. If symptoms occur get medical attention.

Skin Contact:

Wash skin with plenty of soap and water. If irritation or other symptoms occur get medical attention. Wash contaminated clothing and clean shoes before reuse.

Eye Contact:

Flush immediately with large amounts of water for at least 15 minutes. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while flushing. Get medical attention.

Ingestion:

Rinse mouth out with water. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected person warm and at rest. If symptoms develop, seek medical attention.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects:

Causes eye irritation. Symptoms may include redness, itching, and inflammation. May

cause skin irritation and/or dermatitis Preexisting skin conditions and/or respiratory disorders may be aggravated by exposure to this product.

Indication of any immediate medical attention and special treatment needed

Notes To Physician: Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media

For small fires, Class B fire extinguishing media such as CO₂, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.

Unsuitable extinguishing media

Do not use a solid water stream as it may scatter and spread fire.

Specific hazards arising from the chemical

The product is not combustible per the OSHA Hazard Communication Standard, but will ignite and burn at temperatures exceeding the flash point.

Hazardous combustion products

Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data

Sensitivity to Mechanical Impact No.

Sensitivity to Static Discharge No.

Special protective equipment and precautions for firefighters

Avoid using straight water streams. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Avoid excessive water spray application. Use water spray to cool exposed surfaces from as far a distance as possible. Keep run-off water out of sewers and water sources.

Additional firefighting tactics

Not applicable.

NFPA	Health 1	Flammability 1	Instability 0	Special Hazard -
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6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Keep public away. Isolate and evacuate area. Shut off source if safe to do so.

Protective equipment: Use personal protection measures as recommended in Section 8.

Emergency procedures: Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.

Environmental precautions: Avoid release to the environment. Avoid subsoil penetration.

Methods and materials for containment: Prevent further leakage or spillage if safe to do so.

Methods and materials for cleaning up: Use suitable absorbent materials such as vermiculite, sand, or clay to clean up residual liquids. Recover and return free product to proper containers.

7. HANDLING AND STORAGE

Safe Handling Precautions:

Avoid contact with skin, eyes and clothing. Do not swallow. Avoid breathing vapors or mists. Use good personal hygiene practices. Wash thoroughly after handling. Use personal protection measures as recommended in Section 8. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements.

Lifetime, continuous skin contact with used motor oils has caused skin cancer in laboratory tests. In testing, thorough washing has been found to prevent the development of skin cancer from used motor oil exposure. Avoid excessive skin contact. Exercise good personal hygiene including the removal and washing of soiled clothing and destroy used motor oil contaminated leather shoes/boots.

Storage Conditions:

Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Store away from incompatible materials.

Incompatible Materials

Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Name	ACGIH TLV	OSHA PELs:	OSHA - Vacated PELs	NIOSH IDLH
Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts 113706-15-3	-	-	-	-
Dinonyl diphenylamine 36878-20-3	-	-	-	-
Butene, homopolymer 9003-29-6	-	-	-	-
Amines, polyethylenepoly-, reaction products with succinic anhydride polyisobutenyl derivs. 84605-20-9	-	-	-	-

Notes:

The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.

Engineering measures:

Local or general exhaust required when using at elevated temperatures that generate vapors or mists.

Personal protective equipment

Eye protection:

Use goggles or face-shield if the potential for splashing exists.

Skin and body protection:

Wear neoprene, nitrile or PVA gloves to prevent skin contact. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times. Wear appropriate protective clothing.

Respiratory protection:

Use a NIOSH approved organic vapor chemical cartridge or supplied air respirators when there is the potential for airborne exposures to exceed permissible exposure limits or if excessive vapors are generated. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.

Hygiene measures:

Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical State	Liquid
Appearance	Brown Liquid
Color	Brown
Odor	Petroleum
Odor Threshold	No data available.

<u>Property</u>	<u>Values (Method)</u>
Melting Point / Freezing Point	No data available.
Initial Boiling Point / Boiling Range	No data available.
Flash Point	> 220 °C / > 428 °F (Cleveland Open-Cup)
Evaporation Rate	No data available.
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%):	
Upper Flammability Limit:	No data available.
Lower Flammability Limit:	No data available.
Explosion limits:	No data available.
Vapor Pressure	No data available.
Vapor Density	No data available.
Specific Gravity / Relative Density	0.86-0.875
Water Solubility	No data available.
Solubility in other solvents	No data available.
Partition Coefficient	No data available.
Decomposition temperature	No data available.
pH:	No available data.
Autoignition Temperature	No data available.
Kinematic Viscosity	82 mm ² /s @ 40°C / 104°F
Dynamic Viscosity	No data available.
Explosive Properties	No data available.
VOC Content (%)	1.7 (w/w)
Density	No data available.
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

<u>Reactivity</u>	The product is non-reactive under normal conditions.
<u>Chemical stability</u>	Stable under recommended storage conditions.
<u>Possibility of hazardous reactions</u>	None under normal processing.
<u>Hazardous polymerization</u>	Will not occur.
<u>Conditions to avoid</u>	Sources of heat or ignition.
<u>Incompatible Materials</u>	Strong oxidizing agents.
<u>Hazardous decomposition products</u>	None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION

Potential short-term adverse effects from overexposures

Inhalation	Overheating may produce vapors which may cause respiratory irritation, dizziness and nausea.
Eye contact	Irritating to eyes. May cause reddening and tearing.
Skin contact	May cause skin irritation. Prolonged or repeated exposure may cause dermatitis, folliculitis

or oil acne.

Ingestion

May cause irritation of the mouth, throat and gastrointestinal tract.

Acute toxicological data

Name	Oral LD50	Dermal LD50	Inhalation LC50
Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts 113706-15-3	-	-	-
Dinonyl diphenylamine 36878-20-3	-	-	-
Butene, homopolymer 9003-29-6	-	-	-
Amines, polyethylenepoly-, reaction products with succinic anhydride polyisobutenyl derivs. 84605-20-9	-	-	-

Delayed and immediate effects as well as chronic effects from short and long-term exposure

This product is considered to have a low order of acute and chronic oral and dermal toxicity.

USED MOTOR OIL: Lifetime, continuous skin contact with used motor oils has caused skin cancer in laboratory tests. The combustion process produces compounds (polycyclic aromatic hydrocarbons) in motor oils that increase with use and are responsible for the cancer induction. Thorough washing has been found to prevent the development of skin cancer on animals from used motor oil exposure.

ZDDP: Zinc dialkyldithiophosphate (ZDDP) additives are primarily eye and/or skin irritants or corrosives with low acute toxicity via oral, dermal, and inhalation routes of exposure and are not skin sensitizers. In laboratory repeat dose studies by the dermal and oral routes, ZDDPs cause effects only at high doses, primarily due to irritation, in a manner similar to other irritating materials. The weight-of-evidence of genotoxicity testing indicates that ZDDPs are not mutagenic and do not cause larger chromosomal effects.

Adverse effects related to the physical, chemical and toxicological characteristics

Signs and Symptoms

Causes eye irritation. Symptoms may include redness, itching, and inflammation. Contact may cause skin dermatitis and/or irritation. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking.

Sensitization

Not expected to be a skin or respiratory sensitizer.

Mutagenic effects

None known.

Carcinogenicity

Cancer designations are listed in the table below

Name	ACGIH (Class)	IARC (Class)	NTP	OSHA
Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts 113706-15-3	Not Listed	Not Listed	Not Listed	Not Listed
Dinonyl diphenylamine 36878-20-3	Not Listed	Not Listed	Not Listed	Not Listed
Butene, homopolymer 9003-29-6	Not Listed	Not Listed	Not Listed	Not Listed
Amines, polyethylenepoly-, reaction products with succinic anhydride polyisobutenyl derivs. 84605-20-9	Not Listed	Not Listed	Not Listed	Not Listed

Reproductive toxicity	None known.
Specific Target Organ Toxicity (STOT) - single exposure	Not classified.
Specific Target Organ Toxicity (STOT) - repeated exposure	Not classified.
Aspiration hazard	Not classified.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Used motor and/or lube oils can be toxic to birds and fish.

Name	Algae/aquatic plants	Fish	Toxicity to Microorganisms	Crustacea
Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts 113706-15-3	-	-	-	-
Dinonyl diphenylamine 36878-20-3	-	-	-	-
Butene, homopolymer 9003-29-6	-	-	-	-
Amines, polyethylenepoly-, reaction products with succinic anhydride polyisobutenyl derivs. 84605-20-9	-	-	-	-

Persistence and degradability Not expected to be readily biodegradable.

Bioaccumulation Contains component(s) with the potential to bioaccumulate.

Mobility in soil No information available.

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues

No information available.

Safe Handling of Wastes

Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required.

Disposal of Wastes / Methods of Disposal

The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal

Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper Shipping Name: Not Regulated
UN/Identification No: Not applicable
Class: Not applicable.
Packing Group: Not applicable.

TDG (Canada):

UN Proper Shipping Name: Not Regulated
UN/Identification No: Not applicable.
Transport Hazard Class(es): Not applicable.
Packing Group: Not applicable.

15. REGULATORY INFORMATION

US Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b): This product and/or its components are listed on the TSCA Chemical Inventory.

EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product may contain component(s) that have been listed on EPA's Extremely Hazardous Substance (EHS) List:

Name	CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs
Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts	NA
Dinonyl diphenylamine	NA
Butene, homopolymer	NA
Amines, polyethylenepoly-, reaction products with succinic anhydride polyisobutenyl derivs.	NA

SARA Section 304: This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

Name	Hazardous Substances RQs
Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts	NA
Dinonyl diphenylamine	NA
Butene, homopolymer	NA
Amines, polyethylenepoly-, reaction products with succinic anhydride polyisobutenyl derivs.	NA

SARA Section 311/312: The following EPA hazard categories apply to this product:

Acute Health Hazard

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

Name	CERCLA/SARA 313 Emission reporting:
Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts	None
Dinonyl diphenylamine	None
Butene, homopolymer	None
Amines, polyethylenepoly-, reaction products with succinic anhydride polyisobutenyl derivs.	None

State and Community Right-To-Know Regulations:

The following component(s) of this material are identified on the regulatory lists below:

Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Dinonyl diphenylamine

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Butene, homopolymer

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed
New Jersey Right-To-Know:	Not Listed
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Amines, polyethylenepoly-, reaction products with succinic anhydride polyisobutenyl derivs.

Louisiana Right-To-Know:	Not Listed
California Proposition 65:	Not Listed

New Jersey Right-To-Know:	Not Listed
Pennsylvania Right-To-Know:	Not Listed
Massachusetts Right-To Know:	Not Listed
Florida Substance List:	Not Listed
Rhode Island Right-To-Know:	Not Listed
Michigan Critical Materials Register List:	Not Listed
Massachusetts Extraordinarily Hazardous Substances:	Not Listed
California - Regulated Carcinogens:	Not Listed
Pennsylvania RTK - Special Hazardous Substances:	Not Listed
New Jersey - Special Hazardous Substances:	Not Listed
New Jersey - Environmental Hazardous Substances List:	Not Listed
Illinois - Toxic Air Contaminants:	Not Listed
New York - Reporting of Releases Part 597 - List of Hazardous Substances:	Not Listed

Canada DSL/NDSL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all of the information required by those regulations.

Name	Canada - WHMIS: Classifications of Substances:	Canada - WHMIS: Ingredient Disclosure:
Phosphorodithioic acid, mixed O,O-bis(sec-Bu and isooctyl) esters, zinc salts	D2B	1%
Butene, homopolymer	Uncontrolled product according to WHMIS classification criteria	



Note: Not applicable.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety

Revision Notes

Revision Date 05/22/2015

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.



SAFETY DATA SHEET

SDS ID NO.: 0196MAR019
Revision Date 05/22/2015

1. IDENTIFICATION

Product Name: Marathon Petroleum Maratrac Grease
Synonym: Maratrac™ Grease; Maratrac Construction Farm Grease; Maratrac CF Grease; Maratrac No. 2 Grease
Product Code: 0196MAR019
Chemical Family: Petroleum Based Grease
Recommended Use: Lubricating Grease.
Restrictions on Use: All others.

Manufacturer, Importer, or Responsible Party Name and Address:
MARATHON PETROLEUM COMPANY LP
539 South Main Street
Findlay, OH 45840

SDS information: 1-419-421-3070

Emergency Telephone: 1-877-627-5463

2. HAZARD IDENTIFICATION

Classification

OSHA Regulatory Status

This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Hazards Not Otherwise Classified (HNOC)

Not applicable.

Label elements

EMERGENCY OVERVIEW

No known significant effects or critical hazards.

Appearance Gray semi-solid

Physical State Semi-Solid

Odor Petroleum

Precautionary Statements - Prevention

Not applicable.

Precautionary Statements - Response

Not applicable.

Precautionary Statements - Storage

Not applicable.

Precautionary Statements - Disposal

Not applicable.

Additional Information

Read label before use. Keep out of reach of children. If medical advice is needed, have product container or label at hand.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Maratrac™ Grease is a mixture of high viscosity, highly refined lubricating oil base stock with a lithium complex soap thickener.

Composition Information:

There are no ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

4. FIRST AID MEASURES

First Aid Measures

General Advice:	In case of accident or if you feel unwell, seek medical advice immediately (show directions for use or safety data sheet if possible).
Inhalation:	Remove to fresh air and keep at rest in a position comfortable for breathing. If symptoms occur get medical attention.
Skin Contact:	Wash skin with plenty of soap and water. If irritation or other symptoms occur get medical attention. Wash contaminated clothing and clean shoes before reuse.
Eye Contact:	Immediately flush eyes with plenty of water. Eyelids should be held away from the eyeball to ensure thorough rinsing. Gently remove contacts while flushing. Get medical attention if irritation persists.
Ingestion:	Rinse mouth out with water. If spontaneous vomiting occurs, keep head below hips, or if patient is lying down, turn body and head to side to prevent aspiration and monitor for breathing difficulty. Never give anything by mouth to an unconscious person. Keep affected person warm and at rest. If symptoms develop, seek medical attention.

Most important signs and symptoms, both short-term and delayed with overexposure

Adverse Effects:	May cause eye irritation May cause skin irritation and/or dermatitis Symptoms may include redness, itching, and inflammation. Preexisting skin conditions and/or respiratory disorders may be aggravated by exposure to this product.
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Indication of any immediate medical attention and special treatment needed

Notes To Physician:	Treat symptomatically.
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5. FIRE-FIGHTING MEASURES

Suitable extinguishing mediaFor small fires, Class B fire extinguishing media such as CO₂, dry chemical, foam (AFFF/ATC) or water spray can be used. For large fires, water spray, fog or foam (AFFF/ATC) can be used. Firefighting should be attempted only by those who are adequately trained and equipped with proper protective equipment.**Unsuitable extinguishing media**

Do not use a solid water stream as it may scatter and spread fire.

Specific hazards arising from the chemical

The product is not combustible per the OSHA Hazard Communication Standard, but will ignite and burn at temperatures exceeding the flash point.

Hazardous combustion products

Smoke, carbon monoxide, and other products of incomplete combustion.

Explosion data

Sensitivity to Mechanical Impact No.

Sensitivity to Static Discharge No.

Special protective equipment and precautions for firefighters

Avoid using straight water streams. Water spray and foam (AFFF/ATC) must be applied carefully to avoid frothing and from as far a distance as possible. Avoid excessive water spray application. Use water spray to cool exposed surfaces from as far a distance as possible. Keep run-off water out of sewers and water sources.

Additional firefighting tactics

Not applicable.

NFPA

Health 1

Flammability 1

Instability 0

Special Hazard -

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Keep public away. Isolate and evacuate area. Shut off source if safe to do so. All contaminated surfaces will be slippery.
Protective equipment:	Use personal protection measures as recommended in Section 8.
Emergency procedures:	Advise authorities and National Response Center (800-424-8802) if the product has entered a water course or sewer. Notify local health and pollution control agencies, if appropriate.
Environmental precautions:	Avoid release to the environment.
Methods and materials for containment:	Prevent further leakage or spillage if safe to do so.
Methods and materials for cleaning up:	Cover with absorbent materials such as sand or clay. Shovel or sweep up material and place in a designated, labeled waste container.

7. HANDLING AND STORAGE

Safe Handling Precautions:	Avoid contact with skin, eyes and clothing. Do not swallow. Avoid breathing vapors or mists. Use good personal hygiene practices. Wash thoroughly after handling. Use personal protection measures as recommended in Section 8. Do not cut, drill, grind or weld on empty containers since explosive residues may remain. Refer to applicable EPA, OSHA, NFPA and consistent state and local requirements.
Storage Conditions:	Store in properly closed containers that are appropriately labeled and in a cool, well-ventilated area. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Store away from incompatible materials.
Incompatible Materials	Strong oxidizing agents.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Notes:	The manufacturer has voluntarily elected to provide exposure limits contained in OSHA's 1989 air contaminants standard in its SDSs, even though certain of those exposure limits were vacated in 1992.
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Engineering measures:	Local or general exhaust required when using at elevated temperatures that generate vapors or mists.
<u>Personal protective equipment</u>	
Eye protection:	Use goggles or face-shield if the potential for splashing exists.
Skin and body protection:	Wear neoprene, nitrile or PVA gloves to prevent skin contact. Glove suitability is based on workplace conditions and usage. Contact the glove manufacturer for specific advice on glove selection and breakthrough times. Wear appropriate protective clothing.
Respiratory protection:	Use a NIOSH approved organic vapor chemical cartridge or supplied air respirators when there is the potential for airborne exposures to exceed permissible exposure limits or if excessive vapors are generated. Observe respirator assigned protection factors (APFs) criteria cited in federal OSHA 29 CFR 1910.134. Self-contained breathing apparatus should be used for fire fighting.
Hygiene measures:	Handle in accordance with good industrial hygiene and safety practice. Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Physical State	Semi-Solid
Appearance	Gray semi-solid
Color	Gray
Odor	Petroleum
Odor Threshold	No data available.

<u>Property</u>	<u>Values (Method)</u>
Melting Point / Freezing Point	> 260 °C / > 500 °F
Initial Boiling Point / Boiling Range	> 316 °C / > 600 °F
Flash Point	> 204 °C / > 400 °F Pensky-Martens Closed Cup (PMCC)
Evaporation Rate	< 1 (ether (anhydrous) = 1)
Flammability (solid, gas)	Not applicable.
Flammability Limit in Air (%):	
Upper Flammability Limit:	No data available.
Lower Flammability Limit:	No data available.
Explosion limits:	No data available.
Vapor Pressure	<0.13 kPa (<1 mm Hg) [room temperature]
Vapor Density	> 1 (Air = 1)
Specific Gravity / Relative Density	0.92
Water Solubility	Partially soluble in water
Solubility in other solvents	No data available.
Partition Coefficient	No data available.
Decomposition temperature	No data available.
pH:	No available data.
Autoignition Temperature	371 °C / 700 °F
Kinematic Viscosity	No data available.
Dynamic Viscosity	No data available.
Explosive Properties	No data available.
VOC Content (%)	No data available.
Density	No data available.
Bulk Density	Not applicable.

10. STABILITY AND REACTIVITY

<u>Reactivity</u>	The product is non-reactive under normal conditions.
<u>Chemical stability</u>	Stable under recommended storage conditions.

<u>Possibility of hazardous reactions</u>	None under normal processing.
<u>Hazardous polymerization</u>	Will not occur.
<u>Conditions to avoid</u>	Sources of heat or ignition.
<u>Incompatible Materials</u>	Strong oxidizing agents.
<u>Hazardous decomposition products</u>	None known under normal conditions of use.

11. TOXICOLOGICAL INFORMATION

Potential short-term adverse effects from overexposures

Inhalation	Overheating may produce vapors which may cause respiratory irritation, dizziness and nausea.
Eye contact	Exposure to vapor or contact with liquid may cause mild eye irritation, including tearing, stinging, and redness.
Skin contact	May cause skin irritation. Prolonged or repeated exposure may cause dermatitis, folliculitis or oil acne.
Ingestion	May cause irritation of the mouth, throat and gastrointestinal tract.

Acute toxicological data

No information available.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

This product is considered to have a low order of acute and chronic oral and dermal toxicity.

Adverse effects related to the physical, chemical and toxicological characteristics

Signs and Symptoms	May cause eye irritation Contact may cause skin dermatitis and/or irritation. Symptoms may include redness, itching, and inflammation. Repeated or prolonged skin contact may cause drying, reddening, itching and cracking.
Sensitization	Not expected to be a skin or respiratory sensitizer.
Mutagenic effects	None known.
Carcinogenicity	None known.
Reproductive toxicity	None known.
Specific Target Organ Toxicity (STOT) - single exposure	Not classified.
Specific Target Organ Toxicity (STOT) - repeated exposure	Not classified.
Aspiration hazard	Not classified.

12. ECOLOGICAL INFORMATION

<u>Ecotoxicity</u>	No information available.
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Persistence and degradability No information available.

Bioaccumulation No information available.

Mobility in soil No information available.

Other adverse effects No information available.

13. DISPOSAL CONSIDERATIONS

Description of Waste Residues

No information available.

Safe Handling of Wastes

Handle in accordance with applicable local, state, and federal regulations. Use personal protection measures as required.

Disposal of Wastes / Methods of Disposal

The user is responsible for determining if any discarded material is a hazardous waste (40 CFR 262.11). Dispose of in accordance with federal, state and local regulations.

Methods of Contaminated Packaging Disposal

Empty containers should be completely drained and then discarded or recycled, if possible. Do not cut, drill, grind or weld on empty containers since explosive residues may be present. Dispose of in accordance with federal, state and local regulations.

14. TRANSPORT INFORMATION

DOT (49 CFR 172.101):

UN Proper Shipping Name:	Not Regulated
UN/Identification No:	Not applicable
Class:	Not applicable.
Packing Group:	Not applicable.

TDG (Canada):

UN Proper Shipping Name:	Not Regulated
UN/Identification No:	Not applicable.
Transport Hazard Class(es):	Not applicable.
Packing Group:	Not applicable.

15. REGULATORY INFORMATION

US Federal Regulatory Information:

US TSCA Chemical Inventory Section 8(b):	This product and/or its components are listed on the TSCA Chemical Inventory.
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EPA Superfund Amendment & Reauthorization Act (SARA):

SARA Section 302: This product may contain component(s) that have been listed on EPA's Extremely Hazardous Substance (EHS) List:

SARA Section 304: This product may contain component(s) identified either as an EHS or a CERCLA Hazardous substance which in case of a spill or release may be subject to SARA reporting requirements:

SARA Section 311/312: The following EPA hazard categories apply to this product:

None

SARA Section 313: This product may contain component(s), which if in exceedance of the de minimus

threshold, may be subject to the reporting requirements of SARA Title III Section 313 Toxic Release Reporting (Form R).

State and Community Right-To-Know Regulations:

The following component(s) of this material are identified on the regulatory lists below:

Canada DSL/NDSL Inventory: This product and/or its components are listed either on the Domestic Substances List (DSL) or are exempt.

Canadian Regulatory Information: This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the SDS contains all of the information required by those regulations.

Note: Uncontrolled product according to WHMIS classification criteria.

16. OTHER INFORMATION

Prepared By Toxicology and Product Safety

Revision Notes

Revision Date 05/22/2015

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information is intended as guidance for safe handling, use, processing, storage, transportation, accidental release, clean-up and disposal and is not considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.



SAFETY DATA SHEET

1. Product And Company Identification

SDS ID: SDS 501
PRODUCT NAME: Prestone® Antifreeze/Coolant
PRODUCT NUMBER: AF2000X, AF2000L, AF2050, AF2055, 72025, 71605, 71621, PRES04C, AF2000UK, AF2000PL, AF2000-1KL, AF2000LRU, AF2000RU, 65069, AF2000/GF, AF2000/GFC, AF2055/GF, AF2000-1KL/GF, AF2000/GXF, AF2000/GXF-HT, 71621/GF, 71621/GFC, 71621/GFC3
FORMULA NUMBER: YA956BY, YA956BY-B, YA956BY-ED, YA956BY-ED-B, YA-956BY-GLY, YA-992

MANUFACTURER:
Prestone Products Corporation
Danbury, CT 06810-5109

CANADIAN OFFICE:
FRAM Group (Canada), Inc.
Mississauga, Ontario L5L 3S6

MEDICAL EMERGENCIES AND ALL OTHER INFORMATION PHONE NUMBER:

(800)890-2075 (in the US)

(800)668-9349 (in Canada)

TRANSPORTATION EMERGENCY PHONE NUMBER (Chemical Spills and Transport Accidents only):

CHEMTREC 1-800-424-9300 (in the US)

CANUTEC (613)996-6666 (in Canada)

SDS DATE OF PREPARATION/REVISION: 09/24/15

PRODUCT USE: Automobile Antifreeze – consumer product

RESTRICTIONS ON USE: None identified

2. Hazards Identification

GHS/HAZCOM 2012 Classification:

Health	Physical
Acute Toxicity Category 4 (oral) Specific Target Organ Toxicity – Repeated Exposure Category 2 Toxic to Reproduction Category 2	Not Hazardous

Label Elements



WARNING!

H302 Harmful if swallowed.

H361d Suspected of damaging the unborn child.

H373 May cause damage to kidneys through prolonged or repeated exposure.

Prevention:

P201 Obtain special instructions before use.

P202 Do not handle until all safety precautions have been read and understood.

P260 Do not breathe mist or vapors.

P264 Wash exposed skin thoroughly after handling.

P270 Do not eat, drink, or smoke when using this product.



P280 Wear protective gloves.

Response:

P301 + P312 IF SWALLOWED: Call a POISON CENTER or physician if you feel unwell.

P330 Rinse mouth.

P308 + P313 IF exposed or concerned: Get medical advice.

Disposal:

P405 Store locked up.

P501 Dispose of contents and container in accordance with local and national regulations.

3. Composition/Information On Ingredients

Component	CAS No.	Amount
Ethylene Glycol	107-21-1	75-95%
2-Ethyl Hexanoic Acid, Sodium Salt	19766-89-3	1-5%
Neodecanoic Acid, Sodium Salt	31548-27-3	1-5%
Diethylene Glycol	111-46-6	0-5%

The exact concentrations are a trade secret.

4. First Aid Measures

INHALATION: Remove the victim to fresh air. If breathing has stopped administer artificial respiration. If breathing is difficult, have medical personnel administer oxygen. Get medical attention.

SKIN CONTACT: Remove contaminated clothing. Immediately wash contacted area thoroughly with soap and water. If irritation persists, get medical attention.

EYE CONTACT: Immediately flush eyes with large amounts of water for 15 minutes. Get medical attention if irritation persists.

INGESTION: Seek immediate medical attention. Immediately call local poison control center or go to an emergency department. Never give anything by mouth to or induce vomiting in an unconscious or drowsy person.

MOST IMPORTANT SYMPTOMS: May cause eye irritation. Inhalation of mists may cause nose and throat irritation and nervous system effects. Ingestion may cause abdominal discomfort or pain, nausea, vomiting, dizziness, drowsiness, malaise, blurring of vision, irritability, back pain, decrease in urine output, kidney failure, and central nervous system effects.

INDICATION OF IMMEDIATE MEDICAL ATTENTION AND SPECIAL TREATMENT, IF NEEDED: Seek immediate medical attention for large ingestions.

NOTES TO PHYSICIAN: The principal toxic effects of ethylene glycol, when swallowed, are kidney damage and metabolic acidosis. The combination of metabolic acidosis, an osmol gap and oxalate crystals in the urine is evidence of ethylene glycol poisoning. Pulmonary edema with hypoxemia has been described in a number of patients following poisoning with ethylene glycol. Respiratory support with mechanical ventilation may be required. There may be cranial nerve involvement in the late stages of toxicity from swallowed ethylene glycol. In particular, effects have been reported involving the seventh, eighth, and ninth cranial nerves, presenting with bilateral facial paralysis, diminished hearing and dysphagia.

Ethanol is antidotal and its early administration may block the formation of nephrotoxic metabolites of ethylene glycol in the liver. The objective is to rapidly achieve and maintain a blood ethanol level of approximately 100 mg/dl by giving a loading dose of ethanol followed by a maintenance dose. Intravenous administration of ethanol is the preferred route. Ethanol blood levels should be checked frequently. Hemodialysis may be required. 4-Methyl pyrazole (Fomepizole®), a potent inhibitor of alcohol dehydrogenase, has been used therapeutically to decrease the metabolic consequences of ethylene glycol poisoning. Fomepizole® is easier to use clinically than ethanol, does not cause CNS depression or hypoglycemia and requires less



monitoring than ethanol. Additional therapeutic modalities which may decrease the adverse consequences of ethylene glycol metabolism are the administration of both thiamine and pyridoxine. As there are complicated and serious overdoses, we recommend you consult with the toxicologists at your poison control center.

5. Firefighting Measures

SUITABLE EXTINGUISHING MEDIA: For large fires, use alcohol type or all-purpose foams. For small fires, use water spray, carbon dioxide or dry chemical.

SPECIFIC HAZARDS ARISING FROM THE CHEMICAL: A solid stream of water or foam directed into hot, burning liquid can cause frothing. Burning may produce carbon monoxide and carbon dioxide.

SPECIAL FIRE FIGHTING PROCEDURES: Do not spray pool fires directly. Firefighters should wear positive pressure self-contained breathing apparatus and full protective clothing for fires in areas where chemicals are used or stored.

6: Accidental Release Measures

PERSONAL PRECAUTIONS, PROTECTIVE EQUIPMENT AND EMERGENCY PROCEDURES: Wear appropriate protective clothing and equipment (See Section 8).

METHODS AND MATERIALS FOR CONTAINMENT/CLEANUP: Collect with absorbent material and place in appropriate, labeled container for disposal or, if permitted flush spill area with water.

7. Handling and Storage

PRECAUTIONS FOR SAFE HANDLING:

Harmful or Fatal if Swallowed. Do not drink antifreeze or solution. Avoid eye and prolonged or repeated skin contact. Avoid breathing vapors or mists. Wash exposed skin thoroughly with soap and water after use. Do not store in opened or unlabeled containers. Keep container away from open flames and excessive heat. Do not reuse empty containers unless properly cleaned. Empty containers retain product residue and may be dangerous. Do not cut, weld, drill, etc. containers, even empty.

Sudden release of hot organic chemical vapors or mists from process equipment operating at elevated temperature and pressure, or sudden ingress of air into vacuum equipment, may result in ignitions without any obvious ignition sources. Published "autoignition" or "ignition" temperatures cannot be treated as safe operating temperatures in chemical processes without analysis of the actual process conditions. Use of this product in elevated temperature applications should be thoroughly evaluated to assure safe operating conditions.

CONDITIONS FOR SAFE STORAGE, INCLUDING ANY INCOMPATIBILITIES: Store away from excessive heat and oxidizers.

NFPA CLASSIFICATION: IIIB

8. Exposure Controls / Personal Protection

EXPOSURE GUIDELINES

CHEMICAL	EXPOSURE LIMIT
Ethylene Glycol (as aerosol)	100 mg/m ³ Ceiling ACGIH TLV
2-Ethyl Hexanoic Acid, Sodium Salt	None Established
Neodecanoic Acid, Sodium Salt	None Established
Diethylene Glycol	10 mg/m ³ TWA AIHA WEEL



VENTILATION: Use general ventilation or local exhaust as required to maintain exposures below the occupational exposure limits.

RESPIRATORY PROTECTION: For operations where the TLV is exceeded a NIOSH approved respirator with organic vapor cartridges and dust/mist prefilters or supplied air respirator is recommended. Equipment selection depends on contaminant type and concentration. Select and use in accordance with 29 CFR 1910.134 and good industrial hygiene practice. For firefighting, use self-contained breathing apparatus.

GLOVES: Chemical resistant gloves such as neoprene or PVC where contact is possible.

EYE PROTECTION: Splash-proof goggles.

OTHER PROTECTIVE EQUIPMENT/CLOTHING: Appropriate protective clothing as needed to minimize skin contact.

9. Physical and Chemical Properties

APPEARANCE:	Yellow liquid	ODOR:	Characteristic odor
ODOR THRESHOLD:	None	pH:	8.7-9.2
MELTING/FREEZING POINT:	-34°F (-36.6°C) – -36°F (-37.7°C)	BOILING POINT/RANGE:	327°F (164°C) – 340°F (171.1°C)
FLASH POINT:	254 °F (123 °C) TOC >230 °F (>110 °C) Setaflash	EVAPORATION RATE:	Not determined
FLAMMABILITY (SOLID, GAS)	Not Applicable	FLAMMABILITY LIMITS:	LEL: Not determined UEL: Not determined
VAPOR PRESSURE:	<0.06 mm Hg @20°C	VAPOR DENSITY:	2.1
RELATIVE DENSITY:	1.07-1.14	SOLUBILITIES	Water: Complete
PARTITION COEFFICIENT (n-octanol/water)	Not determined	AUTOIGNITION TEMPERATURE:	Not determined
DECOMPOSITION TEMPERATURE:	Not determined	VISCOSITY:	Not determined

10. Stability and Reactivity

REACTIVITY: Normally unreactive

CHEMICAL STABILITY: Stable

POSSIBILITY OF HAZARDOUS REACTIONS: Reaction with strong oxidizers will generate heat.

CONDITIONS TO AVOID: None known

INCOMPATIBLE MATERIALS: Avoid strong bases at high temperatures, strong acids, strong oxidizing agents, and materials reactive with hydroxyl compounds.

HAZARDOUS DECOMPOSITION PRODUCTS: Carbon monoxide, carbon dioxide.

11. Toxicological Information

POTENTIAL HEALTH EFFECTS:

ACUTE HAZARDS:

INHALATION: May cause irritation of the nose and throat with headache, particularly from mists. High vapor concentrations caused, for example, by heating the material in an enclosed and poorly ventilated workplace, may produce nausea, vomiting,



headache, dizziness and irregular eye movements.

SKIN CONTACT: No evidence of adverse effects from available information.

EYE CONTACT: Liquid, vapors or mist may cause discomfort in the eye with persistent conjunctivitis, seen as slight excess redness or conjunctiva. Serious corneal injury is not anticipated.

INGESTION: May cause abdominal discomfort or pain, nausea, vomiting, dizziness, drowsiness, malaise, blurring of vision, irritability, back pain, decrease in urine output, kidney failure, and central nervous system effects, including irregular eye movements, convulsions and coma. Cardiac failure and pulmonary edema may develop. Severe kidney damage which may be fatal may follow the swallowing of ethylene glycol. A few reports have been published describing the development of weakness of the facial muscles, diminishing hearing, and difficulty with swallowing, during the late stages of severe poisoning.

CHRONIC EFFECTS: Prolonged or repeated inhalation exposure may produce signs of central nervous system involvement, particularly dizziness and jerking eye movements. Prolonged or repeated skin contact may cause skin sensitization and an associated dermatitis in some individuals. Ethylene glycol has been found to cause birth defects in laboratory animals. The significance of this finding to humans has not been determined. 2-Ethyl Hexanoic Acid, Sodium Salt is suspected of causing developmental effects based on animal data.

CARCINOGENICITY LISTING: None of the components of these products is listed as a carcinogen or suspected carcinogen by IARC, NTP, ACGIH or OSHA.

ACUTE TOXICITY VALUES:

Ethylene Glycol: LD50 Oral Rat: 4700 mg/kg
LD50 Skin Rabbit: 9530 mg/kg

Diethylene Glycol: LD50 Oral Rat: 12,565 mg/kg
LD50 Skin Rabbit: 11,890 mg/kg

SIGNIFICANT LABORATORY DATA WITH POSSIBLE RELEVANCE TO HUMAN HEALTH: Ethylene glycol has been shown to produce dose-related teratogenic effects in rats and mice when given by gavage or in drinking water at high concentrations or doses. Also, in a preliminary study to assess the effects of exposure of pregnant rats and mice to aerosols at concentrations 150, 1,000 and 2,500 mg/m³ for 6 hours a day throughout the period of organogenesis, teratogenic effects were produced at the highest concentrations, but only in mice. The conditions of these latter experiments did not allow a conclusion as to whether the developmental toxicity was mediated by inhalation of aerosol, percutaneous absorption of ethylene glycol from contaminated skin, or swallowing of ethylene glycol as a result of grooming the wetted coat. In a further study, comparing effects from high aerosol concentration by whole-body or nose-only exposure, it was shown that nose-only exposure resulted in maternal toxicity (1,000 and 2,500 mg/m³) and developmental toxicity in with minimal evidence of teratogenicity (2,500 mg/m³). The no-effects concentration (based on maternal toxicity) was 500 mg/m³. In a further study in mice, no teratogenic effects could be produced when ethylene glycol was applied to the skin of pregnant mice over the period of organogenesis. The above observations suggest that ethylene glycol is to be regarded as an animal teratogen; there is currently no available information to suggest that ethylene glycol caused birth defects in humans. Cutaneous application of ethylene glycol is ineffective in producing developmental toxicity; exposure to high aerosol concentration is only minimally effective in producing developmental toxicity; the major route for producing developmental toxicity is perorally.

Two chronic feeding studies, using rats and mice, have not produced any evidence that ethylene glycol causes dose-related increases in tumor incidence or a different pattern of tumors compared with untreated controls. The absence of carcinogenic potential for ethylene glycol has been supported by numerous invitro genotoxicity studies showing that it does not produce mutagenic or clastogenic effects. This product contains less than 0.3% tolytriazole which has demonstrates mutagenic activity in a bacterial test system. A correlation has been established between mutagenic activity and carcinogenic activity for many chemicals. Tolytriazole has not been identified as a carcinogen or probable carcinogen by NTP, IARC or OSHA.

In a study of Wistar rats, adverse developmental results were reported at a dose of 100 mg / kg of body weight for 2-Ethyl Hexanoic Acid, Sodium Salt.



12. Ecological Information

ECOTOXICITY:

Ethylene Glycol: LC50 Fathead Minnow <10,000 mg/L/96 hr.
EC50 Daphnia Magna 100,000 mg/L/48 hr.
Bacterial (*Pseudomonas putida*): 10,000 mg/l
Protozoa (*Entosiphon sulcatum* and *Uronema parduczi*; Chatton-Lwoff) : >10,000 mg/l
Algae (*Microcystis aeruginosa*): 2,000 mg/l
Green algae (*Scenedesmus quadricauda*) : >10,000 mg/l
Diethylene Glycol: LC50 western mosquitofish >32,000 mg/L/96 hr.

PERSISTENCE AND DEGRADABILITY:

Ethylene Glycol is readily biodegradable (97-100% in 2-12 days). Diethylene glycol is readily biodegradable (>70% in 19 days).

BIOACCUMULATIVE POTENTIAL:

Ethylene glycol: A BCF of 10, reported for ethylene glycol in fish, Golden ide (*Leuciscus idus melanotus*), after 3 days of exposure suggests the potential for bio concentration in aquatic organisms is low.
Diethylene glycol: An estimated BCF of 3 suggests the potential for bio concentration in aquatic organisms is low.

MOBILITY IN SOIL: Ethylene glycol and diethylene glycol are highly mobile in soil.

OTHER ADVERSE EFFECTS: None known

13. Disposal Considerations

Dispose of product in accordance with all local, state/provincial and federal regulations.

14. Transport Information

U.S. DOT HAZARD CLASSIFICATION: Not Regulated (unless package contains a reportable quantity)

Note: IF A SHIPMENT OF A REPORTABLE QUANTITY (5,260 LBS/553 GAL.) IN A SINGLE PACKAGE IS INVOLVED, THE FOLLOWING INFORMATION APPLIES:

PROPER SHIPPING NAME: RQ, Environmentally hazardous substance, liquid, n.o.s. (Ethylene glycol)
UN NUMBER: UN3082
PACKING GROUP: III
LABELS REQUIRED: Class 9

DOT MARINE POLLUTANTS: This product does not contain Marine Pollutants as defined in 49 CFR 171.8.

IMDG CODE SHIPPING CLASSIFICATION: Not Regulated

CANADIAN TDG CLASSIFICATION: Not Regulated

15. Regulatory Information

EPA SARA 311/312 HAZARD CLASSIFICATION: Acute health, chronic health

EPA SARA 313: This Product Contains the Following Chemicals Subject to Annual Release Reporting Requirements Under SARA Title III, Section 313 (40 CFR 372):

Ethylene Glycol	107-21-1	75-95%
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PROTECTION OF STRATOSPHERIC OZONE: This product is not known to contain or to have been manufactured with ozone depleting substances as defined in 40 CFR Part 82, Appendix A to Subpart A.

CERCLA SECTION 103: Spills of this product over the RQ (reportable quantity) must be reported to the National Response Center. The RQ for this product, based on the RQ for Ethylene Glycol (95% maximum) of 5,000 lbs, is 5,260 lbs. Many states have more stringent release reporting requirements. Report spills required under federal, state and local regulations.

CALIFORNIA PROPOSITION 65: This product contains the following chemicals known to the State of California to cause cancer or reproductive toxicity (birth defects):

Ethylene Glycol	107-21-1	75-95%	Developmental
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EPA TSCA INVENTORY: All of the components of this material are listed on or exempt from the Toxic Substances Control Act (TSCA) Chemical Substances Inventory.

CANADIAN ENVIRONMENTAL PROTECTION ACT: All of the ingredients are listed on or exempt from the Canadian Domestic Substances List.

EUROPEAN INVENTORY OF EXISTING COMMERCIAL CHEMICAL SUBSTANCES (EINECS): All of the ingredients are listed on or exempt from the EINECS inventory.

JAPAN: All of the ingredients of this product are listed on or exempt from the Japanese Existing and New Chemical Substances (MITI) List.

AUSTRALIA: All of the ingredients of this product are listed on or exempt from the Australian Inventory of Chemical Substances.

KOREA: All of the ingredients of this product are listed on or exempt from the Korean Existing Chemical List (KECL).

PHILIPPINES: All of the ingredients of this product are listed on or exempt from the Philippine Inventory of Chemical and Chemical Substance (PICCS)

CHINA: All of the ingredients of this product are listed on or exempt from the Inventory of Existing Chemical Substance in China (IECSC).

16. Other Information

NFPA RATING (NFPA 704) - FIRE: 1 HEALTH: 2 INSTABILITY: 0

REVISION SUMMARY: Section 15: Chemical inventories, California Proposition 65.

SDS Date of Preparation/Revision: September 24, 2015

This SDS is directed to professional users and bulk handlers of the product. Consumer products are labeled in accordance with Federal Hazardous Substances Act regulations.

While Prestone Products Corporation believes that the data contained herein are factual and the opinions expressed are those of qualified experts regarding the results of the tests conducted, the data are not to be taken as a warranty or representation for which Prestone Products Corporation assumes legal responsibility. They are offered solely for your consideration, investigation and verification. Any use of these data and information must be determined by the user to be in accordance with applicable federal, state and local laws and regulations.



SDS501
PRESTONE ® ANTIFREEZE/COOLANT
Date Prepared: 09/24/2015

If more information is needed, please contact:

Prestone Products Corporation
69 Eagle Road
Danbury CT 06810
(800) 890-2075



Appendix C

Equipment Inspection Forms

HEAVY EQUIPMENT – Inspection Form

Project Name: <u>AmMg – Deming Mining Project</u> Location: <u>Deming, New Mexico</u> Completed by: _____ Manufacturer: _____	Date: _____ Project Number: _____ Project Manager: _____ Reviewed by: _____ Equipment ID: _____
--	---

- Check “Yes” if an assessment item is complete or is determined to be correct.
- Check “No” if an item is deficient for determined to be incorrect. Items determined to be deficiencies shall be brought to the immediate attention of the Site Supervisor or Safety Officer. Corrective Action must be completed for assessment items marked “No”.
- Check “N/A” if the item is not applicable.

1.0 General Equipment Inspection	Yes	No	N/A
1.1 Boom/Blade/Ripper in good condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.2 Ground engaging attachments in good condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.3 Frame, ladders, access point free of debris and in good condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.4 Hand grabs and steps free of debris and in good condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.5 Power cables and/or hoist cables free of damage?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.6 Braking system and steering components operational?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.7 Tire and/or tracks in good condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.8 Horn tested and operational?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.9 Mirrors in good condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.10 Gauges/turn signals/backup lights operational?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.11 Fire extinguisher maintained and within inspection date?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2.0 Spill Prevention and Control	Yes	No	N/A
2.1 Verified no visible signs of leaking hydraulic oil?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.2 Hydraulic oil level verified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.3 Verified no visible signs of leaking motor oil/transmission fluid?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.4 Motor oil/transmission level verified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.5 Verified no visible signs of brake fluid/transfer case fluids?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.6 Brake fluid level verified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.7 Verified no visible signs of leaking coolant/cooling system fluid?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.8 Verified no staining on ground surface, no visible signs of leaking fuel?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.9 Fuel level verified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3.0 Other Comments

Corrective Action		
Item	Corrective Action Planned	Date Corrected

DRILLING RIG – Inspection Form

Project Name: <u>AmMg – Deming Mining Project</u> Location: <u>Deming, New Mexico</u> Completed by: _____ Manufacturer: _____	Date: _____ Project Number: _____ Project Manager: _____ Reviewed by: _____ Equipment ID: _____
--	---

- Check “Yes” if an assessment item is complete or is determined to be correct.
- Check “No” if an item is deficient for determined to be incorrect. Items determined to be deficiencies shall be brought to the immediate attention of the Site Supervisor or Safety Officer. Corrective Action must be completed for assessment items marked “No”.
- Check “N/A” if the item is not applicable.

1.0 General Equipment Inspection	Yes	No	N/A
1.1 Kill switch clearly identified and operational?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.2 Ground engaging attachments in good condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.3 Rig ropes not wrapped around body parts?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.4 Pressurized lines and hoses secured?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.5 Cathead in clean, sound condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.6 Drill rig ropes in clean, sound condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.7 Augers/bits in clean, sound condition?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.8 Stabilization and leveling mechanisms operational?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.9 Fire extinguisher maintained and within inspection date?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

2.0 Spill Prevention and Control	Yes	No	N/A
2.1 Verified no visible signs of leaking hydraulic oil?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.2 Hydraulic oil level verified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.3 Verified no visible signs of leaking motor oil/transmission fluid?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.4 Motor oil/transmission level verified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.5 Verified no visible signs of brake fluid/transfer case fluids?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.6 Brake fluid level verified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.7 Verified no visible signs of leaking coolant/cooling system fluid?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.8 Verified no staining on ground surface, no visible signs of leaking fuel?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.9 Fuel level verified?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3.0 Other comments

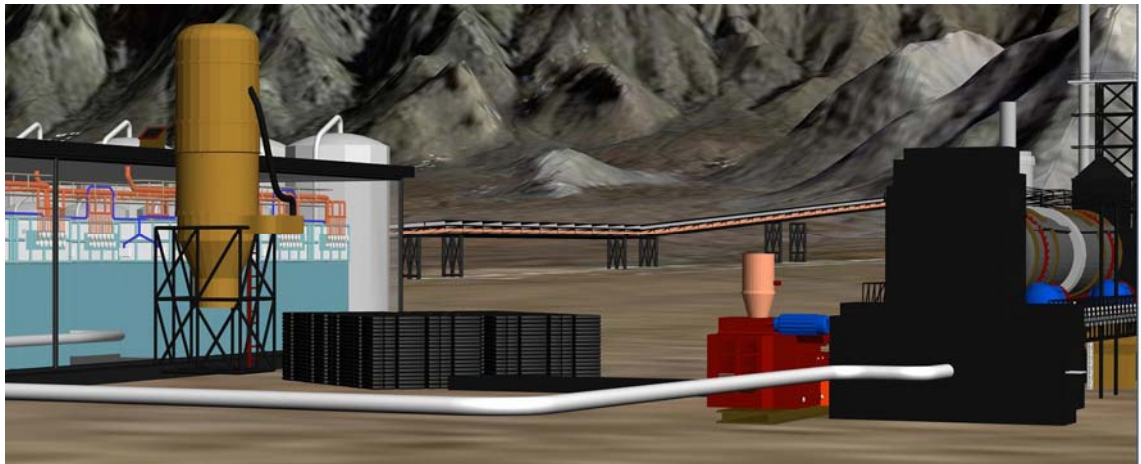
Corrective Action		
Item	Corrective Action Planned	Date Corrected

Enclosure 3
Conceptual Feasibility Study Report

American Magnesium LLLP

Report

Conceptual Feasibility of a Magnesium Metal Complex near Deming NM, USA



April 25, 2013 CONFIDENTIAL



StrategicMindset Technology

TRU Group Inc

trugroup.com

April 25, 2013

David Tognoni
President
American Magnesium LLLP
P.O. Box 684
Elephant Butte, NM 87935

REPORT
**Conceptual Feasibility of a
Magnesium Metal Complex near Deming NM, USA**

We are pleased to submit this report dated April 25, 2013 on an assignment that has the objective to determine a concept for magnesium smelting and producing other magnesium products near Deming New Mexico.

The project is a good idea and generates reasonable profits with low technical risk but moderate market risks. If this is acceptable TRU recommends fast-tracking the project to make American Magnesium LLLP the first company to establish a magnesium operation of this technology in the United States.

A handwritten signature in blue ink, appearing to read "Zeta".

TRU Group Inc

tru-ammg-magnesium-metal-complex-report.docx / .pdf

Executive Summary

Objective

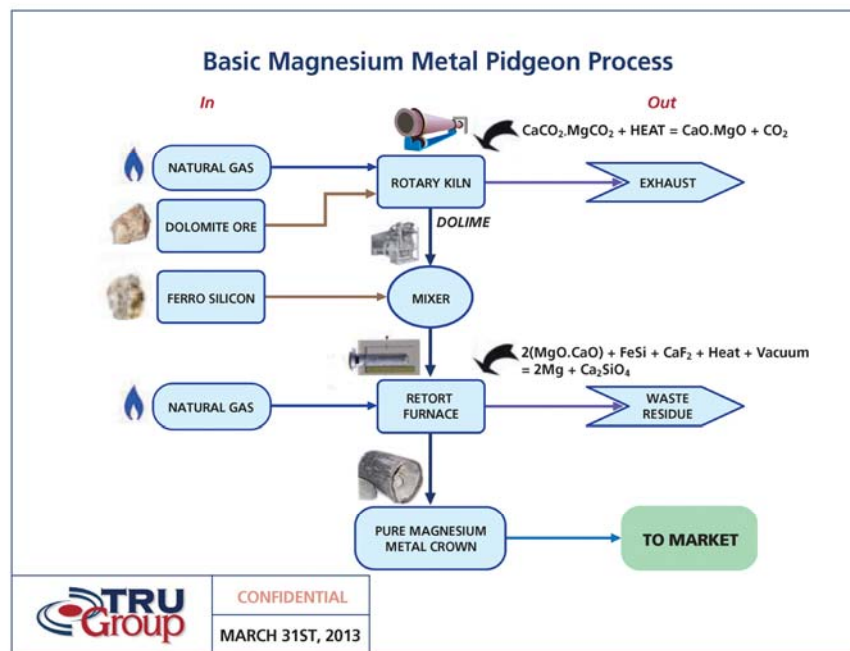
American Magnesium LLLP (AmMg) is investigating the possibility of constructing a magnesium metal production complex south of Deming NM adjacent to a dolomite resource using natural gas for energy. AmMg asked TRU to undertake a study with the objective of determining whether the idea was conceptually viable. The analysis is conceptual with 40% accuracy. All units of measurement are metric unless noted otherwise.

Magnesium Smelter

The AmMg Smelter would use a TRU innovation of the Pidgeon silico-thermal smelting process involving the calcining of dolomite (magnesium and calcium carbonate) to dolime in a rotary kiln and the reduction of the dolime (magnesium and calcium oxide) to magnesium metal 'crowns' using ferrosilicon in a retort furnace. The 'crowns' would be further processed into high purity ingot and various magnesium alloys for sale mainly in the American market. Although the process plant is referred to as a 'smelter', no sulphur dioxide is produced during dolomite conversion to magnesium metal.

The key inputs and largest contributors to costs are dolomite, ferrosilicon and natural gas. A simplified drawing is shown in the following Exhibit I.

Exhibit I: Simplified Drawing of the Magnesium Upgraded Pidgeon Process



▣ Adjacent Dolomite Mine

The capital cost of the open cast dolomite mine is not included in the estimates. TRU assumes the dolomite will be delivered by conveyor at \$20 per metric tonne (t). The following are the core observations of our preliminary assessment of the resource -

- ❖ Excluding sampling outliers the AmMg compositional average MgO assay is 21% and the average SiO₂ assay 0.7% meaning the dolomite is good on main criteria for recovery of Mg metal using the Pidgeon Process.
- ❖ The current surface chip sampling revealed relatively consistent dolomite composition across the sample pathlines and provides an early indicator that a large proportion of the peak is covered by dolomite
- ❖ If the AmMg sampled peak shares similar morphological and geological characteristics as other nearby peaks with large dolomite occurrences then there is a potential for a large dolomite resource on the AmMg claim areas.

▣ Conclusions

The following are the key findings of the assignment -

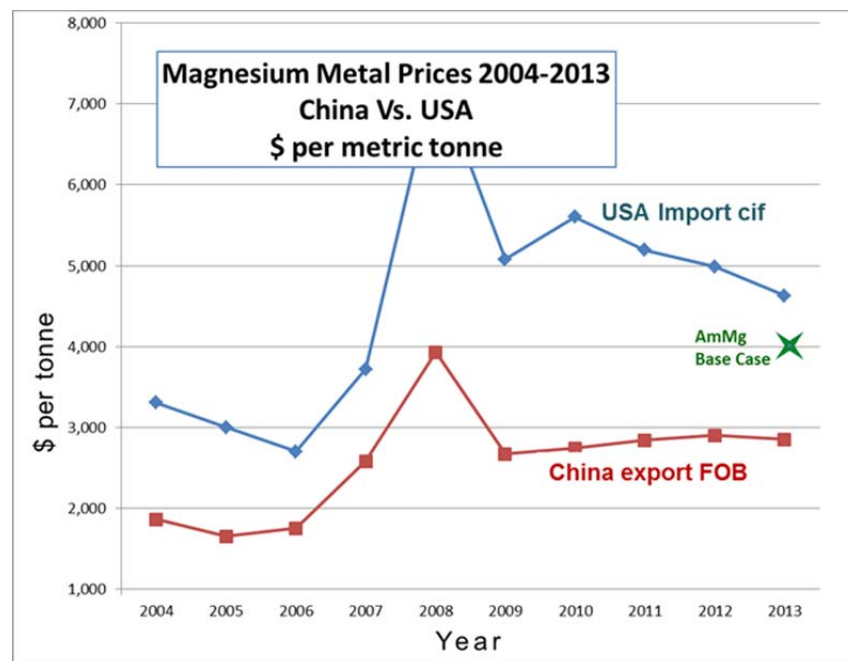
- ❖ The Pidgeon Process Magnesium Smelter with an integrated Alloy and Pure Metal Plant is technically feasible using the well proven Western and Chinese technology
- ❖ The magnesium smelter complex in its current configuration and planned capacity of 30,000 metric tonnes per year (tpy) (33,000 tons/year) has modest requirements of land and utilities with a total footprint of 2.3 hectares (6 acres) and estimated annual requirements of 4.5 million GJ (4,245 million BTU) of energy derived from natural gas, 73,000 MWh of electricity and roughly 63,000 m³ (17 million gallons) of water
- ❖ The magnesium smelter and alloy plant in conjunction with alloy tube and casting plant will need 550 employees which can be sourced from the City of Deming and vicinity of Luna County, New Mexico
- ❖ A stand-alone Magnesium Smelter & Alloy and Pure Metal Plant with a capacity of 30,000 tpy of metal output requires a \$94 million investment and is financially viable provided the *requirements for success* given below are met
- ❖ The project produces moderate to good profits. By year five the business will generate about \$129 million in revenue and earnings of \$21 million. The Net Present Value of \$50 million is significant and Internal Rate of Return 16%. The investment pay-back period is 7 years.
- ❖ Most if not all of the complex output can be sold in the United States and indeed there is potential for significant expansion in the domestic market.

▣ Requirements for Success

The following are some core conditions that are inherent in making the assignment findings -

- ❖ The project is most sensitive to magnesium metal prices in the United States, but US prices are currently superficially inflated due to heavy duties imposed on Chinese suppliers. The duties are in place to protect the sole domestic producer US Magnesium that operates a (non-competitive) plant in Rowley, UT. It is assumed that the duties will remain in place for some time.
- ❖ In a way AmMg will be exploiting the above situation, strategically managing prices. For the purposes of evaluating the project a price of \$4000 per metric tonne (t) of magnesium ingot is assumed as illustrated in the following Exhibit II.

Exhibit II: Base Case Price Positioning for Financial Evaluation



- ❖ Natural gas prices are also critical to profitability. A ten mile natural gas pipeline must be constructed. There is compelling evidence that natural gas prices will remain attractive and it is assumed that it will be delivered for \$3.80 per GJ (\$4.00/MMBTU) long term
- ❖ World ferrosilicon prices are at elevated levels so the AmMg project will need to obtain firm secure long term supplies, probably from China, at a low end price
- ❖ The AmMg Magnesium Metal Complex must produce at lower costs than US Magnesium and although somewhat higher than the main Chinese producers

- ❖ The Complex must include the proposed Alloy Retort and Tube Casting Plant, which will make replacement western-style retorts for the furnace. It is assumed that this facility will also sell special tube products at a profit
- ❖ Core drilling and geophysical exploration will be necessary in the next steps to quantify the extent and scale of the resource.

■ Recommendations to AmMg

The project is a good idea and generates reasonable profits with low technical risk but moderate market risks: If this is acceptable TRU recommends fast-tracking the project to make AmMg a 'first-mover', the first company to establish a magnesium operation in the area. The following are TRU recommendations to AmMg on future steps -

- ❖ Undertake a comprehensive feasibility study to an accuracy of 25% or less at a cost of around \$300,000. This should include updating and more thorough analysis of the proposed concept as well as magnesium compounds
- ❖ In parallel, undertake further geological sampling and preparation of a preliminary mining plan to confirm adequate dolomite quality and quantities at a reasonable cost. These costs are separate from the estimate for the feasibility study.
- ❖ Prepare the financing of the project as construction should begin quickly to retain a competitive advantage as the first company to establish a magnesium operation of this technology in the United States.

TRU Group Inc

trugroup.com

April 25, 2013



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REPORT

Conceptual Feasibility of a Magnesium Metal Complex near Deming NM, USA

INTRODUCTION AND CONCEPT

Objective

American Magnesium LLLP (AmMg) is interested in taking practical steps to investigate and develop a Magnesium Metal Complex to take advantage of a large dolomite deposit near Deming NM and the falling natural gas prices in the United States. AmMg asked TRU to propose a concept for exploiting the situation especially for magnesium smelting. Although the process plant is referred to as a 'smelter', it is not the typical metal sulphide smelter which produces sulphur dioxide off-gas. No sulphur dioxide is produced in the conversion of dolomite to magnesium metal. The study should assess the main issues and advise on whether the project has sufficient promise to investigate in detail.

The objective of this assignment is to determine a concept for magnesium smelting and other magnesium products at Deming New Mexico. In particular -

- derive a conceptual design for magnesium metal & other magnesium products
- broadly assess the viability of a Pidgeon process Magnesium Metal Smelter & Alloy Facility
- assess the main driving issues for the project
- undertake a broad technical and business assessment of the concept
- broadly determine conceptual viability, and recommend the next steps for development, if any

AmMg has undertaken some preliminary analysis of the AmMg dolomite ore that will be the feed for the magnesium metal complex.

This assessment is strategic in nature. Technical viability issues were examined and a preliminary conceptual design is included. Financial data was estimated in the \pm 40 % range of accuracy.

This assessment determined the general viability and configuration of a Pidgeon Process based magnesium complex.

An important output of the study was to quantify the natural gas requirement and its cost. Ferrosilicon supply is also a core issue for the project.

Methodology

The project is based on the substantial work TRU prepared for previous assignments in the magnesium industry. The conceptual idea for this project is derived from a previous detailed design and engineering study but presented here as an overview with some modifications to fit the AmMg project.

This assignment focused on the key parameters driving the strategic and technical success of a magnesium metal operation. For the smelter to be financially viable, the costs of the main inputs – ferrosilicon, natural gas and dolomite – are a priority. TRU therefore analyzed these inputs in some depth and in addition contacted suppliers to firm up the estimates to the level that would satisfy the criteria for making a decision on whether this project should proceed further.

Engineering estimates have been made based on previous work. TRU believes the accuracy of the estimates overall are within the $\pm 40\%$ limits and may in fact be much more precise than this range. Certainly, the specified objectives of the assignment have been achieved.

All units of measurement are metric unless noted otherwise.

Concept

The overall project concept is based on the exploitation of a large dolomite mineral deposit south of Deming NM for the purposes of magnesium metal manufacturing. The idea has a reasonably good foundation as the United States has only one other (high cost) magnesium smelter and is undersupplied domestically. Further, natural gas is abundant in New Mexico and prices have fallen dramatically in recent years, making a project like a Pidgeon technology smelter more attractive.

The smelter has the following main components –

- magnesium smelter for reducing magnesium oxide to magnesium metal & alloy plant
- rotary kilns for the calcination of dolomite (magnesium and calcium carbonate) to dolime (magnesium and calcium oxide)
- a dolomite mine adjacent to the plant
- a conveyor for delivery of the dolomite to the smelter
- a 10 mile gas pipeline for delivery of natural gas to the plant
- ferrosilicon imported from China or possibly American sourced.

The following drawing illustrates the magnesium complex concept -

Figure 1: Illustration of AmMg Project Concept and Layout on Site



MAGNESIUM SMELTER

Design Basis & Output

Summary

A Magnesium Smelter using the Pidgeon process with a metal output capacity of 30,000 metric tonnes per year (tpy) (33,000 tons/year) grading 99.98 % magnesium crown is recommended and is considered technically feasible at Deming NM. A capacity of 30,000 tpy was chosen because the plant can be erected in two distinct self-sufficient plant modules each of 15,000 tpy capacity and the dolime supplied by an optimized 300 metric tonnes per day (tpd) dolime capacity rotary kiln. The smelter (left) and rotary kiln (right) with conveyor (back) for the transport of dolomite from the adjacent mine to the site is seen below in Figure 2-

Figure 2: Magnesium Complex Conceptual Illustration



The Magnesium Smelter with an integrated Alloy and Pure Metal Plant is technically feasible using well proven Western and Chinese technology. China has been using the Pidgeon process with great success in the last 15 years. Over this period constant improvements have been made especially in energy consumption per kg of Mg produced. Chinese Mg producers have and are still using mainly waste gases from coal-based activities such as coke-oven gas.

Timminco in Canada used natural gas but in the early days had used electric power. There is plenty of reasonably priced natural gas available in New Mexico therefore the recommendation is to use natural gas. The plant would use the best technology available today in China. In recent years Chinese producers have improved –

- Mg production productivity
- Energy consumption

The smelter plant would be built according to Western technology and most of the equipment and machines would come from Western companies. Plant automation or advanced mechanization would also be a priority.

The main benefits of combining the Western and Chinese technology could be:

- higher Mg productivity
- energy saving
- better environment
- less labor/ more automation
- lower production costs

Magnesium Smelter Basis of Design

The key design parameters for the smelter include:

- Two rotary kilns to calcine dolomite to dolime
- Two banks of vacuum retort magnesium reduction furnaces each of 15,000 tpy for optimal efficiency with a total of 37 furnace units, each furnace unit containing 36 retort tubes [total individual retort tubes equals 1,332].
- Natural gas fired reduction of a reaction mix containing dolime, ferrosilicon and fluorspar for the vacuum retort magnesium reduction furnaces. The decision was made to use natural gas because it was more economic.
- For optimal efficiency the plant will use 85% ferrosilicon (FeSi), if available, in preference to 75% grades, but will have the flexibility to switch to 75% grade.
- Vacuum retort magnesium reduction furnace banks designed for flexibility to use both Chinese-style iron vacuum tube retorts as well as high tech Nickel-Chromium-Iron (NiCrFe) alloy tube retorts, depending upon availability. The start-up of the Magnesium Smelter will use purchased retorts.
- An Alloy Retort & Tube Casting Plant with a capacity of 2,000 tpy is recommended to support the needs of annual retort consumption at the Magnesium Smelter, which will be brought up to full production by Year 4 of the Magnesium Smelter with confidence and 100% ownership of all retorts.
- Maximum mechanization especially in typically labor intensive production cells such as mechanization in servicing the reduction furnaces.

Dolomite will be provided by the adjacent mine and stored on concrete pads externally and in close proximity to the kiln feed elevators. The recommended granulometry for the dolomite should be restricted to the following size: (Max- 25mm - Min-3mm). The sizing is important to avoid losses and promote calcination. The dolomite source should meet the chemical specifications outlined in the following table –

Table 1: Dolomite Chemical Specifications

CHEMICAL/PARAMETER	Units	Detection Limit	Value
Magnesium (MgO)	pct	0.01	20.73
Calcium (CaO)	pct	0.01	31.18
Silicon (SiO ₂)	pct	0.01	0.52
Manganese (MnO)	pct	0.01	0.02
Sodium (Na ₂ O)	pct	0.01	0.03
Potassium (K ₂ O)	pct	0.05	0.05
Chromium (Cr ₂ O ₃)	pct	0.01	<0.01
Iron (Fe ₂ O ₃)	pct	0.01	0.11
Titanium (TiO ₂)	pct	0.01	0.01
Zinc (ZnO)	ppm	1.00	5
Carbon Dioxide (CO ₂)	pct	0.01	46.85

Sources and notes:
TRU Group Inc

Table 2: Major Process Design Criteria

PARAMETER	MEASUREMENT
Metal Recovery	86%
Product per retort day	68kg
Retort Life	250 days
Product Quality	99.98% Magnesium

The critical detrimental elements in the production of magnesium are as follows.

- Silica - interferes with the calcining process and reduces magnesium recovery downstream.
- Sodium and potassium - cause uncontrollable burning during magnesium extraction from the reduction furnaces.

Process Description

Summary

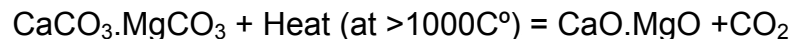
The process flow chart for the production of magnesium crown is shown in Figure 3 and the paragraphs below describe each of the major unit operations of the Magnesium Smelter.

Raw Materials Storage

Most raw materials such as dolomite and FeSi will be stored on concrete pads located on plant property. Finished or in-process materials are stored in concrete or steel bins capable of supplying the process in the event of maintenance upsets for one day.

Calcining

Dolomite meeting chemistry and size requirements is fed at a controlled rate to a gas fired rotary kiln. In this process, the following reaction takes place:



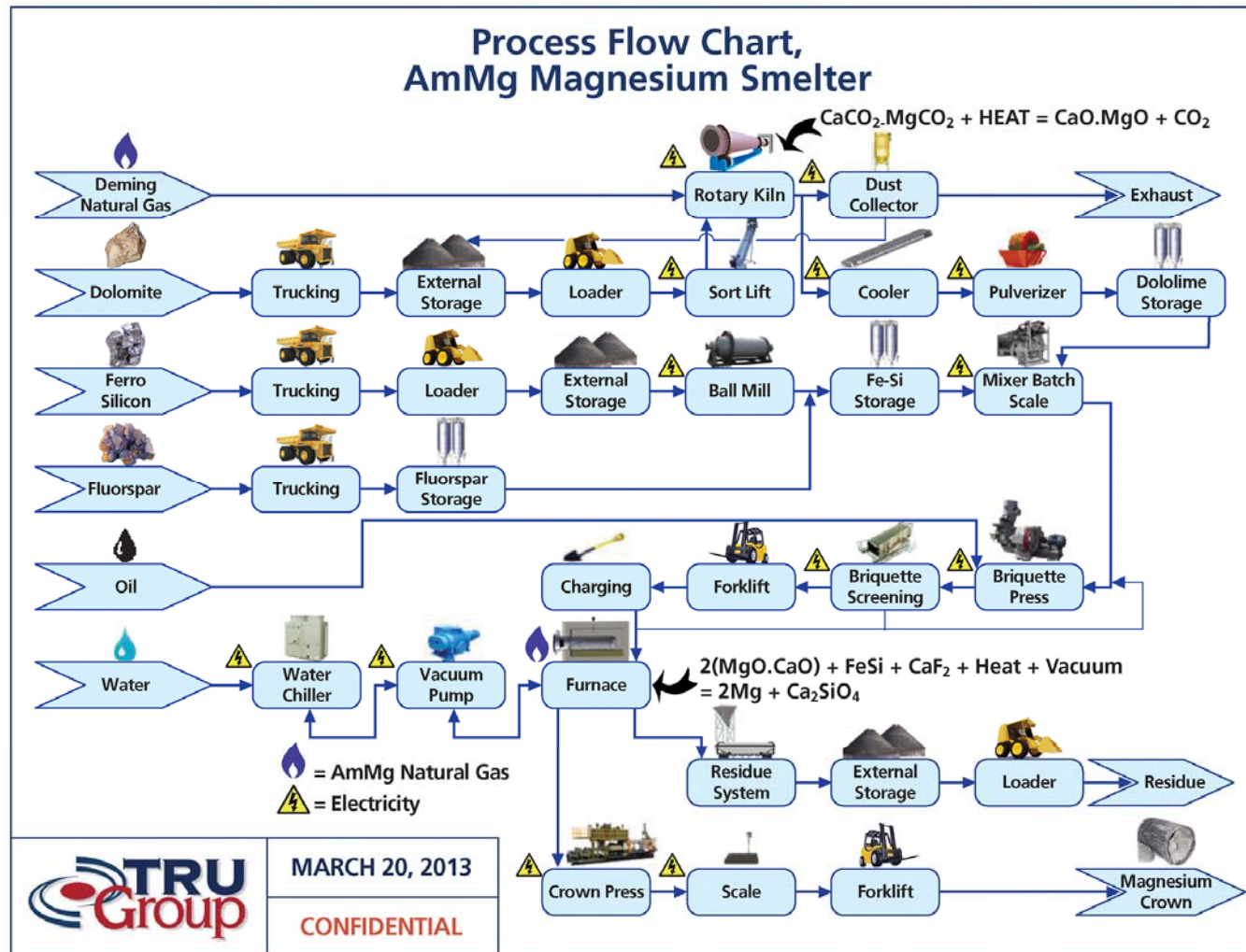
The process is endothermic and hence is one of the primary energy consumers of the Pidgeon process. Present industrial experience reports the following typical energy usages for dolomite: Natural Gas 5 GJ (4.74 million BTU) per t dolomite feed.

The calcined dolomite or dolime (CaO.MgO) exits the kiln and is cooled to handling temperatures by passing the hot material through a rotary cooler. The hot gases from the cooler are utilized as combustion air in the rotary kiln.

Cooled dolime is processed to a fine power by pulverization using a Raymond mill or other suitable grinders. Product from this process is stored in a one day production storage bin to provide a buffer for kiln upsets or maintenance.

The screen distribution of the dolime is critical in producing a durable briquette and promoting the diffusion of magnesium vapor through the briquette.

Figure 3: Magnesium Smelter Flowchart



Ferrosilicon Grinding

Crushed ferro-silicon (FeSi) (25mm nominal size) is required meeting the chemical specifications outlined in Table 3: Ferro-silicon (FeSi) Specifications

Ferrosilicon is stored on a concrete pad in close proximity to a ball mill. Silicon is the reducing agent in the production of magnesium vapor and is readily available in the form of FeSi alloy. The standard grade used in the steel and magnesium industry is 75% silicon. However, since some of the silicon tied with iron is inert to the process, economic FeSi alloys containing silicon above 75% are recommended. For this process, 85% FeSi is recommended. Since silicon is the reducing agent in a solid-solid reaction, its distribution in the mixture is extremely important. Therefore; product emerging from the ball mill must be screened and conform to the following general screen distribution.

TYLER SCREEN SIZE DISTRIBUTION

+65 mesh	12%max
-350 mesh	50%min

In this process, ventilation and dust collection is important to avoid the buildup of explosive gases and to control fugitive dust. Ground FeSi meeting specifications is stored in a day bin to provide a buffer in the event of ball mill maintenance and unplanned down time.

Table 3: Ferro-silicon (FeSi) Specifications

PARAMETER	CHEMICAL /PHYSICAL REQUIREMENTS
Silicon	84% minimum 87% maximum
Manganese	0.15% maximum
Sodium	0.10% maximum
Lead	0.001% maximum
Zinc	0.002% maximum
Arsenic, Antimony, Phosphorous	0.02 each maximum
Moisture	1.5% maximum in fines in 10mm material

Fluorspar Storage

Fluorspar (CaF_2) is an important component of the reaction mix acting as catalyst; improper usage can result in sub-standard yields and process efficiency. For this process, fluorspar is purchased at the following chemical specifications -

Table 4: Fluorspar Specifications

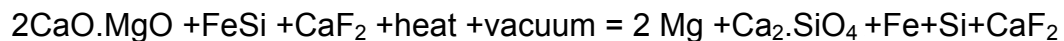
PARAMETER	CHEMICAL/PHYSICAL REQUIREMENTS
Calcium Fluoride (CaF_2)	95.0% Minimum
Silica (SiO_2)	1.0% max.
Calcium Carbonate (CaO_3)	2.5% max.
Moisture	0.2% max.
Aluminum (Al)	0.1% max.
Iron (Fe)	0.1% max
Manganese (Mn)	0.005% max
Lead (Pb)	0.005% max.
Zinc (Zn)	0.005% max.
Nickel (Ni)	0.0005% max.
Copper (Cu)	0.0005% max
All others	Not to exceed 10ppm

Blending and Briquetting

The raw materials are weighed in calculated proportions depending on the silicon content of the FeSi. The correct FeSi addition is critical to ensure optimum metal recovery and maximum utilization of the silicon units. The mixture is formed into a hard pillow shaped briquette using rotating briquette presses. Since the briquettes are only held together by pressure, their life is limited to approximately two hours from formation. All briquettes are screened prior to storage into portable containers. The fines are returned for reprocessing.

Reduction

The reduction process to produce magnesium proceeds by the following chemical reaction:



The reaction takes place in alloy tubes with chemical specifications outlined below. This retort specification would be preferred from a technical perspective. However, lower cost retorts, with lower nickel content, are used “effectively” in China and may be found to be acceptable. Temperature control, vacuum control, charging and discharging operations are critical to ensure optimum metal recovery, furnace efficiency and minimize labor.

Table 5: Alloy Tube Specifications

RETORT SPECIFICATIONS

ITEM	Units			
Casting Method		Centrifugal		
Length	cm	314.96		
Outside Diameter	cm	33.99		
Inside Diameter	cm	27.38		
Retort Caps Diameter	cm	34.06		
Retort Caps weight	kg	26.82		
Finished Weight	kg	26.82		
Chemical Composition	%	100	min	max
iron	%	40.925		
nickel	%	38.000		
chromium	%	18.500		
manganese	%	0.500	0.300	0.700
silicon	%	1.500	1.000	2.000
sulphur	%	0.025	0.000	0.025
carbon	%	0.425	0.400	0.450
phosphorous	%	0.025	0.000	0.025
other	1 %	0.100		
Number of Retorts	pa	1800		
Certificate of analysis required for each retort				
All material will be free of slag, non metallic inclusions, stress cracks and other visual deformities				

Sources & notes -

1 Molybdenum, Copper, Tungsten, Vanadium, Niobium

TRU Group Inc

This component of the process is very labor intensive, since each individual retort is cycled every 8 hours. Each retort will yield approximately 68 kg of magnesium crown per day with a metal yield averaging 86%.

Each furnace contains 36 retorts on one plane in a gas furnace equipped with state of the art temperature control and heat recuperation to ensure minimal energy usage, and optimize retort life to approximately 250 days. Compared to Chinese configurations, this furnace arrangement lends itself to mechanization and good labor utilization.

A vacuum is provided to the retorts by mechanical and diffusion pumps. The state of vacuum is monitored electronically to ensure optimum vacuum control. Poor vacuum due to leaks or failed retorts results in poor metal recovery and poor process efficiency.

The furnaces are serviced by mechanized equipment; namely, a charger, which screens and charges a predetermined amount of briquettes to the retort, a puller which removes condensers and crown from the retort, a discharger which removes the spent hot residue, a reamer which cleans the interior of each retort, and a residue disposal system which moves the hot residue to storage. Steel condensers containing a crown are

transported to an automated press which removes the magnesium crown from the condenser and returns the steel condenser for further usage.

Residue Disposal

The composition of magnesium residue contains Ca_2SiO_4 , a key ingredient in Clinker or Portland cement. The location of the magnesium smelter in close proximity to a cement plant would enable the smelter to dispose of its waste and generate revenue.

Plant Configuration

The plant has been configured to include two independent and identical production phases each capable of producing 15,000 tpy of magnesium ingots. Since the Pidgeon process is characterized by a significant movement of low weight, high volume magnesium units, the plant should have a centrally located Casting Plant able to process the raw magnesium (crowns) into refined pure or alloyed magnesium ingot ready for shipment.

Included with the casting facility are the following: full functional laboratory, maintenance and machine shops, comfort facilities for the employees, offices and raw material and finished product warehouse. The area of land required for the Smelter is expected to 2.3 hectares (5.7 acres). This area does not include a disposal area for magnesium residue and sludge if necessary. Waste materials such as magnesium residue and melt plant sludge are stored on concrete pads. The waste materials can possibly be sold to cement producers.

Raw Materials

Table 6: Major Raw Materials Requirements lists the annual requirements of major raw materials for the production of 30,000 tpy magnesium ingot. The ingot is produced from raw unrefined magnesium, called a crown, because it looks like a crown when removed from a steel cylindrical condenser. There is usually a 5% yield loss going from crown to refined ingot.

Table 6: Major Raw Materials Requirements

MATERIAL	ANNUAL USAGE
Dolomite	362,000 tpy
85% FeSi	31,400 tpy
Fluorspar	5,000 tpy
Spray Oil	586,000 liters

Operating Consumables

Table 7: Annual Major Operating Consumables lists the major consumables for the production of 30,000 tpy of magnesium ingot.

Table 7: Annual Major Operating Consumables

CONSUMABLE	ANNUAL UNITS
Retorts	1865
Roll Shells	49 sets
Kiln Refractory	10% per annum

Table 8: Annual Energy Requirements lists the annual energy required for the production of 30,000 tpy of magnesium ingot. It was assumed that the NM natural gas has a net heating value of 1000 BTU/SCF . Based on these figures the annual gas volume required would be 4,245 million SCF or 14 million SCF/day.

Table 8: Annual Energy Requirements

ENERGY SOURCE	ENERGY UNITS
Natural Gas	4,245 billion BTU (42 million therms)
Electricity	73,000 MWh.

The raw water consumption is expected to be roughly 63,000 cubic meters (17 million gallons) per year.

MAGNESIUM ALLOY & PURE METAL PLANT

Design Basis & Outputs

Summary

Magnesium crown, shown in the flow chart below is produced in the smelter and consists of pure magnesium crystals containing metallic and non-metallic contaminants as shown below -

Table 9: Magnesium Crown Composition

Contaminants	Contaminants Range, wt %
Non Metallic (oxides, nitrides, fluorides, carbon etc.)	Average: 0.65 Range: 0.5 to 1.0
Reactive Metals (alkali and alkali earth metals such as: sodium potassium, calcium and others)	Average: 0.2 Range: 0.1 to 0.5
Other Impurities (Mn, Pb, Zn.Ni, Cu etc.)	Average: 0.02 Range: 0.1 to 0.3

The plant will have a designed capacity capable of processing 32,000 tpy of magnesium crown. Products produced from the plant include pure and alloy magnesium ingots, which will be directed to market.

Plant Design

The plant is centrally located relative to the Smelter sections in order to minimize travel distance from the reduction furnaces and is connected to downstream warehousing and shipping docks.

The key design components include.

- Six gas fired furnaces, containing inconel clad crucibles, capable of containing 3 t of molten magnesium. The plant can process 100 t of crown daily, excess capacity of one melting furnace has been added to ensure process continuity during crucible replacement or furnace maintenance.
- Molten metal is transferred to three electric heated holding furnaces, each capable of containing 3 t of molten magnesium, via heated metal tubes from the crown melters. The metal surface is protected from oxidation by providing an SF₆-CO₂ or an SO₂ gas cover.

Molten metal is introduced to an ingot casting conveyor capable of casting 10 kg ingots at a rate of 4 per hour. Ingots are removed from the conveyor by utilizing an auto

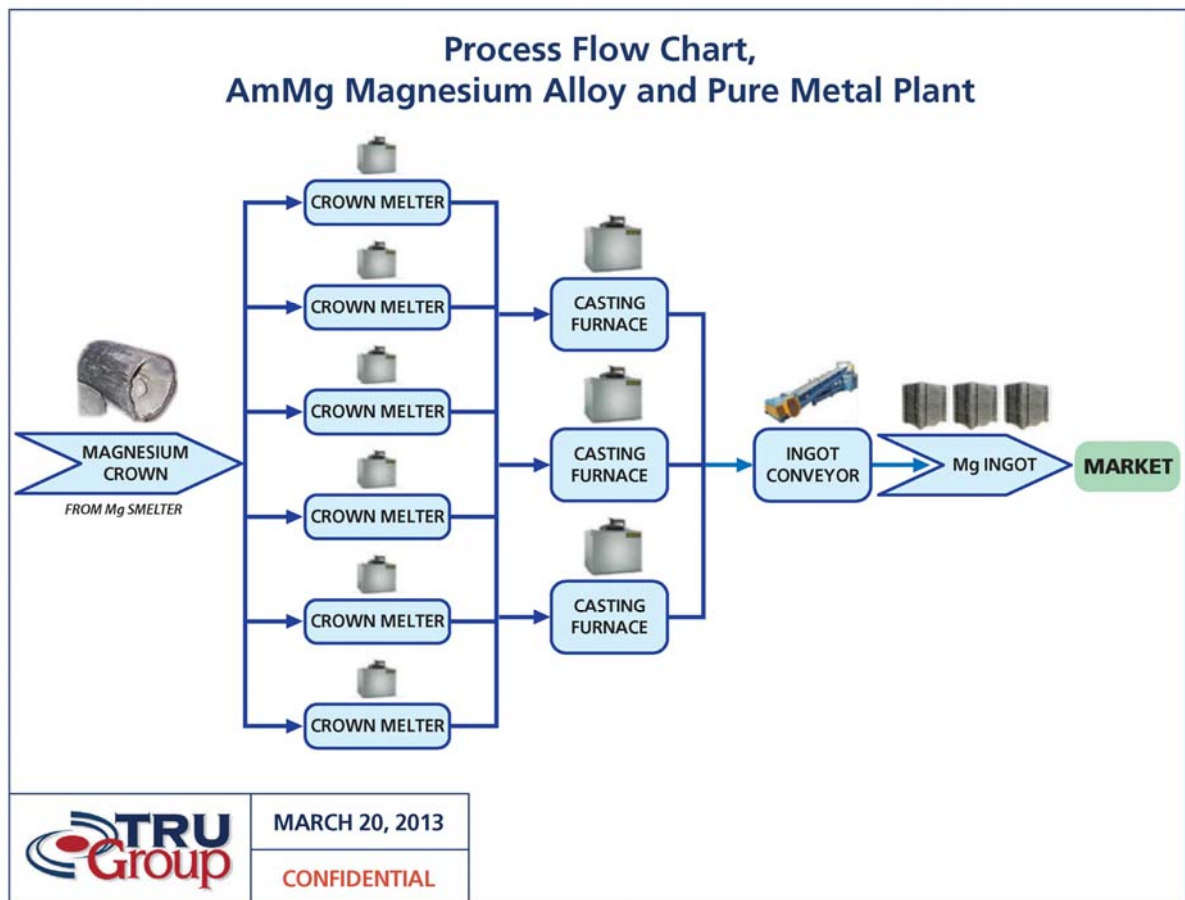
stacking and strapping machine.

- The furnaces are serviced by overhead cranes and with hydraulically operated sludgers required to remove sludge from the melters following casting.
- The plant also provides two molten flux furnaces required to clean process equipment and preheat magnesium delivery tubes.
- Protection gas is provided through a centrally located gas station designed to blend protection gases in the appropriate ratios to ensure proper metal protection during casting.
- To ensure internal worker protection, the plant is equipped with a ventilation system connected to a wet scrubber.

Process Description

The Magnesium Alloy and Pure Metal Plant as described uses magnesium crown from the smelter. The schematic process flow chart is shown in Figure 4.

Figure 4: Mg Alloy and Pure Metal Plant Flow Chart



The detailed process description includes:

- Magnesium crown is received and pre-weighed to specification. At this stage the material is inspected for contamination. Contaminated material is rejected or treated prior to usage.
- Solid (warm) crown is lowered manually into a melter furnace containing a molten heel of approximately 1000 kg. Care is exercised to avoid splashing.
- Dry chloride flux is added to the surface to minimize burning
- Once the metal reaches approximately 700°C, the metal is mixed while adding refining flux. The refined metal is allowed to settle for approximately 30 minutes to ensure proper separation of flux and non-metallic inclusions.
- On request, the refined metal is transferred to the holding pots via a heated steel tube. The rate of removal is controlled by the speed of a submerged pneumatic pump.
- Once the specified metal has been removed, the melter is cleaned of sludge and the process repeated.
- Metal in the holding furnace is maintained at a constant level and protected from oxidation by SF₆ or SO₂ gas. Constant level is maintained to ensure minimal oxide formation resulting in unacceptable metal contamination.
- The metal is transferred to a gas protected ingot conveyor, where ingots of various sizes are cast and palletized to specified bundles.
- Molten metal from the melters or the holding furnaces can be transferred to other down-stream processes such as HPDC.

Plant Configuration

The plant is centrally located relative to the Smelter. It also houses several other important and integral plant functions such as: Warehousing, Shipping and Receiving, Laboratory, Maintenance shop and Employee change and lunch rooms. At present, it is approximated, that 0.5 hectares (1.2 acres) are required to accommodate all of the preceding requirements.

Raw Materials

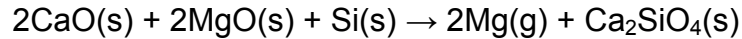
The major raw materials required for this process includes: magnesium crown from the smelter, magnesium alloy or pure scrap from downstream processes, chloride fluxes, alloy elements such as: aluminum, zinc, manganese etc., protective gas, and mold release compounds.

CORE CONSUMABLE REQUIREMENT PLAN

Ferrosilicon

Supply

The Magnesium Smelter is sized to produce 30,000 tpy magnesium metal. The stoichiometric FeSi (85% Si) requirement is 20,500 t per annum based on the following reaction.



The actual amount of FeSi (85%) required is 32,000 tpy because the process is not very efficient due to the reaction of two solids. The specifications for the 85 %FeSi are as follows.

PRODUCT: 85% FERROSILICON - Chemical/Physical Specifications

	Minimum	Maximum
Silicon Content	84%	87%
Manganese		0.15%
Sodium		0.10%
Lead		0.00%
Zinc		0.00%
Arsenic, Antimony, Phosphorus		0.02% each
Moisture		1.5% in -1/4 fraction

The specifications for 75% FeSi follow.

PRODUCT: 75% FERROSILICON - Chemical/Physical Specifications

	Minimum	Maximum
Silicon Content	75%	78%
Manganese		0.15%
Sodium		0.10%
Lead		0.001%
Zinc		0.002%
Arsenic, Antimony, Phosphorus		0.02% each
Moisture		1.5% in -1/4 fraction

Initially the ferrosilicon for the plant will be sourced on the world market. The supply of 85% ferrosilicon would likely be a special order to a ferrosilicon smelter as most produce lower grades and the cost is normally about 5% higher. Although the requirement is for 85% ferrosilicon, 75% ferrosilicon can also be used with less efficiency.

Ferrosilicon is also used in steelmaking and foundries as a source of silicon in the production of carbon steel, stainless steels and other ferrous alloys. Ferrosilicon is used to manufacture silicon, corrosion resistant and high temperature ferrous silicon alloys and silicon steel for electro-motors and transformer cores. Ferrosilicon is a basis for the manufacture of pre-alloys such magnesium ferrosilicon (FeSiMg) which is used for modifying melted malleable iron. It is also an additive to cast irons.

Main producers of ferrosilicon are China, Russia, Ukraine, Brazil and Norway.

Alloy Retort and Tube Casting Plant

Design Basis and Outputs

In-house Retort Manufacture & recycling: A Alloy Retort & Tube Casting Plant with a capacity of 2,000 tpy is recommended to support the needs of annual retort consumption at the Magnesium Smelter. Retort recycling and alloy specification is a significant determinant of the financial viability of the Magnesium Smelter. The Centrifugal Casting Plant capacity has been gauged to meet a specific retort life-cycle which can only be achieved through retorts meeting the alloy specifications.

Specialty Pipe & Tube Sales: It is evident that the Alloy Retort and Tube Casting Plant will be more profitable with higher magnesium smelter output. However, there is an opportunity to diversify production into various specialized tubes, which are used typically in the petroleum and chemical industry. It is noted that the plant has an ideal location to access the substantial regional oil & gas and petrochemicals industry. This activity is included in the financial projections but it is noted that the idea needs further study.

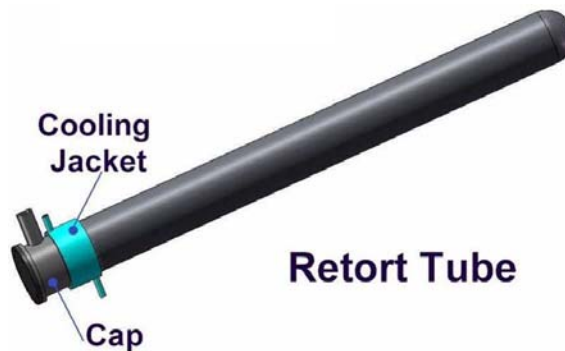
The Alloy Retort & Tube Casting Plant would be located near the Magnesium Smelter. Annual recycling of retorts is expected to be 1865 units, using a 250 day life cycle, for retorts of the western design.

The main advantage of the Alloy Retort & Tube Casting Plant is that it provides the Smelter with the ability to control the quality of the retorts. By increasing the life-cycle of the retort, an additional benefit of reduced downtime to change the retorts is realized.

Technology Transfer of Centrifugal Casting Methods to ensure a successful plant start-up is readily available and included with the purchase price of the equipment.

A simple example of a retort tube is represented in Figure 5: Retort Tube Illustration below.

Figure 5: Retort Tube Illustration



Plans to produce retorts in the Alloy Retort & Tube Casting Plant are based on the following chart, Table 10: Alloy Retort & Tube Casting Plant Retort Blend-in Plan, indicating initial start-up of the Magnesium Smelter using purchased Chinese style retorts. Gradually over 4 years, the Retort Plant is brought up to full production of western-style retorts with confidence and 100% ownership of all retorts.

Process Description

The centrifugal casting process is based on a spinning mold that creates a centrifugal force to position the molten materials within the mold. As the casting cools from the outside, a dense, close grain structure is developed with far superior physical properties than static casting.

At least six retort tubes per day will keep up to the demand of the Magnesium Smelter. The Alloy Retort & Tube Casting Plant described in this report is capable of 1.17 tubes per hour using 90% utilization to account for mold changes and routine maintenance.

A horizontal centrifugal casting machine, with manual pouring, automatic spray coating of the mold and manual tube extraction is planned. Automatic spraying of the mold is recommended and will greatly improve the life of the mold. Molds can require repair after each tube if mold coating is not applied properly. Alternately, with careful mold coating application, molds can last for several thousand retort tubes and as much as ten thousand.

Product quality is highly dependent on process variables such as: mold rotations/minute, mold coatings, mold design, pour speed, cooling rates and metal chemistry. Automated mold coating systems are highly recommended.

Table 10: Alloy Retort & Tube Casting Plant Retort Blend-in Plan

ITEM	units	year-1	year-2	year-3	year-4	year-5	year-6	year-7	year-8	year-9	year-10
1 Smelter output magnesium crown	t	0	9,300	23,250	31,000	31,000	31,000	31,000	31,000	31,000	31,000
capacity utilization %	100%	0%	30%	75%	100%	100%	100%	100%	100%	100%	100%
Crown Capacity	tpy	31,000	31,000	31,000	31,000	31,000	31,000	31,000	31,000	31,000	31,000
operating days	days	350	350	350	350	350	350	350	350	350	350
Retort Blended Plan Cost	\$	\$0	\$4,521,341	\$6,216,444	\$3,239,424	\$2,386,944	\$2,386,944	\$2,386,944	\$2,386,944	\$2,386,944	\$2,386,944
- retort tubes annual replacement	#	0	2,338	3,363	2,531	1,865	1,865	1,865	1,865	1,865	1,865
installed number	#	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332	1,332
weighted average replace period	days	0	87	115	250	250	250	250	250	250	250
% own retorts installed	%	0%	25%	50%	100%	100%	100%	100%	100%	100%	100%
<i>Low Nickel Content Retort</i>											
- retort tubes annual replacement	#	0	1,865	2,331	0	0	0	0	0	0	0
low nickel installed number	#	1,332	1,332	666	0	0	0	0	0	0	0
days replacement period	days	75	75	75	75	75	75	75	75	75	75
<i>Own High Nickel Content Retort</i>											
- retort tubes annual requirement	#	0	473	1,032	2,531	1,865	1,865	1,865	1,865	1,865	1,865
own high nickel installed number	#	0	333	666	1,332	1,332	1,332	1,332	1,332	1,332	1,332
new installation number	#	0	333	333	666	0	0	0	0	0	0
annual replacement number	#	0	140	699	1,865	1,865	1,865	1,865	1,865	1,865	1,865
days replacement period	days	250	250	250	250	250	250	250	250	250	250
Retort Input Unit Prices											
<i>Low Nickel Content Retort</i>											
- retort tubes net price to smelter	\$/unit	\$2,100	\$2,100	\$2,100	\$2,100	\$2,100	\$2,100	\$2,100	\$2,100	\$2,100	\$2,100
purchase price delivered	\$/unit	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
recycle return value	\$/unit	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
<i>Own High Nickel Content Retort</i>											
- retort tubes net cost to smelter	\$/unit	\$1,280	\$1,280	\$1,280	\$1,280	\$1,280	\$1,280	\$1,280	\$1,280	\$1,280	\$1,280
recycle return value	\$/unit	13,720	13,720	13,720	13,720	13,720	13,720	13,720	13,720	13,720	13,720
own production cost	\$/unit	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000
material cost high nickel retort	\$/unit	14000	14000	14000	14000	14000	14000	14000	14000	14000	14000
own conversion cost	\$/unit	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

The planned melting rate of 1 t/h will melt the HU material in about 55 minutes and should be used right away. Two furnaces, using one main controller will provide a steady flow of retort material to the centrifugal caster.

The furnace system recommended in this report is a set of two - 1 t furnaces with tilting mechanisms, one main controller and a backup DC water pump in case of power outage. One furnace will be pouring and the other heating, alternating the use of the main controller. Cooling water is run through the controller and the furnace heaters to an evaporative cooling tower in a closed circuit system.

The technology for this process is readily available and will be supplied as a part of the centrifugal casting machine supplier's package.

Plant Configuration

The Alloy Retort & Tube Casting Plant minimum land area requirements is 0.7 hectares (1.7 acres) including a 4,000 square meter (43,000 square foot) building, which houses the melting furnaces and centrifugal casting process.

The plant requires various storage areas and careful storage of raw materials to produce alloys within tolerance. Finished product storage should also be substantial enough to hold the expected volume. Table 11: Major Equipment and Costs, summarizes the major equipment requirement and costs.

Table 11: Major Equipment and Costs

Item	Description	Quantity	U.S.\$
			Cost (each)
1	4,000 sq. meter building	1	650,000
2	1 ton melting furnace set with controls	1	275,000
3	Centrifugal casting machine	1	220,000
4	Molds	2	40,000
5	Shot Blaster	1	120,000
6	Spectrometer	1	70,000
7	Automation and process equipment	1	120,000
8	Air Compressors	2	25,000
9	Forklift	1	40,000
10	Weigh Scale	1	5,000
11	Storage Bins various sizes	100	20,000
12	Toolroom machines (mill, lathe, shop tools)	1	320,000
13	Evaporative Cooling System	1	80000

Raw Materials

The Alloy Retort & Tube Casting Plant is planned to cast 1,865 retort tubes per year at 90% utilization. A description of the retorts follows in Table 12: Retort Description -

Table 12: Retort Description

Specifications	Measurement	Chemical Composition	%
Length	314.96 cm	Iron	40.925
Outside Diameter	33.99 cm	Nickel	38.000
Inside Diameter	27.38 cm	Chromium	18.500
Retort Caps Diameter	34.06 cm	Manganese	0.005
Retort Caps Weight	26.82 kg	Silicon	1.500
Retort Weight	800 kg	Others	0.000

The main raw materials required to produce the annual output of retorts is show in Table 13: Raw Materials -

Table 13: Raw Materials

Item	Description	Tonnes/Year
1	Iron	610
2	Nickel	570
3	Chrome	285
4	Manganese	8
5	Silicon	15
6	Others	8

Operating Consumables

The operating consumables are summarized in Table 14: Operating Consumables below.

Table 14: Operating Consumables

Item	Equipment name	Item, Utility Requirements
1	1 Ton Melting Furnace	600 Kw, evaporating tower water 600 GPM
2	Centrifugal Casting Machine	10 Kw, tower water 120 GPM, Gas 2.6 CFM
3	Shot Blasting Equipment	11 Kw
4	Automated Mold Coating System	10 Kw, tower water in/out 1", shop air .75"
5	Air Compressors	20 Kw X 2 for 40Kw total
6	Machine Shop Equipment	15 Kw total
7	Evaporative Cooling System	10 Kw, City water 2 GPM

The Alloy Retort & Tube Casting Plant will require approximately 1 drum of mold coating for every 60 retort tubes produced, at a cost of US\$ 500 per drum.

Dolime Production for Market – A Future Consideration

Lime is produced by the calcination of limestone (CaCO_3) to calcium oxide (CaO). Dolomitic lime (dolime) is produced in a similar manner but using dolomite ($\text{MgCO}_3 \cdot \text{CaCO}_3$) as the feed instead of lime to produce magnesium oxide and calcium oxide ($\text{MgO} \cdot \text{CaO}$). Dolime is often added as a slag conditioner in iron and steel production to speed up the slag formation. It is also used in agriculture as a source of magnesia and in water treatment to remove silica and neutralize acidity.

However, the products are commodities in very mature markets – indeed perhaps in decline. It is essential to have a sizeable competitive advantage and in this case it cannot be clearly identified. However, this ought to be studied further at the feasibility stage of the project as there may be operational advantages of increased scale in the dolomite mining and in the use of the pipeline. In addition there could be a regional market opportunity – or indeed competitive advantage - that is not known without looking at this market in more detail. At this time TRU has not factored this activity in the financial or market analysis.

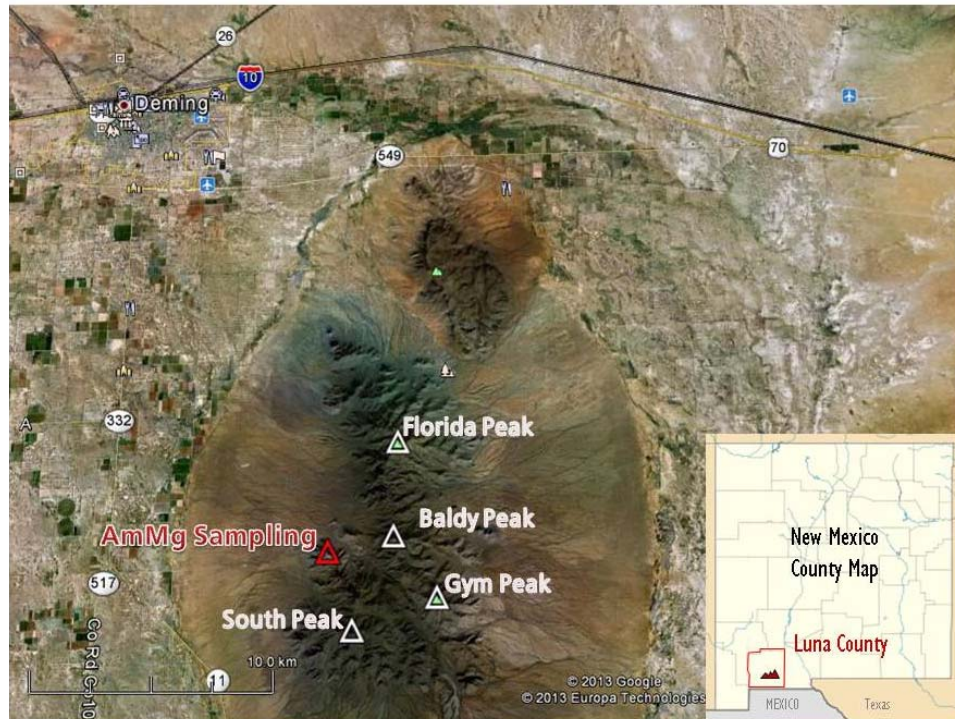
DOLOMITE FROM THE ADJACENT AmMg MINE

Geology and Resources

Location of the Florida Mountains

The Florida Mountains are a small mountain range in the southwestern-most part of New Mexico, USA. They are located in Luna County about 15 miles southeast of the City of Deming (pop 15,000, elev. 4,300 ft a.s.l.) and 12 miles north of the border with the state of Chihuahua, Mexico. New Mexico State Road 11 runs west adjacent to their location. The Florida Mountains extend about 12 miles in a north trending direction and are about 5 miles wide along the east-west axis. The elevation of the major peaks varies from about 5,000 to 7,000 ft a.s.l. Florida Peak (32.124195, -107.6217269) at the northern part of the range has the highest elevation at 7,460 ft a.s.l. The other major peaks at the south center of the mountain range are Baldy (32.0890045, -107.6237869), Gym (32.0660018, -107.6047325) and South (32.0550155, -107.6418113). AmMg sampling was performed on an unnamed peak about 2 miles NNW of South Peak and 1.8 miles WSW of Baldy Peak.

Figure 6: Florida Mountain Range in Luna County New Mexico, USA. Relative location of AmMg sampling to major peaks shown by red marker.



The AmMg property falls within the Upper Chihuahuan Desert climate zone, which is classified as arid continental. The climate is generally dry and hot with summer temperatures often above 100 °F. Annual precipitation is between 9-10 inches/year and falls mostly during the July to September monsoon period. The climate has been punctuated by intervals of wet and dry years that last from 5 to 20 years. Springtime is characterized by moderate to high winds with the possibility of severe dust storms. Winter days are usually sunny and mild with temperatures above freezing although night time temperatures may drop below freezing. Annual snowfall precipitation is about 3 inches/year but there is no accumulation because the mild climate results in melting within one to two days.

Florida Mountains and Prior Exploration

Geological interest in the Florida Mountains has stemmed from the conformal and non-conformal occurrences of different and similar rock types. Kottowski¹ described the structure of the mountain range as being complex particularly the southern part, where

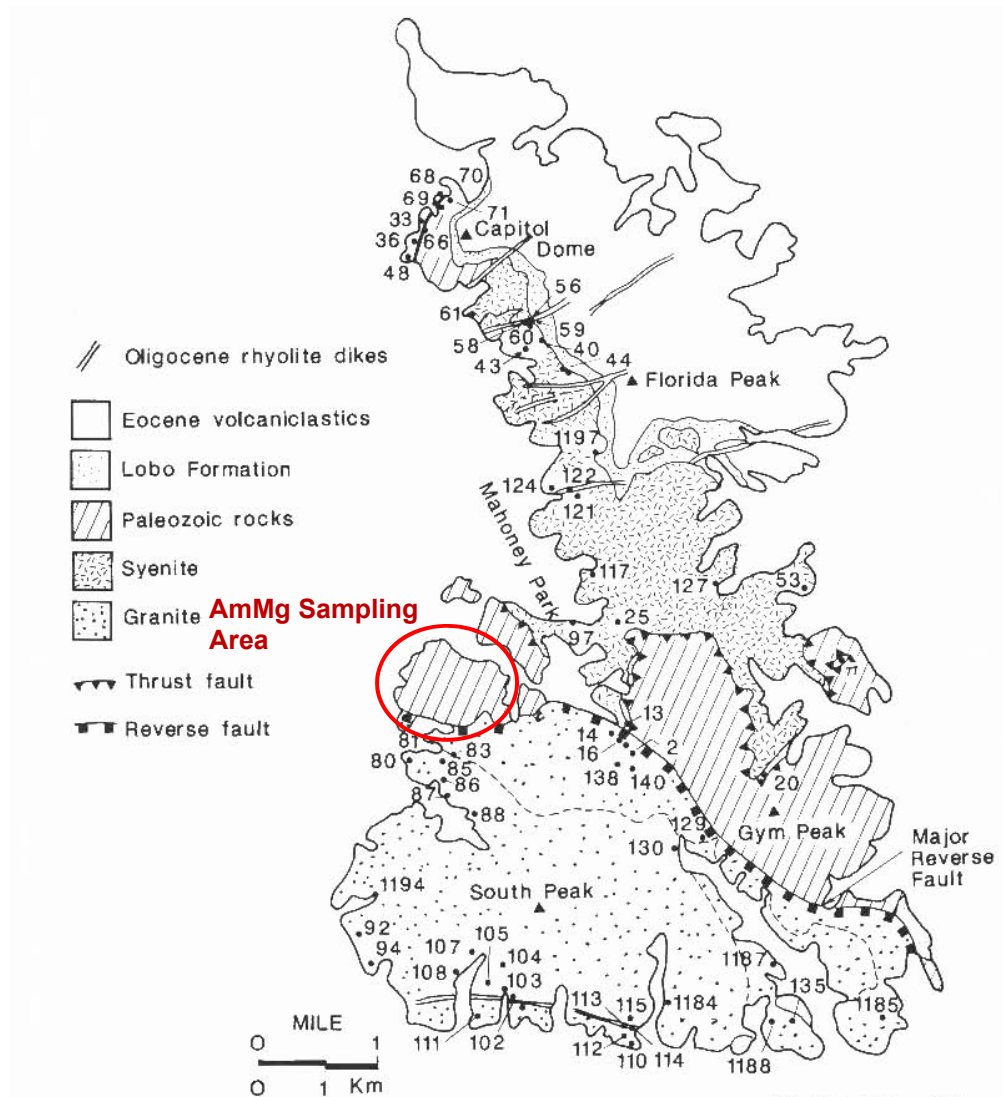
¹ F.E. Kottowski, New Mexico Bureau of Geology & Mineral Resources Circular 47—High-purity dolomite deposits of southcentral New Mexico 1957, 43 pp

the AmMg mining claims are also located, due to the numerous thrust faults, reverse faults and normal faults. Some of the younger, Silurian dolomite formations are overlain by older, pre-cambrian granitic formations that make it difficult to accurately determine the thickness of the former. Prior exploration near Baldy and Gym peak revealed a number of dolomite occurrences from different eras and periods. The Fusselman dolomite formed during the Silurian period in the Paleozoic era is of particular interest because it is relatively pure. Kottowski collected high purity dolomite samples from the ridge west of The Park from several bed layers that represent a cumulative thickness of dolomite of 770 ft over an area of 0.6 square miles or over 907 million t (1 billion short tons) of dolomite. The samples from these layers from top to bottom show a minimum assay of 21.5% MgO, which is only slightly below the theoretical maximum of 21.9% MgO for pure dolomite. The location of the actual sampled area is not shown on a map nor is the reference to The Park well defined as it could refer to 'The Park' mine or to Mahoney Park.

Table 15 Assays of dolomite samples collected by Kottowski from the southern area of the Florida Mountains from the ridge west of The Park

Sample	CaO	MgO	Residue	CaCO ₃ *	MgCO ₃ *	Total
			(in percent)			
F9	30.3	21.7	0.2	54.1	45.3	99.6
F8	30.3	21.7	0.3	54.1	45.3	99.7
F7	30.3	21.8	0.2	54.1	45.5	99.8
F6	30.3	21.7	0.6	54.1	45.3	100.0
F5	30.4	21.7	0.3	54.3	45.3	99.9
F4	30.3	21.7	0.3	54.1	45.3	99.7
F3	30.3	21.8	0.4	54.1	45.5	100.0
F2	30.0	21.5	1.6	53.5	44.9	100.0
F1	30.1	21.6	1.0	53.7	45.1	99.8
* Calculated from the oxides						

The generalized geological map of the Florida Mountains below shows the occurrence of the different rock types which may be correlated to different geological periods and/or eras. Of importance to the AmMg project are the Paleozoic rocks, which would include the Silurian Fusselman dolomite. These rocks are more prevalent in the southern part of the Florida Mountain range; the larger occurrence is seen in the south that extends from the area around Gym Peak and follows a northwestern trajectory to the general location of Baldy Peak. Outcrops of Paleozoic rock are also seen to the west of this occurrence which would coincide with the AmMg sampling area and claims.

Figure 7: Generalized geological map of the Florida Mountains¹

One cross-sectional depiction of the stratigraphy of Gym Peak shows the Silurian Fusselman dolomite bed occurring at the surface of the peak with variable but appreciable thickness with likewise occurrences along Mahoney Ridge. If the AmMg sampled peak shares similar characteristics then it would also represent a sizeable dolomite resource.

¹ Matheney et Al, *Geochronological Studies of the Florida Mountains*, New Mexico, New Mexico Geological Society Guidebook, 39th Field Conference Southwestern New Mexico, 1988

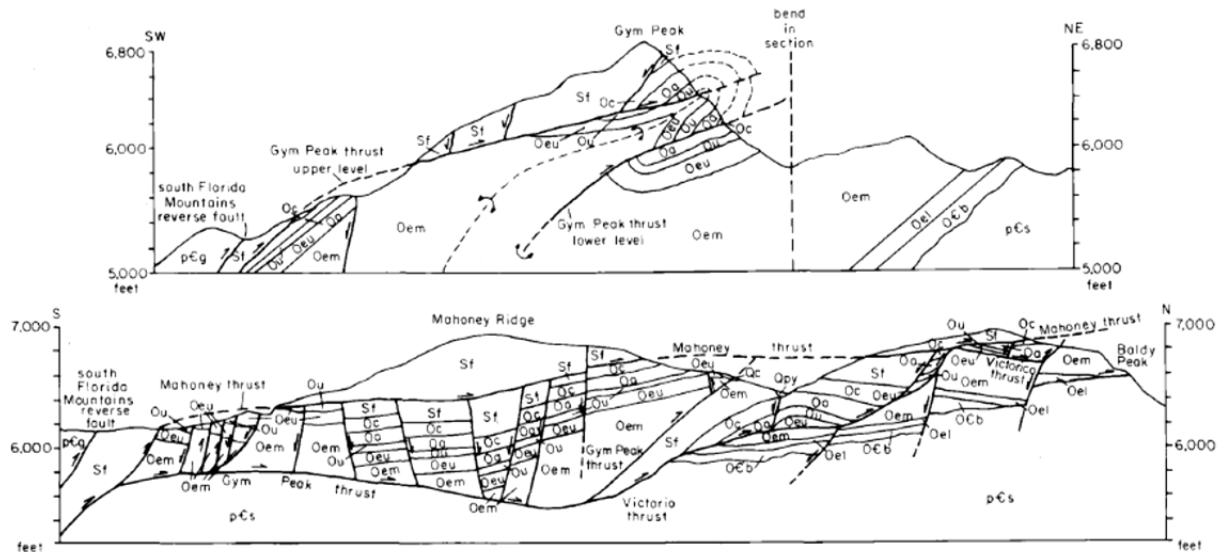
Figure 8: Cross sections through GYM Peak and Mahoney Ridge¹

FIGURE 3—TRUE-SCALE CROSS SECTIONS THROUGH GYM PEAK AND MAHONEY RIDGE. **pCg**, Precambrian granite; **pCs**, Precambrian syenites; **Ocb**, Bliss Sandstone; **Oel**, lower El Paso Formation; **Oem**, middle El Paso; **Oeu**, upper El Paso; **Ou**, Upham member of Montoya Formation; **Oa**, Aleman member of Montoya; **Oc**, Cutter member of Montoya; **Sf**, Fusselman Dolomite; **Qc**, undifferentiated colluvium, **Qpy**, younger piedmont-slope arroyo alluvium.

Similarly on the ridge southwest of Mahoney Park Silurian dolomite of appreciable thickness has been noted.

Figure 9: Rock occurrences on ridge southwest of Mahoney Park showing appreciable occurrences of Silurian dolomite².

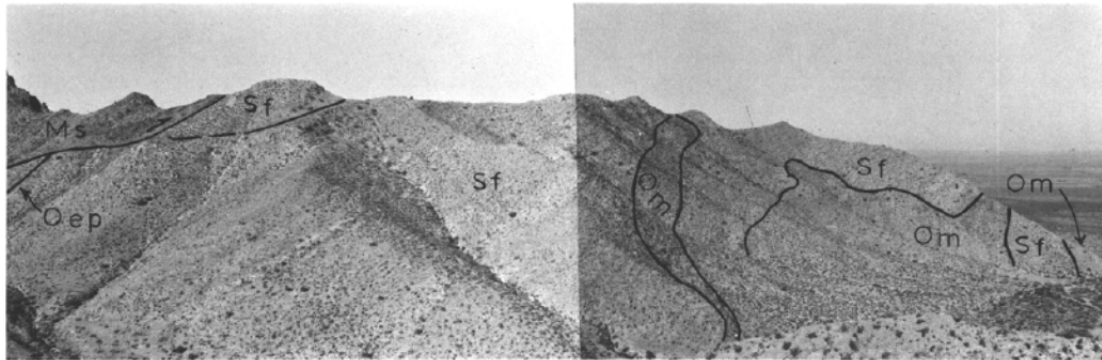


FIGURE 4.

Close-up view southwest of second ridge south of Mahoney Park showing complex imbricate thrust slices of Silurian Fusselman Dolomite (Sf), Ordovician Montoya Group (Om), and Ordovician El Paso.

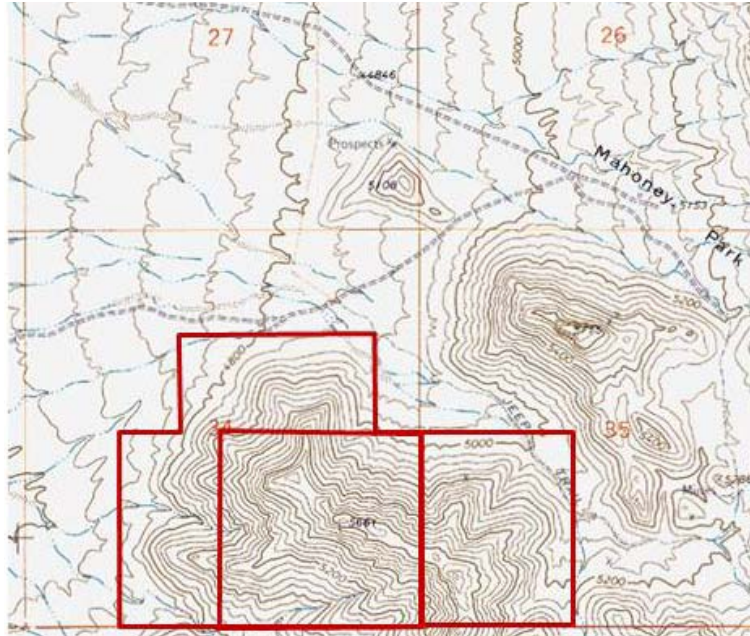
1 G.A. Brown, Florida Mountains section of southwestern New Mexico Overthrust belt —a reevaluation, New Mexico Geology, May 1983, pg 26-29

2 L.L. Corbitt and L.A. Woodward, *Thrust Faults of Florida Mountains, New Mexico and Their Regional Tectonic Significance*, New Mexico Geological Society - Twenty First Field Conference, 1970, pg 69-74

AmMg Claim Maps and Sampling

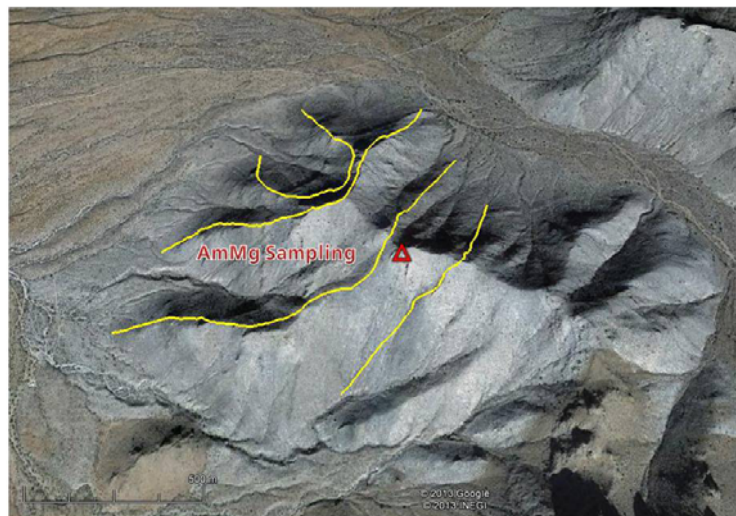
The AmMg claims cover 440 acres on and around the sampled peak.

Figure 10: AmMg Claims on Florida Mountains



Chip samples were collected from 101 locations on the AmMg claims along several pathways depicted in Figure 11. Three of the pathlines intersect the ridgeline of the peak at various elevations of about 5,450 ft to 5,640 ft a.s.l.

Figure 11: AmMg sampling pathways on unnamed peak covered by mining claims

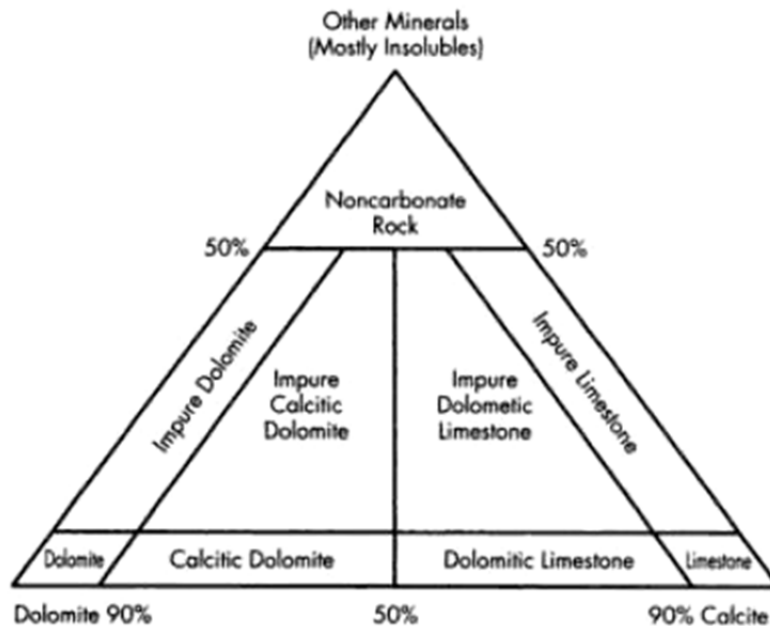


Analysis

Carbonate Rock Classification

Theoretically pure dolomite contains 45.7% (MgCO_3) and 54.3% calcium carbonate (CaCO_3) or 21.9% MgO and 30.4% CaO . For industrial purposes, carbonate rocks can be classified on the basis of the CaCO_3 (or CaO), and/or MgCO_3 (or MgO) content and the threshold tolerance for impurities. Ultra-high calcium limestone has >97.5% CaCO_3 , high calcium limestone has > 95% CaCO_3 , high purity carbonate rock has >95% combined content CaCO_3 and MgCO_3 while high magnesium dolomite is contains 43% MgCO_3 or 20.6% MgO . A general classification diagram of carbonate rocks appears in the figure below.

Figure 12: General classification of carbonate rocks¹.



AmMg Sample Assays

Average Composition of All Samples

Table 16 shows the average composition of the 101 AmMg dolomite samples along with minimum and maximum values for assayed components. The average composition of the AmMg dolomite is 19% MgO and 33% CaO . The principal impurity in this sample set on a weight basis is silica (SiO_2), with an average assay of 1.13% representing 82% of the average impurity concentration of 1.38%. There is evident variability in the compositions of the data set. For MgO , CaO and SiO_2 assays the respective standard

¹ R.C. Freas, J.S. Hayden and C.A. Pryor, *Industrial Minerals - Limestone and Dolomite*, 2006, pg 583

deviations of 5.05%, 5.10% and 2.26% or about 26%, 16% and 200% variation¹ from the average assay.

From a performance standpoint for the Pidgeon Process, process efficiencies are improved with a higher MgO content and lower SiO₂ impurity content in the feed since the latter results in higher consumption of the ferro-silicon reducing agent. TRU considers 1% SiO₂ as the acceptable threshold for the pre-calcined (raw) feedstock.

Table 16 Average composition of AmMg samples compared to TRU dolomite specifications

	All AmMg Samples			TRU Spec
	Average (%)	Max (%)	Min (%)	Average (%)
Magnesium (MgO)	19.17	21.77	1.41	20.73
Calcium (CaO)	32.87	51.79	30.15	31.18
Silicon (SiO ₂)	1.13	20.46	0.08	0.52
Manganese (MnO)	0.03	0.15	0.01	0.02
Sodium (Na ₂ O)	0.04	0.10	0.01	0.03
Potassium (K ₂ O)	0.03	0.17	0.01	0.05
Chromium (Cr ₂ O ₃)	<0.01	<0.01	<0.01	<0.01
Iron (Fe ₂ O ₃)	0.14	0.70	0.04	0.11
Titanium (TiO ₂)	0.01	0.05	0.01	0.01
Zinc (ZnO)				5 ppm
LOI/(Carbon Dioxide (CO ₂))	46.28	47.30	35.20	46.85

Closer examination of the AmMg data indicates fairly consistent composition across the greater majority of the data set. Figure 13 and Figure 14 are respective histograms of the SiO₂ and MgO assays of the AmMg samples whereas Figure 15 plots the MgO, CaO and SiO₂ analyses for each of the sampling points. In the SiO₂ histogram, 70% of the assays are beneath 1% SiO₂; of the remaining assays, 14% are between 1% and 1.5% SiO₂ while 17% are above 1.5% SiO₂ with a maximum of 20.46% SiO₂ in one sample.

¹ Coefficient of variation (CV = average/standard deviation) expressed as percentage

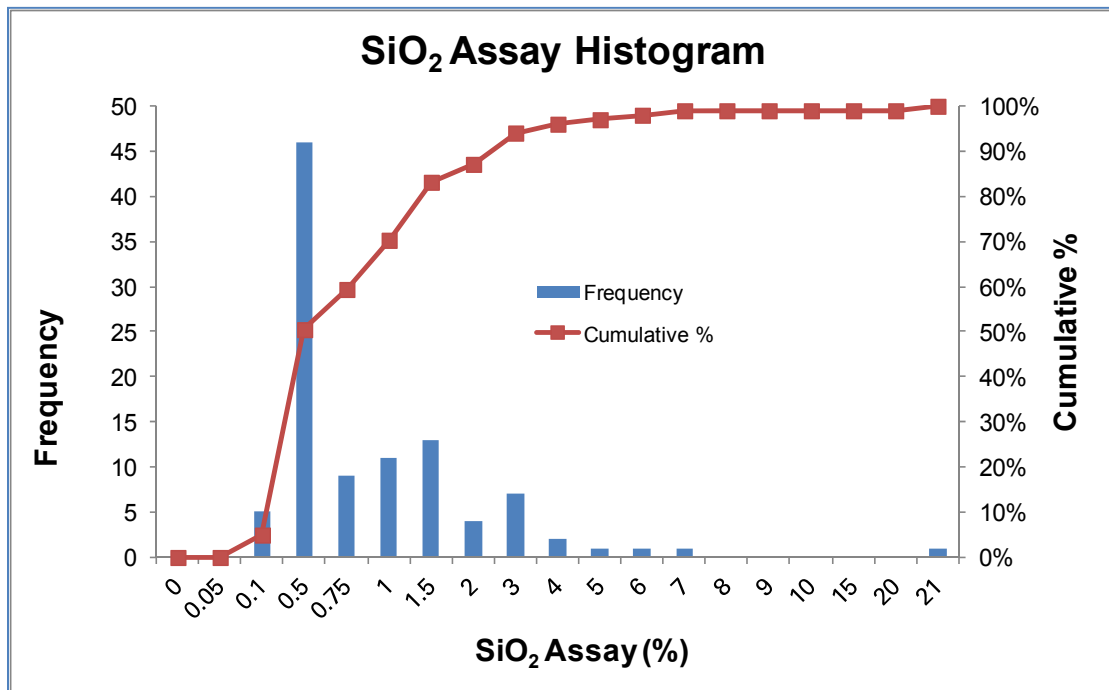
Figure 13: Histogram of SiO₂ assay values in AmMg samples

Figure 14: Histogram of MgO assay values in AmMg samples

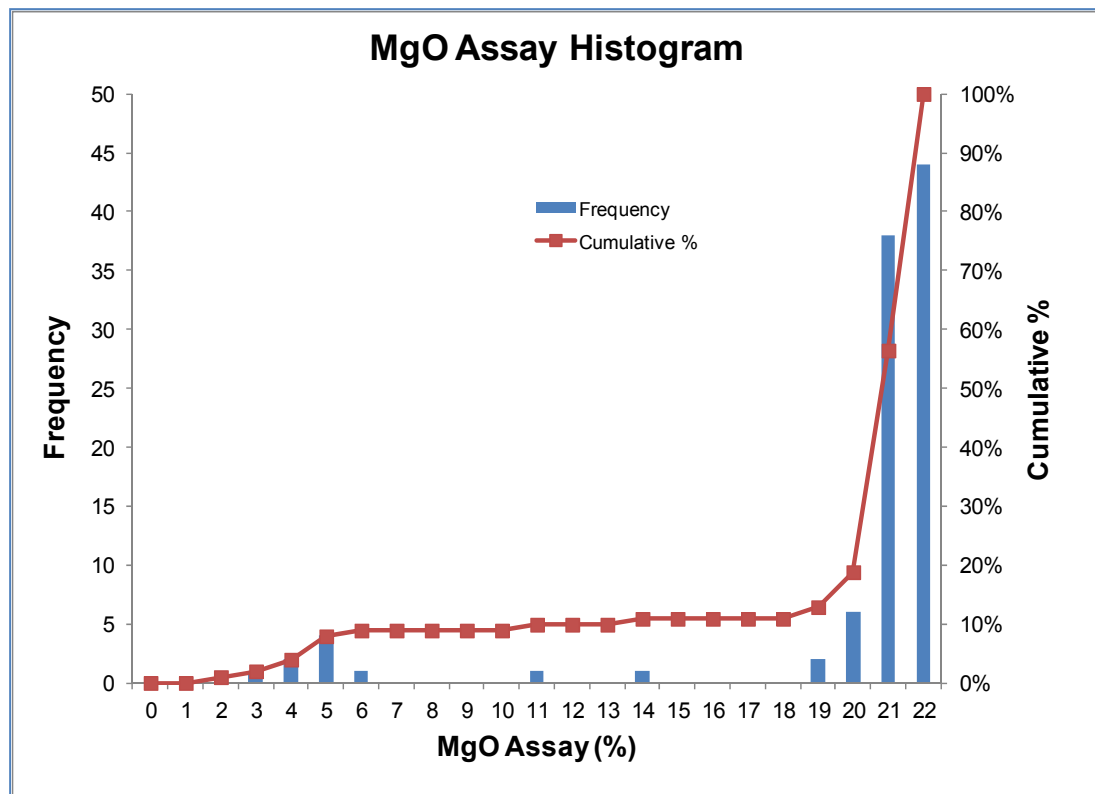


Figure 15 shows eleven (11) samples with MgO assays comparatively lower (<14%) than the average MgO assay. In these 'outlier' samples, the low MgO assays are accompanied by higher than average CaO (> 38%) assays and elevated SiO₂ assays (min 0.95%, max 20.5%). Plotting the position of the sampling points on map of the peak from GPS coordinates in Figure 16, it can be seen that nine of the eleven outlier samples were collected from peripheral points at or near the base of the peak where the low MgO assays may be indicative of the boundary or transition to a different geological unit or carbonate rock. Only outlier samples 1305 and 1312 respectively representing the maximum (13.81 % MgO) and minimum (1.41% MgO) of the MgO assay of the outlier data, were collected at higher elevation and within a sampling pathway where the assays from the preceding and subsequent samples relative to these points conform to the compositional average of the data set. In the area of Gym Peak, Kottowski noted the dolomite was broken by many faults with common occurrences of silicified and mineralized zones. AmMg samples 1305 and 1312 may have been collected from similar zones. Further mineralogical study and additional sampling from the immediate vicinity of samples 1305 and 1312, may be required to clarify the aberrant assays. However, repeat analyses of duplicate outlier samples may also be considered to examine possible bias or error in the sample preparation procedure, particularly in the grinding, mixing and quartering steps.

Figure 15: CaO, MgO and SiO₂ assays vs sample number

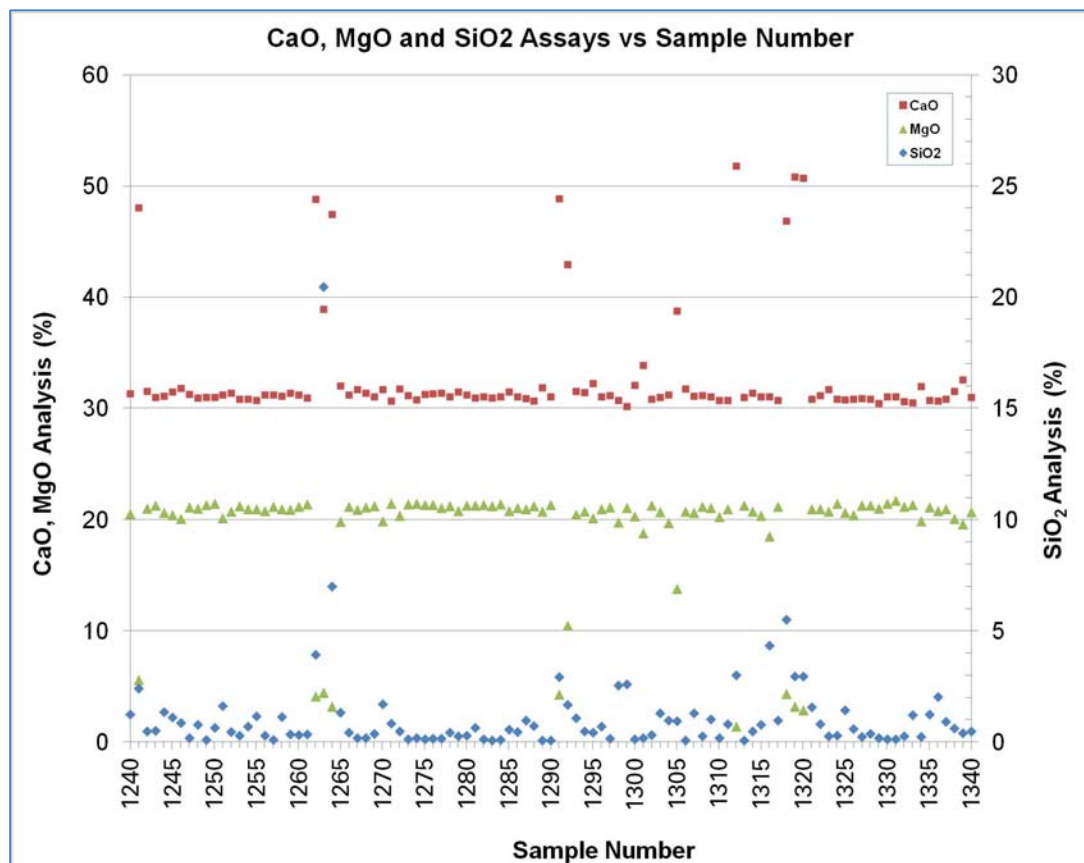
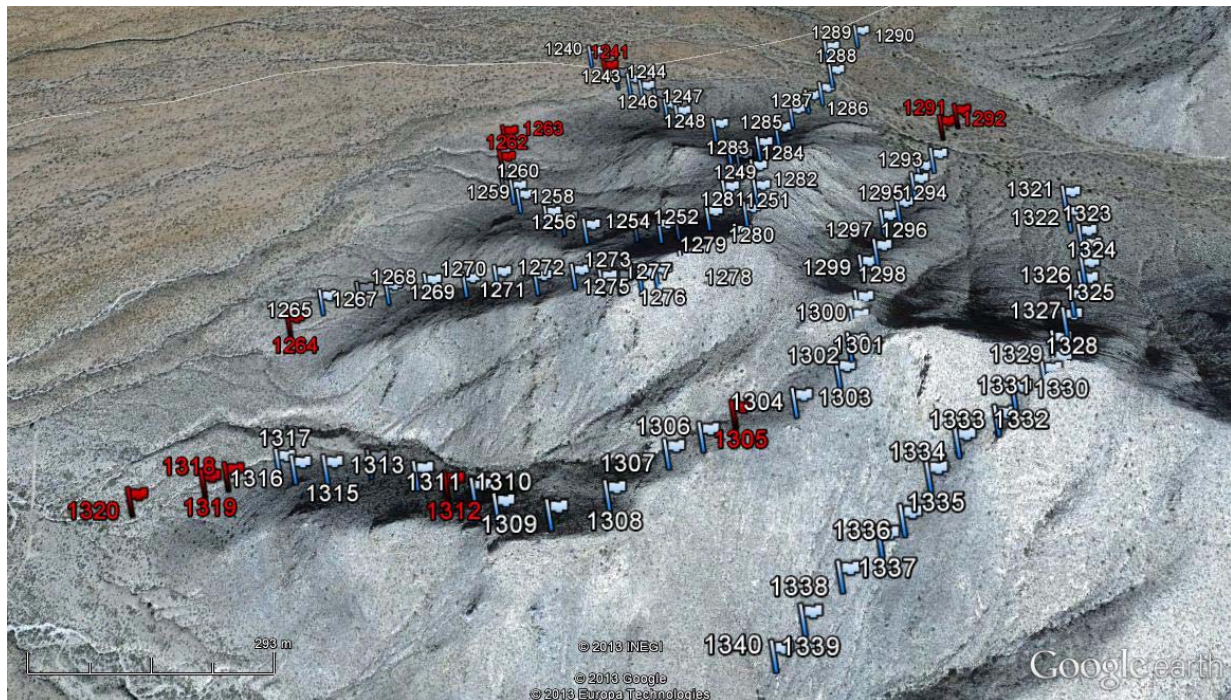


Figure 16: Map plot of the 101 AmMg sampling points



 Position of low MgO assay outlier samples are color-coded in red.

If the eleven outliers are considered non-representative of the deposit and discarded from the data set then the compositional average MgO assay increases to 20.87%, which conforms to the MgO content for high-magnesium dolomite while the average SiO₂ assay drops to 0.67% or below the desired threshold value of 1%. Also, the variability in the assays diminishes with the respective standard deviations for CaO, MgO and SiO₂ calculated at 0.5%, 0.57% and 0.67% or 2%, 3% and 100% variation from the average assays. TRU has assumed the average compositional assays from following Table 17 for the purposes of this scoping study.

Table 17 Average composition of AmMg dolomite samples without low-MgO outlier assays compared to TRU dolomite specifications

	Outliers Removed			TRU Spec Average (%)
	Average (%)	Max (%)	Min (%)	
Magnesium (MgO)	20.87	21.77	18.52	20.73
Calcium (CaO)	31.18	33.87	30.15	31.18
Silicon (SiO ₂)	0.67	4.35	0.08	0.52
Manganese (MnO)	0.03	0.09	0.01	0.02
Sodium (Na ₂ O)	0.04	0.10	0.03	0.03
Potassium (K ₂ O)	0.01	0.03	0.01	0.05
Chromium (Cr ₂ O ₃)	<0.01	<0.01	<0.01	<0.01
Iron (Fe ₂ O ₃)	0.13	0.29	0.04	0.11
Titanium (TiO ₂)	0.01	0.03	0.01	0.01
Zinc (ZnO)				5 ppm
LOI/(Carbon Dioxide (CO ₂))	46.78	47.30	44.60	46.85

Dolomite Resources

If the AmMg sampled peak is assumed to be composed entirely of dolomite then a rough calculation using a four sided pyramidal shape for the mountain with an average base side length of 1,000 m and elevation of 280 m¹ yields a maximum potential in-situ dolomite resource of 255 million t. In the absence of drill data for the AmMg sampled peak, if the thickness of the dolomite layer is conservatively assumed to average 20 m (66 feet) from all surfaces then the in-situ resource would still be sizeable at 14.6 million t. Next stage sampling/exploration would need to confirm both dolomite bed depth and purity to perform actual resource estimates. These exploration costs are not included in the budget for the feasibility report.

Future Sampling/Exploration

The composition, stratigraphy/lithology and mineralogy will have to be validated by core drilling at the next stage of the project. Weathering of exposed surfaces of carbonate rock can provide misleading initial results; in humid conditions, calcite and dolomite might be leached from the rock and decrease the purity of the rock relative to the rest of the block while under arid conditions the surface may become enriched in calcite and dolomite². If other secondary economic uses are being assessed for the dolomite on the AmMg claims, such as for sale as aggregate material, then it will be of importance to

¹ Difference between base elevation at 1,420 m a.s.l. and peak elevation of 1,700 m a.s.l.

² R.C. Freas, J.S. Hayden and C.A. Pryor, *Industrial Minerals - Limestone and Dolomite*, 2006, pg 584

determine whether the dolomite contains SiO_2 as quartz grains or as chert since the latter would render the dolomite unsuitable for such purposes.

Given the relative homogeneity of the AmMg chip samples, sampling by BX core drilling can begin on a square grid pattern on initial 30 meter centers until the homogeneity is confirmed after which the spacing can then be increased. Depending on the inclination of the rock surface, inclined drilling may also need to be considered.

Geophysical techniques such as electrical resistivity profiling and/or gravimetric surveying can subsequently be used to determine the depth of the dolomite bed.

Mining Methodology

The dolomite between Gym Peak and Baldy occurs as a deep surface bed. If the dolomite occurrence on the AmMg claims around the sampled peak can be similarly described then there may be the option to use either surface or underground mining techniques. Surface techniques such as mountain top mining (MTM) or strip mining (SM) may be considered due to the proximity of the deposit to the surface while underground techniques such as drift mining may also be suitable due to the dolomite bed thickness. Delineation and accessibility to the resource will be the principal technical consideration although state and federal legislation on the environment and permissible mining techniques will likely be the final determinants since there are recreational parks and a diversity of flora and fauna that inhabit the areas near and on the Florida Mountains.

MARKETING REVIEW FOR THE COMPLEX

AmMg Metal Complex Sales Plan Summary

The plan for the AmMg Magnesium Smelter is to optimize the product mix while maximizing capacity utilization of the facilities. At this pre-feasibility level we have assumed full capacity utilization is achievable believing this to be realistic. The smelter will only produce magnesium products since no ferrosilicon smelter is currently planned.

Sales from the smelter will begin as soon as possible rising from about \$38 million in year-one to over \$129 million by year-four 2017. The summary sales plan for the ten year horizon is given in Table 18 (sales in tonnes metric).

Table 18: AmMg Smelter Summary ten-year Sales Plan

constant 2013\$millions											
SALES ITEM	units	year-0	year-1	year-2	year-3	year-4	year-5	year-6	year-7	year-8	year-9
Smelter output mag crown	t	0	9,300	23,250	31,000	31,000	31,000	31,000	31,000	31,000	31,000
REVENUE TOTAL	\$	\$0	\$38	\$95	\$127	\$129	\$129	\$129	\$129	\$129	\$129
Sales of Pure Metal+Alloy		\$0	\$38	\$95	\$127	\$127	\$127	\$127	\$127	\$127	\$127
- pure magnesium sales	\$	\$0	\$28	\$71	\$94	\$94	\$94	\$94	\$94	\$94	\$94
volume	t	0	7,059	17,647	23,529	23,529	23,529	23,529	23,529	23,529	23,529
price FOB plant	\$/t	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000	\$4,000
- magnesium alloy sales	\$	\$0	\$10	\$25	\$33	\$33	\$33	\$33	\$33	\$33	\$33
volume	t	0	2,241	5,603	7,471	7,471	7,471	7,471	7,471	7,471	7,471
price FOB plant	\$/t	\$4,400	\$4,400	\$4,400	\$4,400	\$4,400	\$4,400	\$4,400	\$4,400	\$4,400	\$4,400
Sales Alloy Tube Castings	\$	\$0	\$0	\$0	\$0	\$2	\$2	\$2	\$2	\$2	\$2

The strategy for the AmMg Smelter is to maximize market share in the United States in competition with the only producer US Magnesium LLC of Salt Lake City, UT. Canada and Mexico are the other two main targets where there is no production. The smelter will have to compete mainly against Chinese producers.

Prices in the above table are based on market prices in March 2013 achievable in the USA. Overall world prices are determined strongly by supply from China. The prices are kept constant in the base case. Price assumptions for the sales plan will be discussed in more detail below but underlying them is our belief that they are realistic if not conservative for the future smelter to be constructed in accordance with our plan.

Pure Metal and Alloy Sales

Pure Metal Sales

In the plan, 99.8% or above pure magnesium metal ingot will be the major launch product. Customers are mainly aluminum smelters that produce aluminum alloys [typically containing between 0.5% and 5% magnesium]. Aluminum alloys containing smaller amount of magnesium (between 0.5%-1.1%) are typically used for decorating materials and those containing higher amounts of magnesium (between 2.2%-5%) are used for beverage can lids and structural materials. Magnesium is used in the aluminum industry to produce:

- Wrought alloys: 6000 series (Mg:0.5 to 1.1%)
- Foundry alloys: A356 (Mg:0.25 to 0.45%)

The world production of primary aluminum was over 45 million t in 2012 of which about 4.8 million t or 11% was produced in North America at fourteen smelters in the USA and ten in Canada.

Magnesium Alloy Sales

The Complex plans to offer a breadth of magnesium alloys – typically specified as AZ91; AM60, AM50; AZ63 – containing 90% magnesium and remainder mostly aluminum. AZ91 is a diecasting alloy and is by far the most common:

- AZ91A, AZ91B, and AZ91D which have the same nominal composition except for iron, copper, and nickel contents, are die casting alloys used in the as-cast condition (F temper).
- AZ91D is a high-purity alloy which has excellent corrosion resistance. It is the most commonly used magnesium die casting alloy.
- AZ91A and AZ91B can be made from secondary metal, reducing the cost of the alloy. They must be used when maximum corrosion resistance is not required.
- AZ91E is a high-purity alloy with excellent corrosion resistance used in pressure-tight sand and permanent mold castings with high tensile strength and moderate yield strength.
- AZ91C is used in sand and permanent mold castings when maximum corrosion resistance is not required.

AM60 the other main alloy contains 93% magnesium is a die casting alloy used as-cast (F) temper for production of automotive wheels and other parts requiring good elongation and toughness combined with reasonable yield and tensile properties. AM50 has lower aluminum content than AM60 and offers a further increase in ductility but at a slightly reduced strength and a slight reduction in castability. It is typically used where the performance requirements demand elongation properties beyond that of AM60. Cast magnesium anodes are usually supplied in AZ63 (Mg-6Al-3Zn) and extruded shapes in AZ31 (Mg-6Al-1Zn) alloys.

North America, followed closely behind by Europe, are by far the largest markets for magnesium die casting alloys and these regions will be the Complex major target markets. The USA could become a major catch-up market if magnesium pure metal and alloy were available at the lower prices prospectively offered by AmMg. Currently, lowest cost producer China is almost totally shut out of the American market by the huge anti-dumping duties.

Magnesium Market Environment

World Market Summary

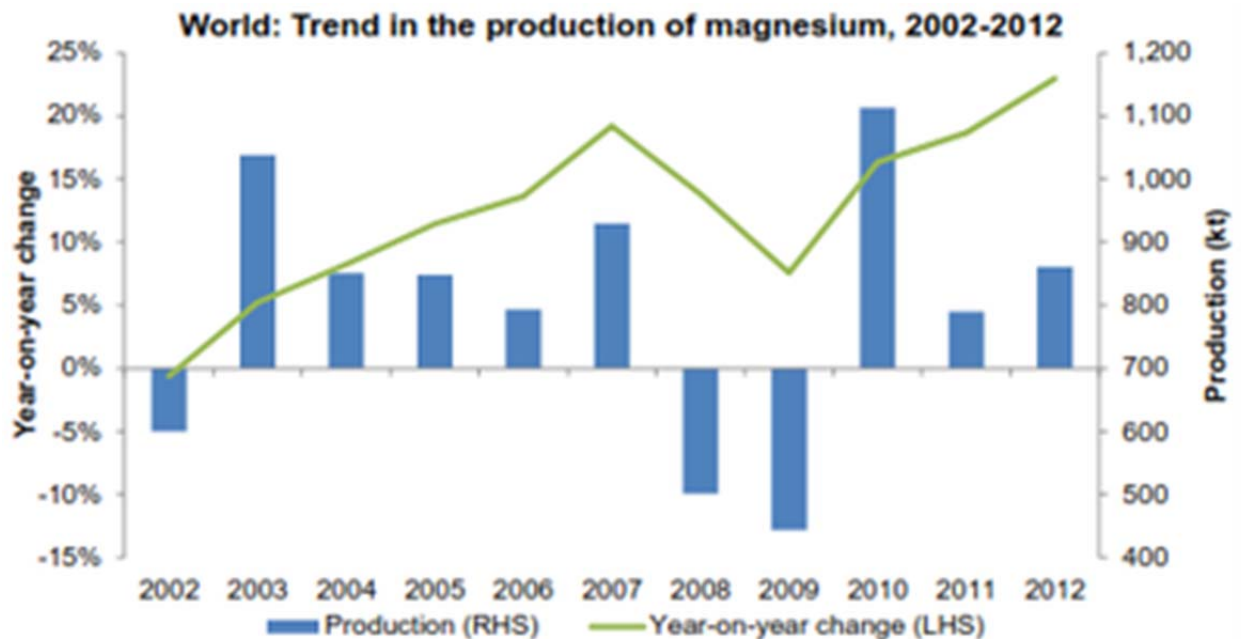
“Consumption of primary magnesium metal contracted by 7% in 2008 and a further 15% in 2009, to just under 690,000 t. The market has since recovered, however, exceeding 2007 levels in 2011 and registering a new peak in use in 2012. Secondary magnesium use adds further to consumption, with total magnesium consumption exceeding 1million t in 2007 and 1.1million in 2012. Magnesium is used primarily in die-cast parts and as an alloy in aluminium, and together these two markets accounted for two-thirds of total consumption in 2012.

The largest end-use for die-cast magnesium parts is the transport industry. While rising automotive output in some regions has boosted consumption since the 2008/09 downturn, the market has been somewhat held back by lower European vehicle shipments. Nevertheless, pressured by emissions reduction targets, growth in use of magnesium in transport applications continues to out-pace traditional materials such as steel and the die-casting market is forecast to grow by 6-7%py through to 2017. In aluminium alloys, magnesium’s use is predominately in packaging applications, with this market continuing to show strong gains based on economic development in emerging markets.

China continues to dominate primary magnesium metal production, with output exceeding 730,000 t in 2012, equivalent to over 75% of total supply. Within China, however, there has been a shift in production. Abundant and cheap gas as a by-product of coke production has seen magnesium producers turn their attention to Shaanxi in the search for greater returns. This has left some traditional magnesium producing provinces struggling to compete and the Chinese magnesium industry languishing with an operating rate barely exceeding 50%. There has also been consolidation in China, with eight Chinese producers now in the top-10 of global producers.

Despite several plant closures in the run-up to the 2008/09 downturn, especially in Canada, production in the USA, Russia and Israel has since expanded, albeit largely to feed demand from rising titanium metal output. Secondary magnesium production is more evenly spread globally, with the USA still the number one recycler. New primary magnesium plants have opened in Malaysia and South Korea since 2010, with Iran likely to follow suit in 2013. The anticipated start-up of Qinghai Salt Lake Industry’s

100,000 tpy electrolytic plant in China in 2013 could yet further alter the landscape in China in the short-term”.¹



Western Demand

The magnesium market data is notoriously unreliable but TRU has made estimates from a number of sources. The data is partly shown in Table 19.

Western consumption of primary magnesium metal products was about 430,000 t in 2012 its highest level since the recession in 2009. Although the market has recovered, it is still below the peak years as the key European market remains in recession. China (and Russia) account for over 60% of the total consumption.

Magnesium alloy use in die casting is the fastest growing segment due to the proliferation of magnesium alloy components in cars to reduce weight. Europe is an important target region as is the United States. The United States accounts for about half western world demand and could develop more strongly were the dumping duties on cheaper Chinese magnesium fully removed.

¹ Roskill, United Kingdom.

Table 19: Western Consumption of Primary Magnesium by Application
2008 – 2017 in tpy

Magnesium Use	2008	2009	2010	2011	2012	2013	2017	Growth % pa	
								2008-13	2012-17
Aluminum Alloying	160,000	120,000	145,000	150,000	155,000	160,000	190,000	0.0%	4.2%
growth rate % pa	-7.0%	-25.0%	20.8%	3.4%	3.3%	3.2%	-		
Die Casting	185,000	130,000	160,000	170,000	180,000	190,000	240,000	0.5%	5.9%
growth rate % pa	-5.1%	-29.7%	23.1%	6.3%	5.9%	5.6%	-		
Other	90,000	70,000	90,000	90,000	95,000	100,000	106,500	2.1%	2.3%
growth rate % pa	-10.4%	-22.2%	28.6%	0.0%	5.6%	5.3%	-		
West Primary Mag Use	435,000	320,000	395,000	410,000	430,000	450,000	600,000	0.7%	6.9%
growth rate % pa	-7.0%	-26.4%	23.4%	3.8%	4.9%	4.7%	-		
% of world	44%	35%	35%	38%	37%	37%	40%		
Global Mg Metal Use	995,598	906,374	1,122,905	1,077,155	1,150,400	1,207,920	1,500,000	3.9%	5.5%
including recycled	-8.5%	-9.0%	23.9%	-4.1%	6.8%	5.0%	-		

Sources and Notes:

Derrick Webb, May 22, 2005 use segmentation. "Magnesium Supply and Demand 2004" IMA Annual Conference Berlin. Primary magnesium
US Geological Survey, China Magnesium Association, International Magnesium Association

TRU Group Inc confidential 2013

Recovery from the 2009 recession in China appears quite robust and in the west (particularly the USA) car sales have bounced back. Europe demand has been weak with car sales down in the past year. Although the overall market is mature in the west the fundamentals driving demand remain solid and TRU therefore projects growth above that expected in Western economies – a rate on average of about 6.9 % per annum 2012 through 2017 for primary magnesium.

United States Market

Domestic Production and Use: In 2012, magnesium was produced by one company at a 63,500-ton-per-year plant in Utah by an electrolytic process that recovered magnesium from brines from the Great Salt Lake. Magnesium used as a constituent of aluminum-based alloys for packaging, transportation, and other applications was the leading use for primary magnesium, accounting for 43% of primary metal use. Structural uses of magnesium (castings and wrought products) accounted for 40% of primary metal consumption. Desulfurization of iron and steel accounted for 11% of U.S. consumption of primary metal, and other uses were 6%.

The following table provides the key relevant statistics for the United States.

Table 20: U.S. Geological Survey Magnesium Statistics in short tons

Salient Statistics—United States:	2008	2009	2010	2011	2012^a
Production:					
Primary	W	W	W	W	W
Secondary (new and old scrap)	88	69	72	75	75
Imports for consumption	83	47	53	48	53
Exports	14	20	15	12	18
Consumption:					
Reported, primary	65	51	56	59	60
Apparent	² 130	³ 80	² 100	² 110	² 110
Price, yearend:					
U.S. spot Western, dollars per pound, average	3.15	2.30	2.43	2.13	2.20
China free market, dollars per metric ton, average	2,665	2,950	2,925	3,025	3,250
Stocks, producer and consumer, yearend	W	W	W	W	W
Employment, number ^c	400	400	400	400	400
Net import reliance ^d as a percentage of apparent consumption	50	33	38	33	31
Recycling: In 2012, about 24,000 tons of secondary production was recovered from old scrap.					
Import Sources (2008–11): Israel, 32%; Canada, 25%; China, 13%; and other, 30%.					

The U.S. Department of Commerce, International Trade Administration (ITA), revised the final results of its decision regarding imports of pure magnesium from a specific Chinese firm into the United States from May 1, 2006, through April 30, 2007, because the review was “tainted by fraud.” The ITA had originally calculated a dumping margin of 0.63% ad valorem, but amended the duty to 111.73% ad valorem. The U.S. Court of International Trade (CIT) denied an appeal from the U.S. magnesium producer that contested a 2011 decision by the U.S. International Trade Commission (ITC) to revoke antidumping duties on pure magnesium from Russia. In a 5-year sunset review of imports of magnesium from China and Russia, the ITC had determined that the duties on magnesium from China should be maintained, but the duties on magnesium from Russia should be discontinued¹.

Competition & Production

By far the most significant competitive determinant in the last five years at least has been the seemingly unstoppable onslaught on the world market by Chinese producers. China still produced about 85% of world primary magnesium metal production in 2012, as shown in the following table, production in short tons –

¹ U.S. Geological Survey, Mineral Commodity Summaries, January 2013

Table 21 U.S. Geological Survey World Primary Production in Short Tons

World Primary Production and Reserves:		
	Primary production	
	2011	2012^a
United States	W	W
Brazil	16	16
China	661	640
Israel	30	30
Kazakhstan	21	21
Malaysia	2	5
Russia	37	37
Serbia	2	2
Ukraine	2	2
World total ^b (rounded)	771	750

World magnesium capacity in thousands tpy by plant as it was in 2006 is shown in the following snapshot –

Brazil	
Rima Industrial	12
China	
Taiyuan Tongxiang Magnesium	90
Inner Mongolia Zhongrun Magnesium Industry ²	50
Taiyuan Yiwei Magnesium Industry	50
Shanxi Wenxi Yinguang Magnesium	50
Ningxia Huizhe Magnesium Industry	35
Ningxia Huayuan Metallurgy Industry	25
Shanxi Wanke Jinrun Magnesium Products	25
Shanxi Jinxin Yiwei Magnesium Industry	15
Shanxi Xiaoyi Dongyi Coal-Power-Aluminium Group	15
Shanxi Wenxi Hongfu Magnesium Industry	12
Shanxi Qizhen Magnesium Industry	12
Other	431
Subtotal	810
Israel	
Dead Sea Magnesium	35
Kazakhstan	
UKTMC ¹	40
Russia	
VSMPO Avisma	60
SMZ	20
Subtotal	80
Serbia	
...	5
Ukraine	
Kalush Magniy ³	20
ZMTK ¹	23
Subtotal	43
USA	
US Magnesium	43
Total	1,068

The following shows that China produces magnesium metal (tonnes metric) in a variety of forms – some high tech.

	Total Shipments Jan-Dec 2006	Total Shipments Jan-Dec 2007	Total Shipments Jan-Dec 2008	Growth rate y-o-y %
Magnesium Ingots	173,211.7	207,649.9	197,059	-5.05%
Magnesium Alloys	85,655.6	106,588.6	100,814	-5.42%
Chips, granules, powders	79,811.2	79,928.9	85,927	+7.50%
Wrought Magnesium	4,632.6	5,508.7	5,988	+8.71%
Scrap	1,869.0	1,143.9	275	-75.96%
Magnesium Articles	4,623.0	7,227.8	6,323	-12.52%
Totals	349,803	408,048.1	396,385	-2.85%

Competitive Strategy: The AmMg smelter should be able to compete with China to be successful at least while the tariffs are in place. The competition against Chinese imports is based on:

- a USA price at least 10% below the China sourced landed offering (after duty)
- better quality assurance than available from China, and
- much better delivery time and sales service.

The established western producers are inefficient and no strong match for AmMg. Since 2012 new primary magnesium plants have opened in Malaysia by CVM Minerals Limited and South Korea by Posco since 2010. CVM Minerals has not proved competitive but may in the future while the POSCO output so far is for internal consumption. There are other plants in prospect so AmMg ought to move quickly to establish itself to be a frontrunner.

Competition from US Magnesium, Rowley, UT: The only North American competitor is US Magnesium. The process is based on brine from the Great Salt Lake and involves brine evaporation for concentration, chemical treatment and electrolytic reduction. It also produces byproducts such as chlorine, potash containing salt, and sodium chloride. The company's profitability as a magnesium metal producer turned to losses in the early 2000s pushing it into bankruptcy. However, heavy duties against China imports and process upgrading of magnesium metal production in the last five years has allowed it to survive but still not likely with significant profits.

A potential strategy for AmMg is to compete on price significantly below the US Magnesium offering, above the Chinese offering FOB China, but below the average import landed price after duty. This price point is used as the base case analysis in this report.

Magnesium Prices

Base Case Price History and Forecast:

TRU price assumptions for the AmMg Complex are based on competitive pricing compared to American import and China FOB dollar per t expected for year 2013. We have also taken into account the need to compete with US Magnesium of Salt Lake City, UT which is the only magnesium metal producer in North America. Our base case price assumption is \$4000 per t for 99.95% pure magnesium metal. TRU market prices forecast for 2013 is in the following table -

Table 22: TRU Magnesium Metal Price Assumption 2013
US\$ per t

Magnesium Metal Price Basis	US\$ per t									
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
China FOB	1,865	1,654	1,754	2,580	3,930	2,670	2,740	2,840	2,900	2,850
Free Market	2,034	1,826	1,935	2,580	3,930	2,670	2,740	2,840	2,900	2,850
USA Import	3,307	3,000	2,700	3,720	7,380	5,080	5,600	5,191	4,990	4,630
Price Movement										
China FOB	14.9%	-11.3%	6.0%	47.1%	52.3%	-32.1%	2.6%	3.6%	2.1%	-1.7%
Free Market	2.3%	-10.2%	6.0%	33.3%	52.3%	-32.1%	2.6%	3.6%	2.1%	-1.7%
USA Import	38.9%	-9.3%	-10.0%	37.8%	98.4%	-31.2%	10.2%	-7.3%	-3.9%	-7.2%

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There is risk in the price outlook mainly due to the uncertainty over whether the US will continue high anti-dumping duties on China magnesium imports and ferrosilicon costs in China.

The base case 2013 magnesium alloy price is assumed at a 10% premium above the pure metal price.

Historic Prices Graph China vs USA:

The following graph compares ten years of historic price data for USA imports and China exports.

Figure 17: Magnesium historic Price Trends 2004 - 2013

Source: TRU chart from Metal Pages data

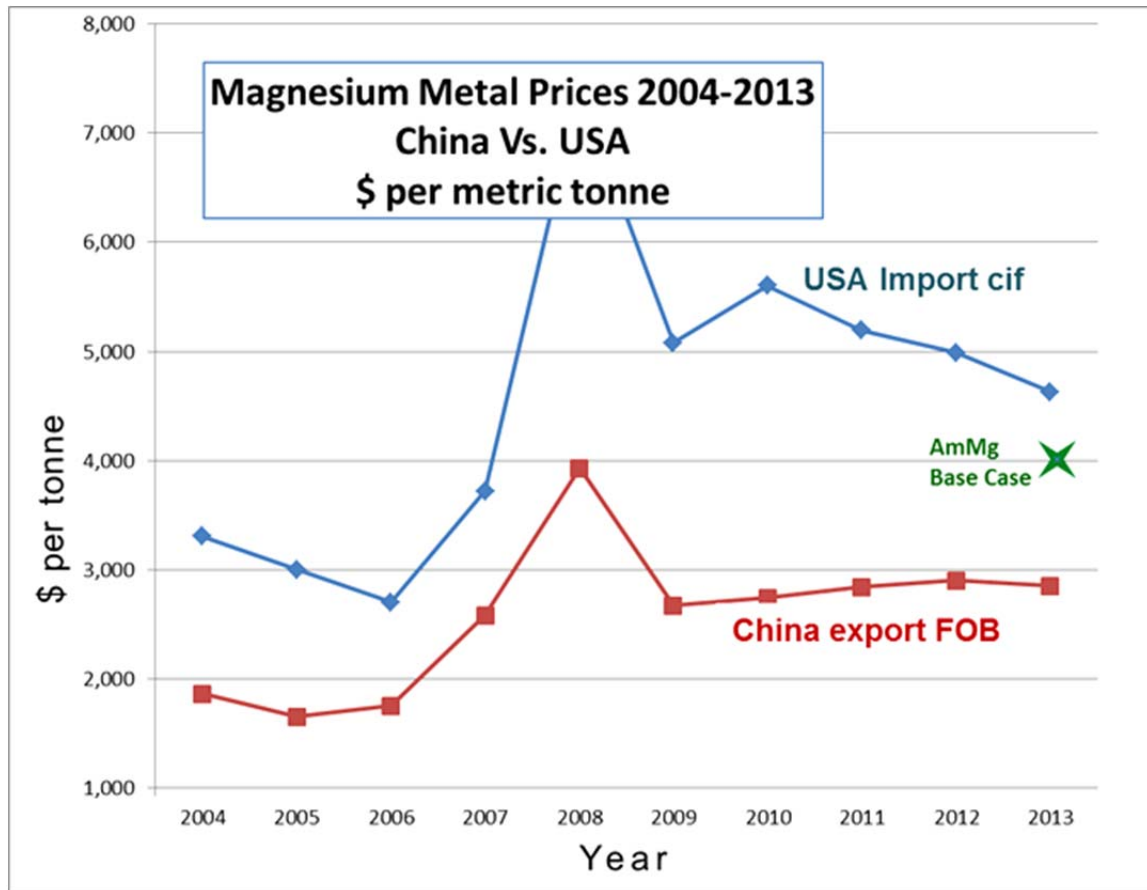
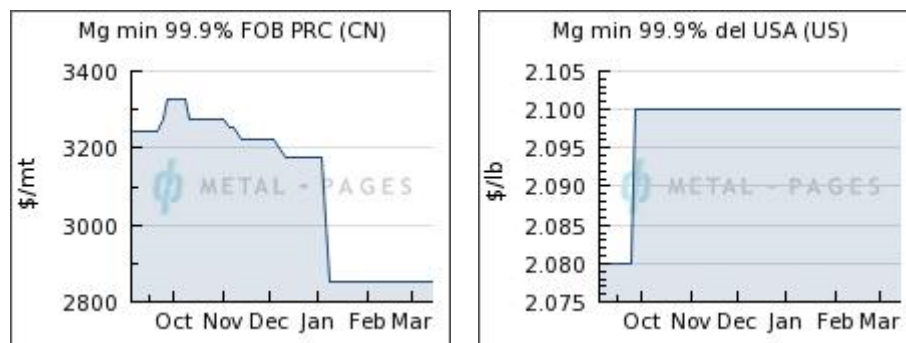
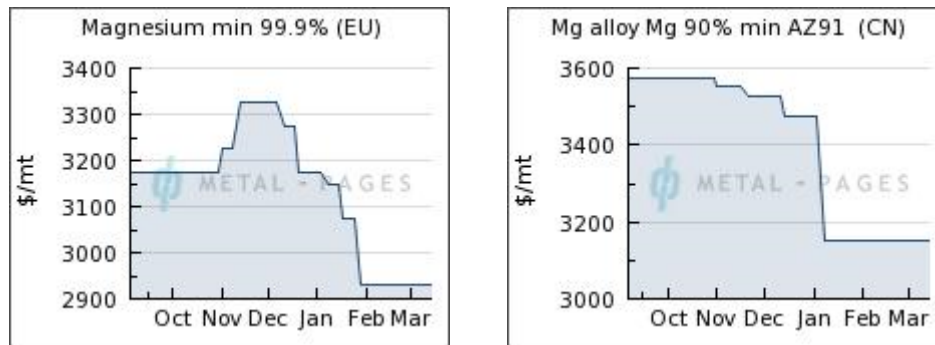


Figure 18: Recent Published Magnesium Metal Prices





Source: Metal Pages

Note that all China magnesium export prices dropped suddenly in February 2013 as the Chinese Government dropped the 10% export duty in attempt to boost exports in the face of sluggish demand domestically and abroad.

Ferrosilicon Prices and Relationship to Magnesium

Magnesium Vs Ferrosilicon Prices:

Ferrosilicon metal prices are correlated quite strongly with magnesium prices for Chinese magnesium producers. This is because ferrosilicon is a major consumable item in smelting magnesium as can be seen in the following comparison in the following table

Table 23: Historic Magnesium to Ferrosilicon Prices 2004-2013

	US\$ per t									
Metal Product	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Magnesium Metal	1,865	1,654	1,754	2,580	3,930	2,670	2,740	2,840	2,900	2,850
Ferrosilicon 75%	728	625	641	885	1506	1116	1455	1380	1400	1430
ratio FeSi/Mg price	39%	38%	37%	34%	38%	42%	53%	49%	48%	50%


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Ferrosilicon Quotation

In the base case 2013 we assume that the ferrosilicon price will remain about the current price in first quarter 2013. The USA produces ferrosilicon but the prices are not competitive with Chinese or Brazilian material at this time. Unfortunately, Mexico according to our search does not produce ferrosilicon.

Note that the plan for the AmMg smelter is to use 85% FeSi at \$1400 per t which is usually a higher cost than the 75% standard assumed but which we balance by large volume and the quotation received (from China).

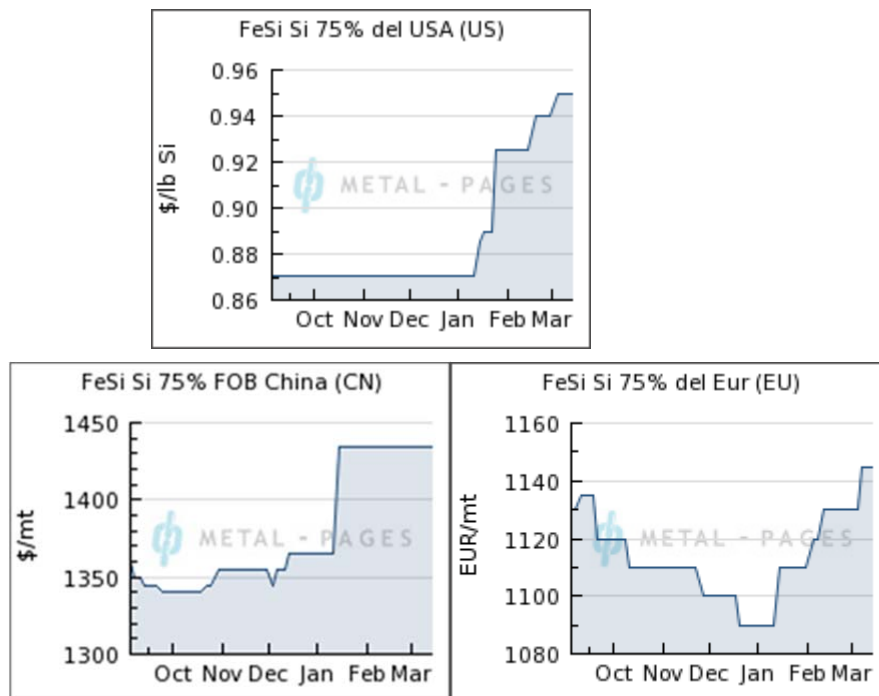
China FeSi Quote: The following are prices quoted to TRU by a Chinese supplier in March 2013 -

Picture	Item	Package	Payment term	CIF Los Angeles USD
 Ferro Silicon	ferro silicon 75%	we can according to your requirment to pack it	T/T or 100% L/C at sight	1075/MT

Picture	Item	Package	Payment term	CIF Los Angeles USD
 Ferro Silicon	ferro silicon 85%	we can according to your requirment to pack it	T/T or 100% L/C at sight	1290/MT

Recent Published Ferrosilicon Prices

Table 24 Recent Published Ferrosilicon Prices



FINANCIAL ASSESSMENT

AmMg Magnesium Metal Complex Financial Summary

The AmMg Magnesium Smelter that was investigated for this conceptual feasibility study includes an integrated Alloy and Pure Metal Plant. In deciding the plant configuration, many financial issues were considered along with the non-financial. Various scenarios are possible using the model developed for the Metal Complex and for this report we have focused on one base case since it became obvious that energy costs trump most other operating cost considerations. There is strong competition in the magnesium industries and success is conditional upon the operational units being competitive – especially against the one US and several Chinese producers.

In China, for example, coal-gas waste by-product from nearby coke ovens is available at almost no cost to some magnesium smelters. The lower US cost of natural gas must be leveraged to the smelter's advantage. This being so, the underlying base case in all our analysis assumes availability of natural gas at a price of a conservative maximum of \$3.80 per GJ (\$0.38 per therm).

A ten year projection of a base case scenario is presented for the Magnesium Metal Complex. For the operations, the projections assume the use of middle to high tech equipment and advanced mechanization that will result in optimal operational costs. Naturally the optimization of investment dollars required to build the plant is the other side of the profitability equation. An underlying approach was to optimize equipment cost expecting to source some of it in China and some in the West. In addition, the complex configuration includes the construction of an Alloy Retort & Tube Casting Plant which will be used to supply the Magnesium Smelter with some new and most replacement retorts.

The recommended AmMg operation, which includes the Magnesium Smelter and Alloy and Pure Metal Plant with an Alloy Retort and Tube Casting Plant, will cost \$94 million $\pm 40\%$. In the base case, by year five the business will generate about \$129 million in revenue and earnings¹ of \$21 million. The Net Present Value NPV² of \$50 million is significant and Internal Rate of Return [IRR] of 16%. The financial analysis is summarized in the following table -

¹ EBDIT is Earnings before depreciation, interest and taxes.

**Table 25: AmMg Magnesium Complex Consolidated Financial Summary
Income and Profitability**

constant 2013\$ millions											
FINANCIAL ITEM	units	year-0	year-1	year-2	year-3	year-4	year-5	year-6	year-7	year-8	year-9
REVENUE	\$	\$0	\$38	\$95	\$127	\$129	\$129	\$129	\$129	\$129	\$129
LESS Plant Operating Cost	\$	2	37	83	104	103	103	103	103	103	103
Plant Operating Profit	\$	-\$2	\$1	\$13	\$23	\$24	\$24	\$24	\$24	\$24	\$24
- less head office sales & admin	\$	0.0	0.8	1.9	2.5	2.5	2.5	2.5	2.5	2.5	2.5
EBDIT*	\$	-\$2	\$1	\$11	\$20	\$21	\$21	\$21	\$21	\$21	\$21
TOTAL CAPITAL REQUIRED		89	5	0	0	0	0	0	0	0	0
Plant & Equipment Cost	\$	\$79	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	0
Natural Gas Pipeline	\$	\$5	\$5								
Environmental Upgrade	\$	\$5									
Operating Capital	\$	\$0	\$2	\$2							
annual net cash flow	\$	-\$91	-\$4	11	20	21	21	21	21	21	21
cumulative cash flow	\$	-\$91	-\$95	-\$84	-\$64	-\$43	-\$22	-\$1	21	42	63
PROFITABILITY -	yr	0	1	2	3	4	5	6	7	8	9
EBDIT as % of revenue	\$	-	2%	11%	16%	16%	16%	16%	16%	16%	16%
Net Present Value [NPV]**	at	8%	\$50	million							
Internal Rate of Return [IRR]	%	16%									
Pay Back Period	yrs	7									
Scenario: Base Case											

* EBDIT = Earnings before depreciation, interest and taxes

** Residual value of business in year ten assumed \$100 million

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The Base Case financial results for the project are moderately attractive, if not reasonably good, given the relatively low risk. Some of the assumptions used in the financial analysis appear in other sections of this report, for example, sales prices. All data is in constant 2013US dollars without inflation adjustment. Of course much of the detail is recorded in the separate digital excel-based financial model of the magnesium operations rather than in this report.

Sensitivity to Key Input Variables

The key variables generating most uncertainty for the project are the prices for inputs natural gas and ferrosilicon. Also the price for output product magnesium metal will obviously vary based on a number of factors some of which can be partly strategically managed by AmMg. In TRU's opinion, all three variables have a high probability of actually being within a range of 25% of the estimates used in the base case¹. Table 26 presents the profit sensitivity to input costs and output prices (t are metric)

¹ The study overall is considered accurate to $\pm 35\%$, and capital estimates $\pm 40\%$, compared to the base case

Table 26: Profit Sensitivity to Input Costs and Output Prices

Variable \ profit measure	units	Variable Change over Base Case		
		Less 25%	Base Case	Add 25%
Natural Gas Cost	\$/MM BTU	\$3.01	\$4.01	\$5.01
	\$ per GJ	\$2.85	\$3.80	\$4.75
EBDIT*	\$millions	\$25	\$21	\$17
EBDIT % sales	%	20%	21%	13%
IRR**	%	19%	16%	13%
Pay-back	years	6	7	8
Ferrosilicon Cost	\$ per t	\$1,050	\$1,400	\$1,750
EBDIT	\$millions	\$32	\$21	\$10
EBDIT % sales	%	25%	21%	8%
IRR	%	24%	16%	7%
Pay-back	years	5	7	>10
Magnesium Price ± 25	\$ per t	\$3,000	\$4,000	\$5,000
EBDIT	\$millions	(\$10)	\$21	\$52
EBDIT % sales	%	-10%	21%	32%
IRR	%	-8%	16%	38%
Pay-back	years	>10	7	3

* EBDIT = earnings before depreciation, interest and taxes

** IRR = internal rate of return

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The project profitability is three times more sensitive to metal prices than it is for the ferrosilicon cost which in turn is double the sensitivity of the project profitability to the natural gas cost. The three variables are discussed further in this report.

Plant Level Operating Cost Estimates

Summary

The operating profitability was assessed for the AmMg Magnesium Smelter integrated with the Alloy & Pure Metal Magnesium Plant as one operating unit. Since there is no market for magnesium crowns, the Magnesium Smelter alone would not be a meaningful operating unit. The other operating unit is the Alloy Retort & Tube Casting Plant. All the magnesium operating units recommended are profitable as stand-alone operations.

Operating cost estimates were prepared for the plant. The accuracy of this estimate is within $\pm 35\%$. Table 27: Production Cost Estimate Summary Smelter in year-five, summarizes the production costs (operating costs less plant administration costs) for

the Magnesium Smelter & Alloy Operation assuming full capacity utilization or as at year five -

Table 27: Production Cost Estimate Summary Smelter in year-five

Plant Unit	Total \$million	\$ per t product
Magnesium Smelter & Alloy	100	\$3,228

Sources & notes -
TRU Group Inc - March 2013

The above is the Base Case cost with the main cost items being by far ferrosilicon (44% of total cost) and natural gas half this percentage and dolomite (17% of total cost).

Base Case Assumptions for Cost Estimates

Labor

The labor requirements are based on operating 365 days per year, 24 hrs per day with three 8-hour shifts using up to four operating crews. Support staff is scheduled on a 5-day week on an 8-hour shift. The labor requirements are summarized in the table below.

Table 28: Summary Labor Requirements

Plant Unit	Total Employees
Magnesium Smelter & Alloy	1 561
Alloy Tube & Casting Plant	20

Sources & notes -
1 excludes HO management
TRU Group Inc

Labor costs were provided by in-house data with confirmation from outside sources. The summary of these costs is presented in Table 29.

Table 29: Labor Costs

	\$/yr
Director	\$100,000
Plant Manager	\$90,000
Engineering	\$60,000
Shift workers	\$25,000
Weekday plant labor	\$37,000
Supervisors & senior	\$45,000

The main labor cost was estimated at \$18 per hour fully loaded although a 10% labor burden was added as a variable overhead for all labor in the model to account for social and housing costs. Of course the labor costs are considerably higher than those in China but could be optimized by using locals (as there is apparently high unemployment in the town of Deming and vicinity of Luna County NM).

Raw Materials

Unit costs per metric tonne or liter for complex raw materials were provided by in-house data and from outside sources. The summary of the costs of the complex raw materials is presented in Table 30: Complex Main Raw Materials Costs.

Table 30: Complex Main Raw Materials Costs

Plant Unit	Unit	\$ per Unit
<i>Magnesium Smelter & Alloy</i>		
Dolomite	t	\$20
85% FeSi	t	\$1,400
Fluorspar	t	\$120
Flux	t	\$620
Spray Oil	l	\$1
MnCl ₂	t	\$4,000

Sources & notes -
TRU Group Inc March 2013

Dolomite is the major raw material and will be supplied from the mine in the proximity of the plant site.

Reagents and Consumables

Unit costs for major process consumables and reagents were provided by in-house data. The summary of the costs of the complex consumables is presented in Table 31.

Table 31: Major Reagent and Consumables Costs

Plant Unit	Unit	\$ per Unit
<i>Magnesium Smelter & Alloy</i>		
Retorts	1 unit	\$2,100
Roll Shells	set	\$8,000
Melting/holding pots	unit	\$70,000
Flux Pots	unit	\$2,000
SF ₆	kg	\$10
CO ₂	kg	\$0.14
Retort Equipment	t/crown	\$42
Magnesium Moulds	t/ingot	\$17

Sources & notes -
1 retort net price delivered
TRU Group Inc

Energy Costs

Energy cost is of major importance for the magnesium complex, especially the cost of natural gas. It is critical that the AmMg smelter has access to a solid long term source of natural gas with the following maximum price shown in Table 32: Energy Costs

Table 32: Energy Costs

Plant Unit			\$ per unit
<i>Magnesium Smelter & Alloy</i>			
natural gas	1	GJ	\$3.80
electricity	2	kWh	\$0.05

Sources & notes -

TRU Group Inc March 2013

The plant is designed for using the best form of energy for the process – natural gas for the rotary kiln calciner and smelter, and mainly electricity for the alloy & pure metal plant.

Operating Costs for Mg Smelter and Mg Alloy & Pure Metal Plant

The operating costs for the Magnesium Smelter, Alloy and Pure Metal Plant are summarized in Table 33: Annual Cost of Operations - Magnesium Smelter and Alloy & Pure Metal Plant. Note that the consumables costs go down from year 3 to 4 due to the transition of purchased alloy retorts to on-site manufactured.

Table 33: Annual Cost of Operations - Magnesium Smelter and Alloy & Pure Metal Plant

ITEM	units	year-0	year-1	year-2	year-3	year-4	year-5	year-6	year-7	year-8	year-9
Smelter output magnesium crown	t	0	9,300	23,250	31,000	31,000	31,000	31,000	31,000	31,000	31,000
REVENUE TOTAL		\$0	\$38,096,520	\$95,241,300	\$126,988,400	\$126,988,400	\$126,988,400	\$126,988,400	\$126,988,400	\$126,988,400	\$126,988,400
- pure magnesium sales	\$	0	28,234,800	70,587,000	94,116,000	94,116,000	94,116,000	94,116,000	94,116,000	94,116,000	94,116,000
- magnesium alloy sales	\$	0	9,861,720	24,654,300	32,872,400	32,872,400	32,872,400	32,872,400	32,872,400	32,872,400	32,872,400
- magnesium transfer	\$	0	0	0	0	0	0	0	0	0	0
DOLOMITE ORE COST	\$	\$0	\$2,183,640	\$5,459,100	\$7,278,800	\$7,278,800	\$7,278,800	\$7,278,800	\$7,278,800	\$7,278,800	\$7,278,800
CONVERSION COST	\$	\$378,000	\$31,468,524	\$72,481,902	\$91,173,368	\$90,320,888	\$90,320,888	\$90,320,888	\$90,320,888	\$90,320,888	\$90,320,888
Production Labor:	\$	\$378,000	\$5,038,530	\$11,493,825	\$14,905,100	\$14,905,100	\$14,905,100	\$14,905,100	\$14,905,100	\$14,905,100	\$14,905,100
Energy Cost:	\$	\$0	\$6,429,444	\$16,073,610	\$21,431,480	\$21,431,480	\$21,431,480	\$21,431,480	\$21,431,480	\$21,431,480	\$21,431,480
- natural gas	\$	0	5,130,684	12,826,710	17,102,280	17,102,280	17,102,280	17,102,280	17,102,280	17,102,280	17,102,280
- electricity cost	\$	0	1,298,760	3,246,900	4,329,200	4,329,200	4,329,200	4,329,200	4,329,200	4,329,200	4,329,200
Consumables:	\$	\$0	\$20,000,550	\$44,914,467	\$54,836,788	\$53,984,308	\$53,984,308	\$53,984,308	\$53,984,308	\$53,984,308	\$53,984,308
- magnesium smelter	\$	0	18,685,241	41,626,194	50,452,424	49,599,944	49,599,944	49,599,944	49,599,944	49,599,944	49,599,944
- mag alloy and pure metal plant	\$	0	1,315,309	3,288,273	4,384,364	4,384,364	4,384,364	4,384,364	4,384,364	4,384,364	4,384,364
MAINTENANCE & REPAIRS	\$	\$0	\$744,000	\$1,860,000	\$2,480,000	\$2,480,000	\$2,480,000	\$2,480,000	\$2,480,000	\$2,480,000	\$2,480,000
TOTAL PRODUCTION COST:	\$	\$378,000	\$34,396,164	\$79,801,002	\$100,932,168	\$100,079,688	\$100,079,688	\$100,079,688	\$100,079,688	\$100,079,688	\$100,079,688
- production cost per t	\$/t	-	\$3,699	\$3,432	\$3,256	\$3,228	\$3,228	\$3,228	\$3,228	\$3,228	\$3,228
PRODUCTION GROSS MARGIN	\$	-\$378,000	\$3,700,356	\$15,440,298	\$26,056,233	\$26,908,713	\$26,908,713	\$26,908,713	\$26,908,713	\$26,908,713	\$26,908,713
- margin % of revenue	%		10%	16%	21%	21%	21%	21%	21%	21%	21%
PLANT GENERAL ADMINISTRATION	\$	\$1,134,600	\$2,241,653	\$2,755,183	\$3,096,310	\$3,195,310	\$3,195,310	\$3,195,310	\$3,195,310	\$3,195,310	\$3,195,310
Manage & administration people	\$	300,000	610,000	490,000	490,000	580,000	580,000	580,000	580,000	580,000	580,000
Plant labor burden	\$	67,800	564,853	1,198,383	1,539,510	1,548,510	1,548,510	1,548,510	1,548,510	1,548,510	1,548,510
Land rentals	\$	566,800	566,800	566,800	566,800	566,800	566,800	566,800	566,800	566,800	566,800
Equipment & transport	\$	100,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
Other miscellaneous	\$	100,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000	300,000
TOTAL PLANT OPERATING COST:	\$	\$1,512,600	\$36,637,817	\$82,556,184	\$104,028,478	\$103,274,998	\$103,274,998	\$103,274,998	\$103,274,998	\$103,274,998	\$103,274,998
Plant Operating Profit	\$	-\$1,512,600	\$1,458,703	\$12,685,116	\$22,959,923	\$23,713,403	\$23,713,403	\$23,713,403	\$23,713,403	\$23,713,403	\$23,713,403
% of revenue	%		4%	13%	18%	19%	19%	19%	19%	19%	19%

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Capital Costs

Summary

Order-of-magnitude $\pm 40\%$ preliminary capital cost estimates were prepared for each of the process units (mine and ore delivery excluded) –

Table 34: Capital Cost Estimate Summary for Five Years

Plant Unit	\$ millions
Magnesium Plant Total	\$79
<i>Magnesium Smelter & Alloy</i>	77.2
<i>Alloy Tube & Casting Plant</i>	2.3
Natural Gas Pipeline	\$10
Environmental Upgrade Charge	\$5
TOTAL FIXED CAPITAL	\$94

Sources & notes -

Cost is installed plant & equipment including EPCM

TRU estimates $\pm 40\%$ blend of China-Western equip

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Basis of Estimate

Magnesium Operations

The Magnesium Smelter and Magnesium Alloy and Pure Metal Plant capital cost estimate was based on in-house data as well as some quotations. For most of the equipment, the average of the estimated western and Chinese sources equipment was used.

Exclusions

- Electrical power supply tie-in to grid
- Water supply
- Exploration and Mining

Magnesium Smelter

The order-of-magnitude capital cost estimate for the Magnesium Smelter is summarized in the following Table 35 -

Table 35: Magnesium Smelter Capital Cost Estimate

Equipment Item \$millions	\ #	Equipment Cost		
		West	China ¹	Expected
Kilns	2	18.00	6.4	12.2
Furnaces	36	30.00	11.3	20.6
Vacuum Systems		9.00	4.2	6.6
Retorts	1322	4.76	4.8	4.8
Oil Reclamation Systems		4.30	1.7	3.0
Piping-Gas-Ventilation		4.30	1.0	2.6
Residue Disposal System		4.50	1.8	3.1
Furnace Service Equipment		3.00	1.1	2.0
Crown Press		3.00	0.9	1.9
FeSi Ball Mill		0.50	0.1	0.3
Dolime Mill		0.50	0.2	0.4
Briquette Presses		3.00	1.1	2.0
Storage Bins		2.00	0.9	1.5
Dust Collection		1.00	0.3	0.6
Air Compressors		1.00	0.2	0.6
Cooling Towers		2.00	0.6	1.3
Electrical Power Distribution		1.50	0.7	1.1
Gas Distribution		1.00	0.4	0.7
Electrical Transformer		0.75	0.3	0.5
Front End Loaders		0.30	0.1	0.2
Trucks		0.10	0.0	0.1
Office & Comfort Facility		0.15	0.1	0.1
Warehouse, Lab, Maintenance		0.15	0.1	0.1
Reduction, Melting Buildings		2.00	0.9	1.5
Site Preparations		0.40	0.2	0.3
Eng, Procure, Cons & Man	EPCM	4.00	1.5	2.8
Total Capital Equipment		\$101	\$41	\$71

Sources & Notes -

1 China, Local or Other Non-Western Source

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There is an additional capital cost of \$2.3 million for the Alloy Retort & Tube Casting Plant, which will produce the western style retorts for the magnesium smelter reduction furnace. The main equipment for this plant are, melting-alloying furnace, casting machine, shot blasting system and spectrometer.

Magnesium Alloy & Pure Metal Plant

The order-of-magnitude capital cost estimate for the Magnesium Alloy and Pure Metal Plant is summarized in following Table 36: Magnesium Alloy & Pure Metal Plant Capital Cost Estimate –

Table 36: Magnesium Alloy & Pure Metal Plant Capital Cost Estimate

Equipment Item	#	\$ millions
Gas fired melt furnances	6	1.70
Electric heated holding furnances	3	0.60
3-flux furnaces	3	0.60
Ingot conveyor and pallitizer	2	1.40
Sludgers	2	0.45
Overhead cranes	2	0.35
Fume control and wet scrubber	1	0.75
Mixers	6	0.01
General melting tools	-	0.05
Protection gas mixing facility	1	0.05
Weigh scales	3	0.03
Fork lifts	2	0.15
Total Capital Equipment		\$6

Sources & Notes -
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OPERATIONS REVIEW

AmMg Magnesium Metal Complex Location

The planned AmMg Plant will be about twelve miles south of the City of Deming in New Mexico, USA which has a population of around 15,000. The main west-east I10 interstate highway runs through the city and the Amtrak's Sunset Limited and Texas Eagle train routes stop at the city. There are excellent connections to the Gulf and Pacific coasts as well as to the markets to the north. Importantly, natural gas pipelines are within 12-15 miles and power available locally. The AmMg project site is shown on location in the map of Figure 19 -

Figure 19: Map Showing AmMg Magnesium Metal Complex Location and Utilities





Utilities & Infrastructure

Natural Gas Supply & Prices

Natural gas is a major process consumable for the complex and it was important even at this conceptual stage in the AmMg project to be clear on its availability, capital cost and purchase price. The minimum consumption at full capacity is 4.5 million GJ as shown in the following Table 37 -

Table 37: AmMg Magnesium Smelter Natural Gas Requirement

Infrastructure Item	units	Plant	Smelter	Ingot Pure & Alloy	Mfg	Quantity Minimum	Quantity Plan
Energy							
- gas:natural or coal-gas total	GJ		4,500,000	650	2,000	4,500,000	9,000,000
for reduction furnace	GJ	1	2,680,000			2,680,000	5,360,000
for calcining rotary kiln	GJ		1,820,000			1,820,000	3,640,000

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Gas pipeline capital cost: The capital cost of the pipeline is estimated conservatively at \$10 million. This is based on budget quotations from two gas utility companies namely –

⊙ New Mexico Gas Company¹

"The plant operation is 350 days per year, 24 hours per day. During this time period 4.5 million GJ of natural gas will be delivered. On a daily or peak basis 13,000 GJ/day or 540 GJ/h (500 million BTU/h) is required. This would require NMGC to install approximately 15 miles (11 miles south on State Rd 11 and 4 miles east on Co B013) of new pipeline. As you are aware, this is a sizeable load, roughly 500 Mcf/h or 12,000 Mcf a day. Price includes: EPNG tap, 15 miles of 6", and meter station for smelter with a delivery pressure of 100 psig - \$8.4 million ± 30%".

⊙ Kinder Morgan Inc - El Paso Natural Gas Division²

"First look at the cost for a ~17 mile 8" pipeline and a full interconnect with meter station, GC, controls and transmitter. Assuming \$15,000,000 CAP EX, the COS incremental rate to achieve an annual revenue recovery of the initial investment is ~\$0.68/Dth. The Reservation rate for New Mexico is \$0.34/Dth.. To get close to making this work, we would be looking at ~\$1.13/Dth for the total demand charge (comprised of both a incremental rate and reservation rate).

Currently supply prices are ~\$3.50 for Permian. Therefore, your delivered would be \$1.13 + 3.50 + \$0.08 (~fuel and ACA) = ~\$4.60/Dth. Basis:

- 4.5 MM GJ ~ 4.3 x10¹¹ Btu
- 4.3 x10¹¹ Btu/yr * 1 Dth/1.0 x10⁵ Btu =4,300,000 Dth/yr
- 4,300,000 Dth/yr *1/365 day = ~12,000 Dth/d."

Natural gas purchase price per GJ: In this study we assume a price of \$3.8 per GJ for delivered natural gas. This is based on the assumption that the company would build, finance and own its own about fifteen mile pipeline. The price assumption is considered reasonable (if not conservative) based on a negotiated long term large user rate.

Also New Mexico has large natural gas reserves under development and there is compelling evidence that natural gas prices will be attractive long term as these (and other natural gas resources in the US) are developed³.

Power and Other Utilities

Power lines already exist within a few miles to the east and west of the site. Power sources will likely need upgrading but this is not thought to be at significant cost as the

¹ New Mexico Gas Company, Lloyd Hatch, March 2013

² Kinder Morgan Inc - El Paso Natural Gas Division, Stephen R. Dines, March 2013

³ US Energy Information Administration, spring 2013. "Annual Energy Outlook". Quote: "With increasing natural gas production, reflecting continued success in tapping the nation's extensive shale gas resource, Henry Hub spot natural gas prices remain below \$4 per million Btu (2011 dollars) through 2018 in the AEO2013 Reference case".

smelters needs are manageable. Water is required in the process for cooling and as the requirement is modest, local sources, including wells, are likely to be adequate.

Environmental Issues

Overview

Fortunately, the smelter is quite environmentally friendly as is evident by the fact that a similar smelter operated in Haley Canada in a jurisdiction that has one of the strictest environmental regulations in the world. Magnesium production utilizing the Pidgeon process is generally free of toxic emissions, unlike its electrolytic counterpart; however, certain precautions must be taken to ensure that air and ground pollution is maintained to the best western standards, due to the smelter proximity to a proposed City of Deming. The following section outlines the quantities, sources and suggested control, storage and disposal of the various pollutants.

Nevertheless, in the interests of implementing the best optimal environmentally friendly operation - for example, the use of hoods or enclosure for the capture and treatment of emissions - an extra capital charge of \$5 million is assumed.

Process Inputs Table 38: Process Input for Environmental Consideration outlines the process inputs for the production of 30,000 t of magnesium ingot or alloy.

Table 38: Process Input for Environmental Consideration

Material	Annual Usage
Dolomite Ore	362,000 t
85% Fe-Si	31,400 t
Fluorspar	5,000 t
Spray Oil	586,000 l
MgCl ₂	1,260 t
KCl	840 t
SF ₆	60t
CO ₂	2,000t
Coke Gas	52,000 m ³
Vacuum Pump Oil	9000l
Process Water	58,000 m ³

Process Outputs

Table 39: Process Emissions or Wastes outlines the process pollutant outputs and emission points.

Table 39: Process Emissions or Wastes

<i>Pollutant/Waste</i>	<i>Emission per year</i>	<i>Emission Point</i>	<i>Control Method</i>
Dolime Dust	700 t	Kiln Stacks	Bag House
CO ₂	181,000 t	Kiln Stacks	None
Magnesium Residue	180,000 t	Residue Systems	None
Magnesium Sludge	2,300 t	Melting and Refining Operations	None
Chloride Fume	0	Melting and Refining Operations	Wet Scrubber
Magnesium Oxide	0	Melting and Refining Operations	Wet Scrubber
FeSi Dust	0	Crushing Operations	Bag House
Waste Oil	20,000 l	Vacuum System and other plant lubrication	None
SF ₆	60 t	Melting and Refining Operations	None

Properties of Pollutant and Waste

CO₂ (Carbon Dioxide) Carbon dioxide is a color less, odorless gas. Major impact to environment is the effect on global warming and is considered a green house gas.

Dolomitic Lime (MgO. CaO) Dolomitic Lime is odorless, white-grayish in color. Contact can cause irritation to eyes, skin and respiratory system. The material is not flammable or combustible. It may react with acids to produce heat and steam

explosions. Emissions from the source are normally considered nuisance dust, and will have ecological impact on local surface water, raising pH up to 12.4 in large quantities. Particulates less than 10 microns have been shown to have health effects on respiratory system in humans.

Magnesium Process Residue ($\text{Ca}_2\text{SiO}_4 + \text{FeSi} + \text{MgO} \cdot \text{CaO} + \text{CaF}_2 + \text{Mg} + \text{Mg}_3\text{N}_2$)

Magnesium residue is a residual product of reaction in the Pidgeon process. It is gray-white in color and is not flammable or combustible. Due to the presence of residual dolomitic lime, magnesium nitride and magnesium metal exposure to acids or water will result in the liberation of heat, hydrogen and ammonia. Material will have a detrimental effect on surface and underground aquifers increasing pH and ammonia levels. The FeSi and CaF_2 components are generally considered inert to the environment and pose no health or environmental problems.

Magnesium Sludge

($\text{MgCl}_2 + \text{KCl} + \text{MgO} + \text{NaCl} + \text{CaCl} + \text{Mg}_3\text{N}_2 + \text{Mg} + \text{Be} + \text{Al} + \text{Zn} + \text{Mn}$) - Raw magnesium crowns are refined by using a mixture of salts called refining flux. The major constituents of the flux consist of magnesium chloride, potassium chloride and fluorspar. The resulting sludge consists of a variety of elements outlined above depending whether the process is producing alloy or pure metal. Sludge is very hygroscopic and will react with water or acids to release heat, hydrogen and ammonia. Material will have a detrimental effect on surface water and underground aquifers increasing chloride, nitride and possibly toxic beryllium levels. Air contamination consisting of water, hydrogen and ammonia is minimal due to low release rates and quick dispersal.

Waste Oils Oil and lubricants are used throughout the plant; necessary for equipment maintenance. Material will have a detrimental effect on surface water and underground aquifers.

SF6 Gas This gas is an inert gas when blended with 99% by volume carbon dioxide and is used to prevent molten magnesium from burning in the absence of chloride fluxes. This gas is critical in ingot casting; dc casting and high pressure die casting. Although this gas is inert, it is considered have an extreme effect on the ozone layer, and is targeted for replacement by the magnesium industry.

Proposed Methods of Control, Disposal, and Storage

CO2 (Carbon Dioxide) Integral part of the process, no control required.

Dolomitic Dust ($\text{MgO} \cdot \text{CaO}$) Process emissions will be controlled by standard cyclone and bag house technology. Present standards are 4.4 kg/t of product produced. Additional controls can be placed to reduce -10 micron emissions, if required, to minimize health risks.

Magnesium Process Residue This is major process waste. Storage should be in a location, which will have minimal impact on surface and underground aquifers. Since the major constituent of this waste is Ca_2SiO_4 , local cement companies can add up to 10% by weight to clinker production.

Magnesium Sludge Storage of this waste must be restricted from impacting surface or underground aquifers. No secondary use is known at this time.

Waste Oils It is recommended that all oil and lubricant wastes be fed to the kilns as supplemental fuel or expedited to a regional oil treatment center.

SF6 It is recommended that substitution with a non-green-house gas is adopted when technology permits.

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Toronto, Canada

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