



Supplemental Environmental Assessment

**Sapphire Integrated Algal
Bio-Refinery (IABR) Facility
Columbus, New Mexico**

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**SUPPLEMENTAL
ENVIRONMENTAL
ASSESSMENT**

SAPPHIRE INTEGRATED ALGAL BIO-REFINERY (IABR) FACILITY

**Columbus
New Mexico**

JULY 2012

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PROJECT DESCRIPTION

Summary

Sapphire Energy, Inc. (Sapphire) proposes to modify the Operational Plan for the Integrated Algal Bio-Refinery (IABR) Facility located near Columbus, Luna County, New Mexico and their Pilot Processing Plant located in Las Cruces (Las Cruces Facility), Dona Ana County, New Mexico. An Environmental Assessment (EA) was prepared in 2009 (USDA 2009), describing the IABR Facility's proposed demonstration scale project and identifying potential impacts related to the construction of the IABR facility. Sapphire is proposing to temporarily modify the original Operational Plan for the IABR facility to include:

- 1) Temporary suspension of construction of oil extraction equipment at the IABR facility.
- 2) Shipment of de-watered algal biomass grown in the pond system at the IABR facility to the Pilot Processing Plant located in Las Cruces, New Mexico (**Figure 1**);
- 3) Transportation of dewatered algal biomass via tanker trucks from the IABR Facility to the Las Cruces Facility where oil extraction from the algae would occur (an increase of approximately 7 tanker trucks a day);
- 4) Transportation of solid and liquid wastes from the Las Cruces Facility to the IABR Facility in order to recycle these wastes back into the algal production (an increase of approximately 7 tanker trucks a day);
- 5) Shipment of extracted oil via tanker trucks from the Las Cruces Facility to a rail loading facility located in Las Cruces for shipment to a refinery for conversion into liquid fuels. This process has not changed from the original Operational Plan except that the extracted oil would be shipped from the Las Cruces Facility to a rail loading facility in Las Cruces instead of being shipped from the rail loading facility located in Deming; and
- 6) Modification of existing equipment and construction of new equipment at the Las Cruces Facility for oil extraction and additional tank storage, within the area of disturbance of the original Las Cruces Pilot Plant Facility construction.

Under this proposed modification, Sapphire will propagate, harvest and dewater algal biomass at the IABR facility in keeping with the original Operational Plan. However, harvested dewatered algal biomass would be transported via tanker truck to the Las Cruces facility located approximately 100 miles from Columbus instead of being extracted at the IABR Facility. Oil extraction from algae would occur at the Las Cruces Facility. Extracted oil would be shipped via tanker truck to a rail loading facility located in Las Cruces for shipment to a refinery for conversion into liquid fuels.

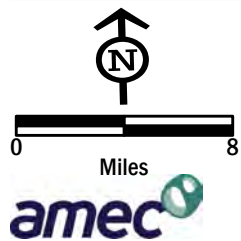
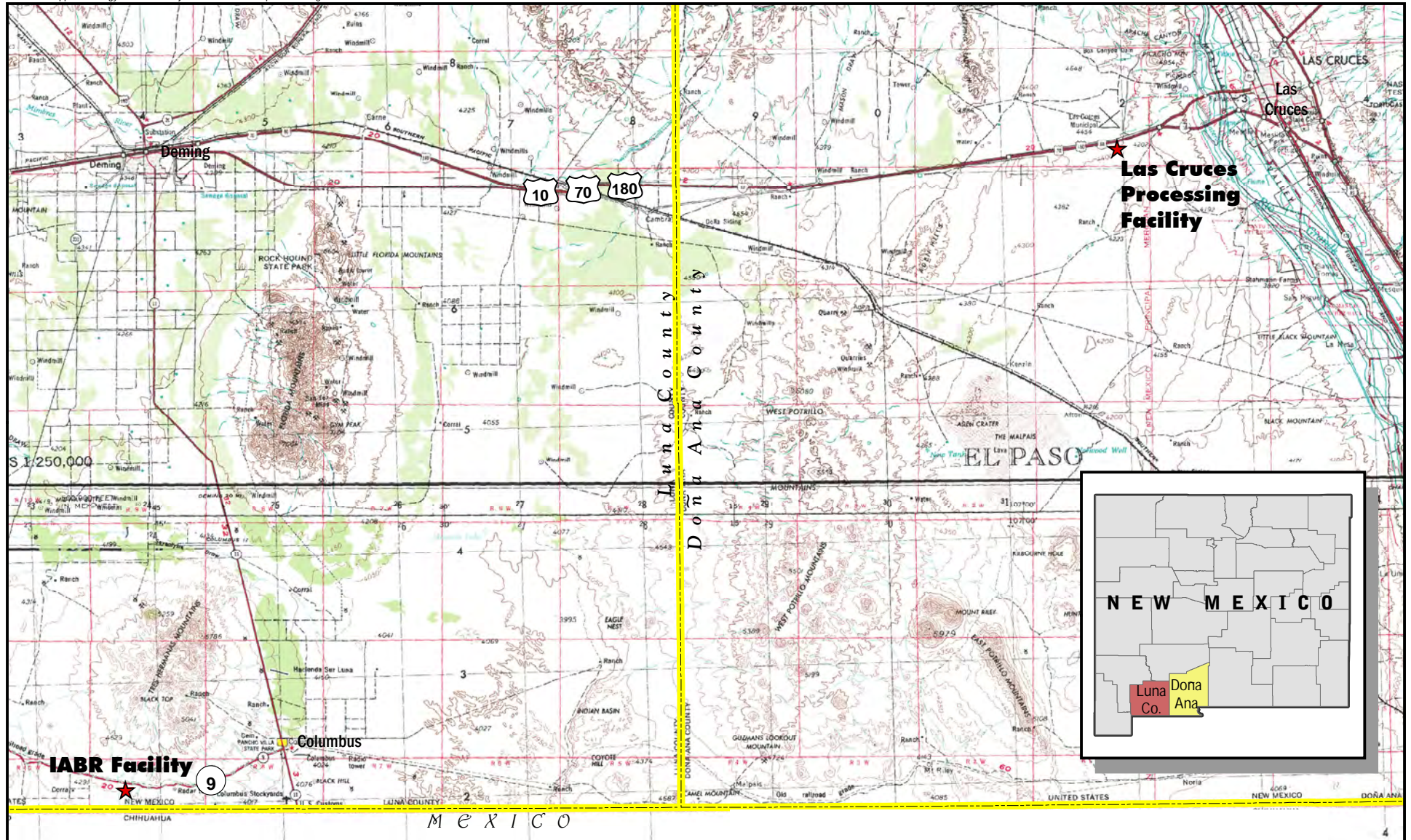
The IABR facility is designed to operate up to 300 acres of ponds which are capable of producing enough algae to support extraction of up to 100 barrels (bbl) of refined oil per day. These production rates have not been modified from that proposed under the original Operational Plan.

The types of algae used in the Sapphire Project, which are various strains of microalgae, have not been changed since the original Operational Plan. The original Operational Plan for the IABR Facility was to operate the algal production facility for a three-year test period beginning in 2012. The original Operational Plan allowed that, should additional time be required to obtain necessary data to support Project decisions, the IABR facility may be operated an additional two years. Under this modification operations at the IABR Facility and oil extraction operations at Las Cruces would occur for a three to five-year test period beginning in 2012, depending on the time needed to obtain the necessary data to support Project decisions.

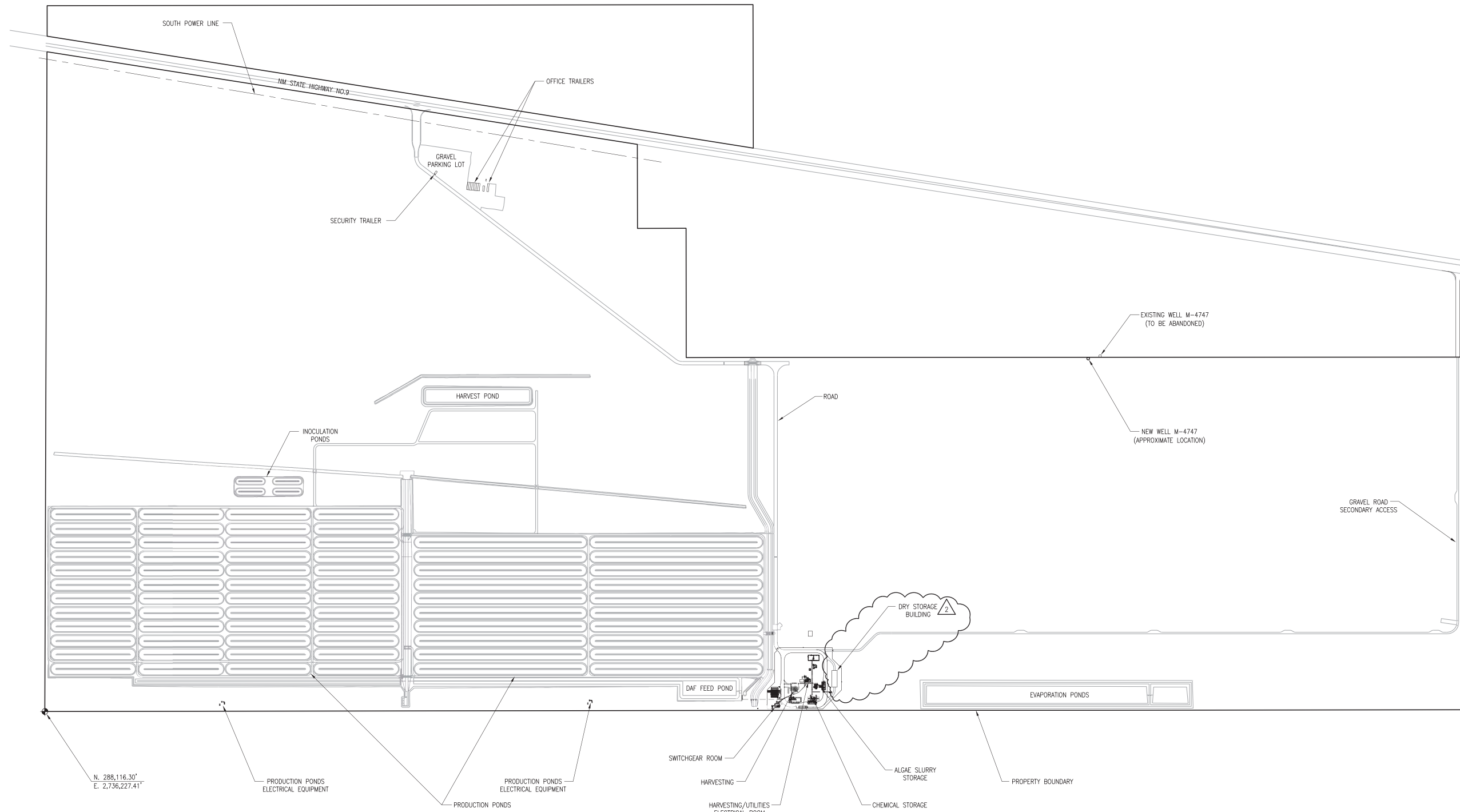
After the necessary data on the oil extraction process is obtained, oil extraction may be initiated at the IABR Facility within this 5-year time period. The EA for this proposal included an evaluation of the oil extraction process and equipment at the IABR Facility. If this oil extraction process is proposed for construction at the IABR facility those plans will be evaluated at that time to determine if a supplement to the EA is needed.

A site map of key components associated with the IABR facility, including approximately 300 acres of ponds at full build-out, is presented in **Figure 2**.

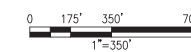
Figure 3 shows the current general site layout for Pilot Processing Plant facility at Las Cruces. Expansion of the facility under this modification would be required for oil extraction equipment and additional tank storage; however the revised footprint would not substantially increase the existing area of disturbance for the site (**Figure 4 - Proprietary Information**). The main modification of the Project is the location of the oil extraction process moving to the Las Cruces pilot plant facility as shown in the Process Flow Chart (**Figure 5 - Proprietary Information**).



Location Map
Integrated Algal Bio-Refinery
Luna and Dona Ana Counties, New Mexico
FIGURE 1



PLAN
1"=350'



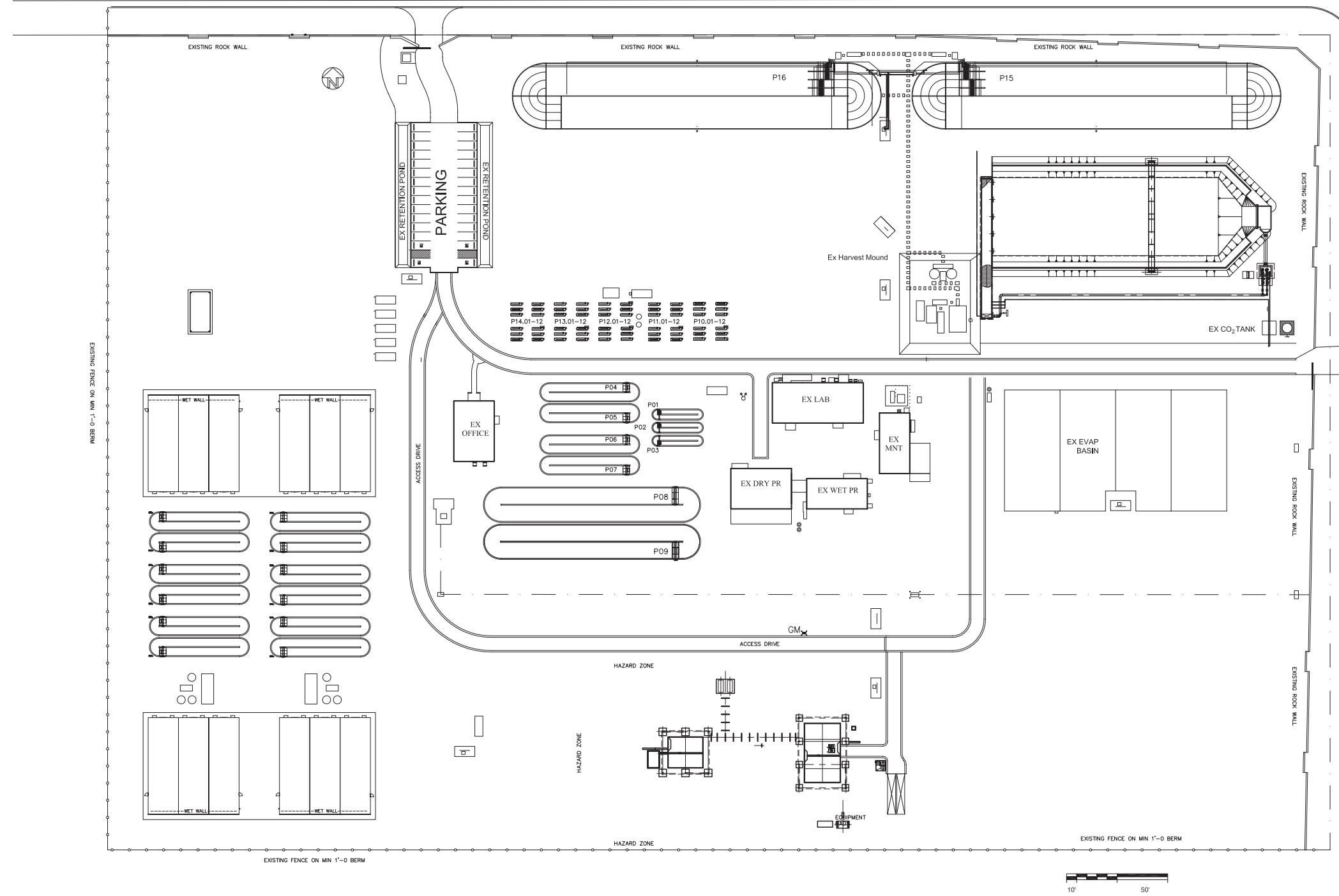
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Not To Scale

Site Features Map
Integrated Algal Bio-Refinery
Luna County, New Mexico
FIGURE 2

ADVANCEMENT AVE.

VENTURE DR.



Not To Scale

Existing General Layout for Las Cruces
Integrated Algal Bio-Refinery
Las Cruces, New Mexico
FIGURE 3

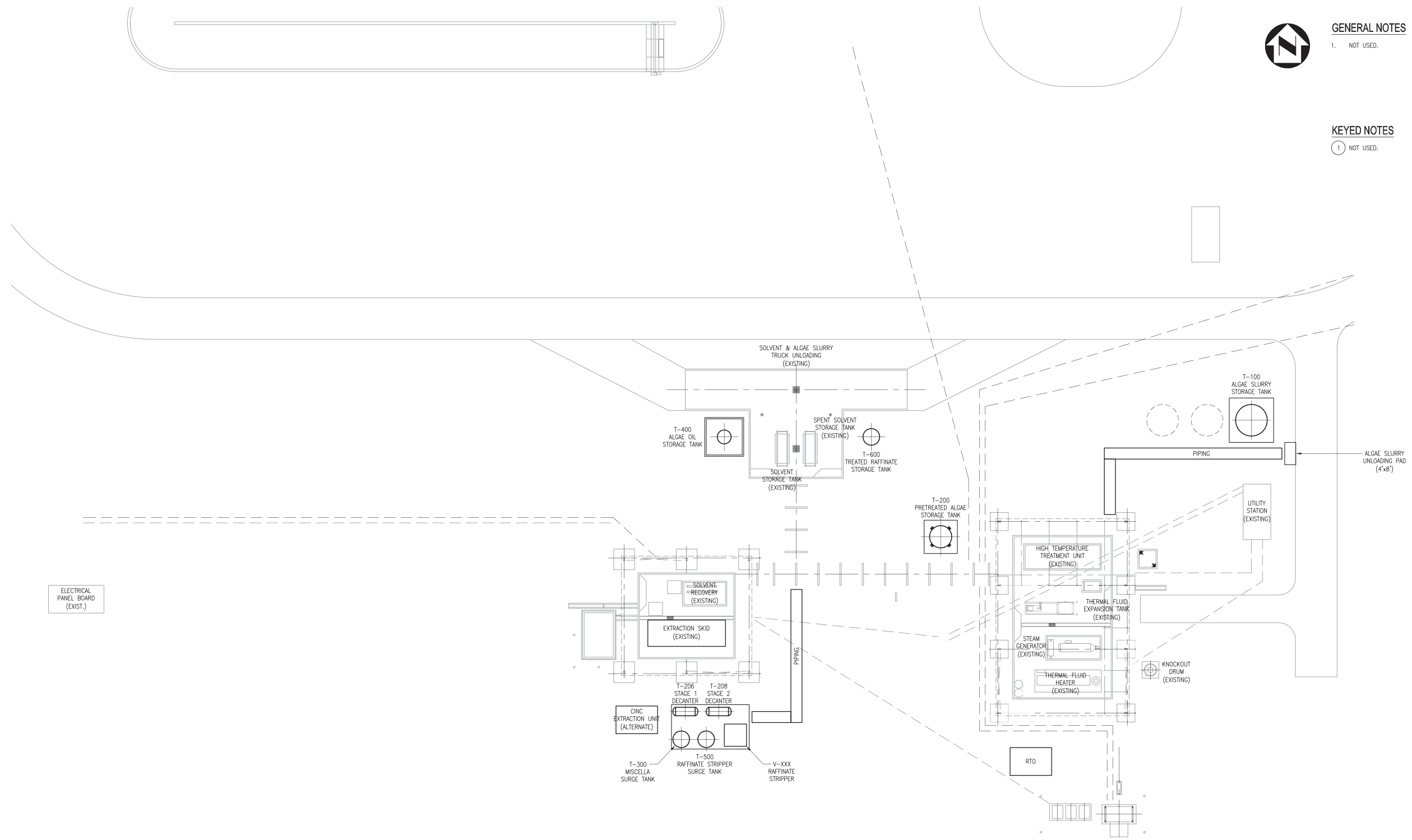


GENERAL NOTES

1. NOT USED.

KEYED NOTES

1. NOT USED.



ELECTRICAL PANEL BOARD (EXIST.)

PLAN
SCALE: 1/16"=1'-0"

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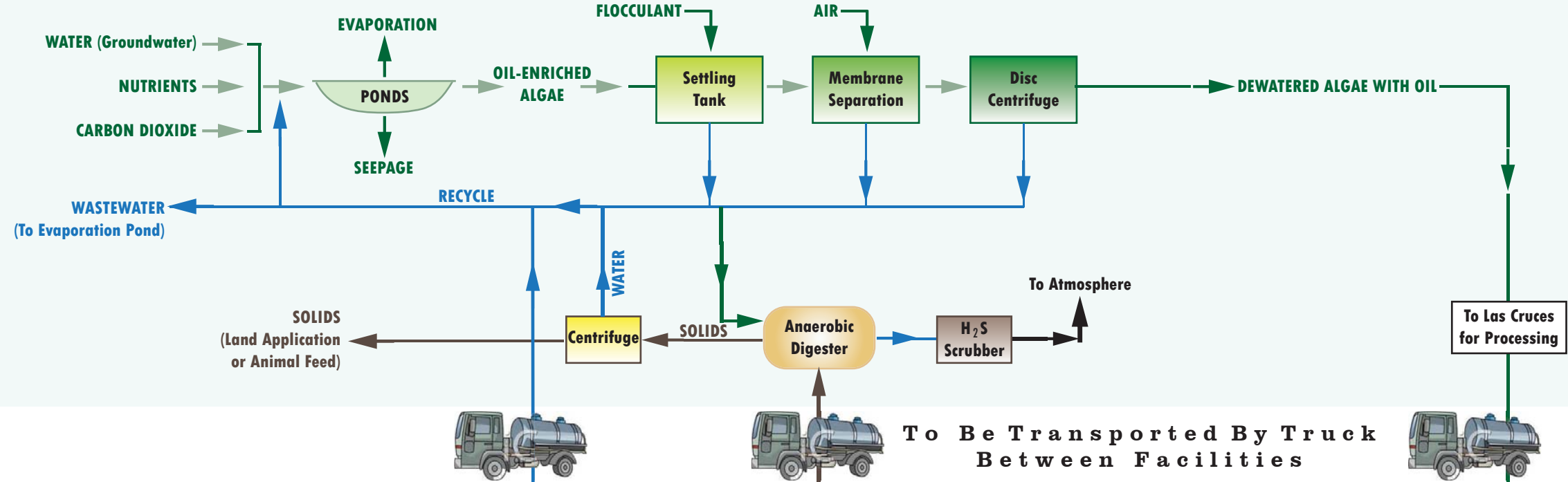
Not To Scale
Proprietary Information

Proposed General Layout Las Cruces
Integrated Algal Bio-Refinery
Las Cruces, New Mexico
FIGURE 4

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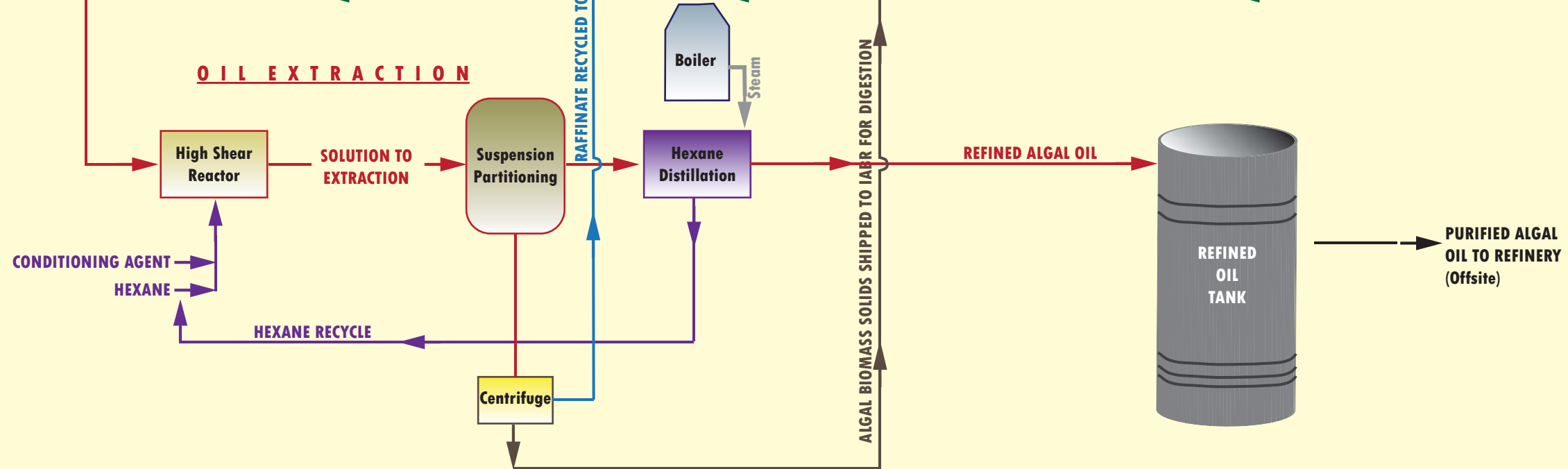
ALGAL GROWTH AND HARVESTING

WATER SEPARATION



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OIL EXTRACTION



Process Flow Diagram
Integrated Bio-Algal Bio-Refinery and
Las Cruces Processing Facility
Luna and Dona Ana Counties, New Mexico
FIGURE 5

PROCESS DESCRIPTION

This section identifies specific modifications that would occur to the process description included in the 2009 EA for the IABR Facility, as well as process description for the Pilot Processing Plant facility in Las Cruces.

Oil generation process generally involves four distinct sub-processes:

- Algae growth and harvesting;
- Algae/water separation;
- Oil extraction; and
- Oil refining.

Figure 5 (*Proprietary Information*) provides the general process to be used to produce refined fuel from algae. At the IABR Facility, algae will be grown in ponds, harvested, and separated from water. Dewatered algae would then be transported to the Las Cruces Facility for oil extraction. Extracted oil will be shipped via rail tanker cars located in Las Cruces to be refined at the Dynamic Fuels, LLC facility located in Geismar, Louisiana, which will operate under contract to Sapphire. The entire process will be engineered to recapture and reuse solid and aqueous waste streams to the greatest extent possible. Algae inoculum and solids, including majority of aqueous streams resulting from oil extraction process at the Las Cruces facility, would be transported back to the IABR facility in Columbus to be reintroduced as nutrient recycle or disposed of in evaporation ponds. One wastewater stream would be discharged to the concrete basins at the Las Cruces facility to evaporate liquids resulting from extraction and solvent recovery skids.

Algal Growth and Harvesting - IABR Facility

This modification proposes no change to the Operational Plan for algal growth and harvesting at the IABR Facility, other than recycling a smaller amount of wastewater back into the system. Since a portion of water would be taken out of the system during the oil extraction process and left at the Las Cruces Facility, the amount of water recycled back into the ponds for algal growth would be smaller. Other than this minor modification, the modified Operational Plan for algal growth and harvesting at the IABR Facility is consistent with the original Operational Plan at the IABR Facility. Algae will be grown in shallow ponds to maximize exposure to sunlight. Nutrients and carbon dioxide (CO₂) will be continually fed to influent water stream to the ponds. CO₂ and nutrient-enriched water will be circulated from one end of the ponds to the other to enhance algal growth and keep algae near water surface to improve harvesting. Algae-containing water will be constantly removed at the distal end of the pond for harvesting, water separation and oil extraction. CO₂ used in the process will be purchased from off-site sources and hauled by truck to the demonstration facility and stored on-site. Approximately 56 metric tons per day of carbon dioxide will be added to the ponds. At initial startup, approximately 60 percent of CO₂ added to the water will be consumed by algae, the remainder emitted to the atmosphere. As algal stock matures at the facility, efficiency of CO₂ consumption will increase.

Algae/Water Separation - IABR Facility

This modification proposes no change to the Operational Plan for algae/water separation at the IABR Facility, other than the transport of dewatered algae to the Las Cruces Facility for oil extraction. To

prepare algae for the oil extraction process, algae from the ponds will be dewatered by settling, membrane separation, and centrifuge separation. A flocculent is added to the settling tank to improve the settling process. The membrane system concentrates the algae. The centrifuge continues and intensifies the process of separation of water from algae. Water captured during settling, membrane, and centrifuge separation will be recycled back to the influent to the ponds, directly reducing the amount of make-up water required from the aquifer at the site. Periodically, a small portion of this recycled water will be directed to a lined evaporation pond to remove excess salt and metals that will tend to concentrate in the water stream. The frequency of diversion and the volume of water diverted to the evaporation pond will be dependent on chemical analysis of samples collected during operation of the IABR; the goal is to minimize discharge of water to the evaporation pond to the extent possible. Once the algae has been dewatered, it would be transported by tanker trucks to the Las Cruces facility. The transportation route for tanker trucks is described below.

Oil Extraction - Las Cruces Facility

This modification proposes a change in the:

- 1) Transport of dewatered algae to the Las Cruces Facility for oil extraction;
- 2) Location for the oil extraction process to Las Cruces Facility;
- 3) Transport of remaining biomass and water from the Las Cruces Facility back to the IABR Facility for recycling back into the on-site anaerobic digester;
- 4) Storage location of algal oil to the Las Cruces Facility;
- 5) Origination location of algal oil for the transport to Geismar, Louisiana.

Otherwise, the Operational Plan for oil extraction has not changed significantly from that which was proposed at the IABR Facility. Algal oil would be extracted in Las Cruces using a wet extraction process that utilizes hexane. Unused hexane would be recovered during the oil extraction process. Any remaining biomass from oil extraction process would be collected and shipped back to the IABR where it would be recycled into the on-site anaerobic digester. Algal oil extracted from biomass would be stored and transported daily off-site to a rail loading facility in Las Cruces for final refining at the Dynamic Fuels, LLC facility in Geismar, Louisiana.

Oil Refining - Geismar, Louisiana

This modification proposes no change to the Operational Plan for oil refining at the Dynamic Fuels Facility, other than origination location for shipment of algal oil at the rail loading facility, algal oil extracted from biomass at the Las Cruces facility would be refined at the existing Dynamic Fuels facility in Geismar, Louisiana. Dynamic Fuels is an independent company that operates its Louisiana facility under separate environmental and operating permits. The process used at the Dynamic Fuels facility will produce a green jet fuel in addition to a green diesel with a higher cetane value and lower cloud point than traditional diesel. The algal oil will be transported to a rail loading facility in Las Cruces, New Mexico then railed to the refinery in Geismar, Louisiana. This modification proposes a change from the original Operational Plan of the rail loading facility, from Deming, to Las Cruces for shipment of algal oil to Louisiana.

PROJECT COMPONENTS

IABR Facility - Columbus

Project components associated with the IABR facility will remain as described in the original Operational Plan and EA (USDA 2009); however, under this modified plan, full build-out of Project components at the IABR would be delayed pending results of processing algae at the Las Cruces Facility.

Pilot Processing Plant Facility - Las Cruces

Sapphire proposes to expand the Las Cruces Pilot Processing Plant Facility (**Figure 4 - *Proprietary Information***) to equip the facility to extract oil from algae transported from the IABR facility. **Figures 6 and 7** indicated proposed expansion areas in the Las Cruces Facility. In order to extract oil from a larger volume of algae from the IABR Facility, compared to its current pilot program volumes, the Las Cruces Facility would need to include the following:

- 1) Addition of tank storage for solvents, raffinate and algae slurry;
- 2) Addition of a cooling tower, a conveyor systems, and a thermal heater enclosure;
- 3) Expansion of extraction and raffinate solvent removal/recovery building; and
- 4) Total area of expansion would be approximately 2,000 square feet near existing structures and other site infrastructure.

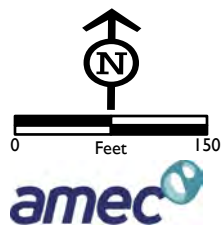
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Data Source: NAIP 2011

 Proposed Expansion to Las Cruces Site

Aerial View of Proposed Expansion
at Las Cruces Facility
Integrated Algal Bio-Refinery
Las Cruces, New Mexico
FIGURE 6





 Proposed Expansion Areas
To Las Cruces Site

Photograph of Land for Proposed Expansion
at Las Cruces Facility
Integrated Algal Bio-Refinery
Las Cruces, New Mexico
FIGURE 7

ENVIRONMENTAL IMPACTS

Transportation

Dewatered algae would be transported via 5,000-gallon tank trucks from the IABR Facility to the Las Cruces Facility for oil extraction. Trucks would transport solid waste and wastewater from Las Cruces back to the IABR Facility. Trucks would also transport algae inoculum from the Las Cruces Facility to the IABR Facility to charge inoculation ponds. It is estimated that 7 tanker truck loads per day would be used to transport dewatered algae oil from the IABR Facility to Las Cruces and 7 tanker truck loads per day would be used to transport waste and algae inoculum from Las Cruces back to the IABR Facility. Therefore, this modification proposes a cumulative increase of 14 trips (or 7 round trips) per day from the original Operational Plan. Transportation to and from the Project sites would occur along existing roads and infrastructure.

Table I summarizes the transportation pattern for the revised Project. An additional 7 roundtrips per day would be required to deliver the dewatered algae from the IABR site and transport the solid waste and wastewater back to the IABR Facility for recycling. One tanker truck of algal oil would be delivered daily to the rail loading facility in Las Cruces.

Table I Transportation Summary				
From	To	Material	Route	Daily Truck Roundtrip
IABR	Las Cruces	Dewatered Algae	Transport to follow a route initiating from the IABR site to State Highway 9, continuing on to State Highway 11 and East on Highway 10 to Las Cruces.	7
Las Cruces	IABR	Solid and Aqueous Waste including Algae Inoculum	Transport to follow route from site to Highway 10, continuing South on State Highway 11, and to IABR site via State Highway 9.	7
Las Cruces	Geismar, Louisiana	Algae Oil	Transport via railroad from the Las Cruces loadout to Dynamic Fuels processing facility in Geismar, Louisiana.	1 ¹
Linde Facility	IABR	CO ₂	Transport to follow a route initiating from Linde's CO ₂ production facility, entering the region on State Highway 9 and terminating at the IABR site.	2 ²
El Paso	Las Cruces	Hexane	Transport to follow route from El Paso, West on I-10 to Las Cruces	Less than 1 per day ³

¹ One train carrying algae oil produced by the Las Cruces site will travel to Louisiana per month. Shipments of algae oil would not change from original Operational Plan, and would include 1 tanker truck per day from Las Cruces to the rail loading facility.

² Number of shipments of CO₂ to the IABR would not change from original Operational Plan.

³ Shipments of hexane would not change from original Operational Plan.

This modification proposes a cumulative increase of 14 one way trips per day along existing state highways and roads/infrastructure, within areas that are already operating in an industrial use. This increased amount of traffic is not expected to have a significant impact on traffic patterns and is not

expected to have a significant impact to air quality from the additional expenditure of fossil fuels and exhaust generation. The New Mexico State Highway and Transportation Department has been advised of current estimate of trip frequencies presented in **Table I** however no comments have been received from the Department to date.

AIR QUALITY

IABR Facility

There are No Class I air quality airsheds (pristine quality airshed) located within 100 miles of the Project site. Air impacts associated with the IABR Facility and the Las Cruces Facility will be within guidelines included in New Mexico's air quality implementation plan and will comply with air quality standards within the region, including those administered by the government of Mexico. An air permit for the IABR Facility and the Las Cruces Facility will be obtained, if necessary, under New Mexico's Air Quality Control Act.

Determination of whether the facility will require a New Source Review air quality permit and/or a Clean Air Act (CAA) Title V permit will be completed when final design plans for the IABR are developed in concert with the State of New Mexico Air Quality Bureau (Bureau). Depending on level of emissions expected from the IABR, emissions may exceed the Potential to Emit (PTE) thresholds discussed in NMAC § 20.2.72.200 and a New Source Review (NSR) air quality permit may be necessary. The procedure for determining the necessity of a NSR permit requires the applicant to file emissions calculations for review by the Bureau.

Algae ponds will off-gas carbon dioxide and a small amount of particulate matter will emanate from the site; these emissions are not regulated or have been reviewed by New Mexico Environment Department (NMED) and found to be de-minimus.

Sapphire is planning to transport algae solids from the Las Cruces Facility back to the IABR Facility to treat algae solids after completion of oil removal. Once this equipment has been specified, it will be evaluated under the New Mexico guidance to determine if there are any associated impacts that may change the air permitting scenario at the IABR Facility.

Las Cruces Pilot Processing Plant

At present time, a No Permit Required determination has been made by NMED regarding the Pilot Processing Plant at Las Cruces. Under proposed modification to the Operational Plan, algae produced at the IABR Facility would be extracted at the Las Cruces Facility. Therefore, with this increased volume of oil extraction, the Las Cruces Facility would require a reassessment of air quality permit needs. Since volume of algae to be processed would increase under the modified Operational Plan, the present Las Cruces Facility would be increased by approximately 2,000 square-feet. Existing equipment would be expanded in size and numbers. Increased algal oil production would result in similarly increased emissions at the site.

If changes to the processing plant at Las Cruces result in increased emissions to air of criteria pollutants or Hazardous Air Pollutants (HAPS), such as hexane, in excess of de-minimus thresholds, Sapphire will apply to NMED for a New Source Permit, and for a Clean Air Act (CAA) Title V Permit only as needed. Sapphire is currently evaluating empirical data being generated at the Las Cruces Facility to develop data supporting the permit applications planned for submittal to NMED for review and action.

This modification does not propose a significant change from the original Operational Plan in emissions affecting air quality and will be monitored under existing state of New Mexico air quality regulations.

NATURAL ENVIRONMENT/LAND USE

This modification proposes no significant change to existing operations at the IABR Facility, and proposes new construction within and adjacent to existing infrastructure at the Las Cruces Facility. There is no new road construction, and traffic patterns would not be significantly disrupted. For these reasons the proposed modification to the Operational Plan is not expected to have a significant adverse effect to the natural environment or significantly change land use. **Figure 3** shows the current general site layout for Pilot Processing Plant Facility at Las Cruces.

Expansion of the facility under this modification would be required for oil extraction equipment and additional tank storage; however the revised footprint would not substantially increase the existing area of disturbance for the site (**Figure 4 - Proprietary Information**). **Figures 6** and **7** show the existing and proposed areas of disturbance for the site in aerial view. As shown in these aerial images, there are no known biological resources located within the existing area of disturbance and no land use changes would occur with proposed Project modifications. Based on the scale of proposed site changes and the nature of infrastructure changes (within and near existing facilities), it is not anticipated that formal notification is required to the State Historic Preservation Officer (SHPO) for New Mexico. **Figure 8** depicts the area FEMA Firmette which indicates the Las Cruces Facility is not within the 100-year or 500-year floodplains.

SITE ABANDONMENT AND CLOSURE

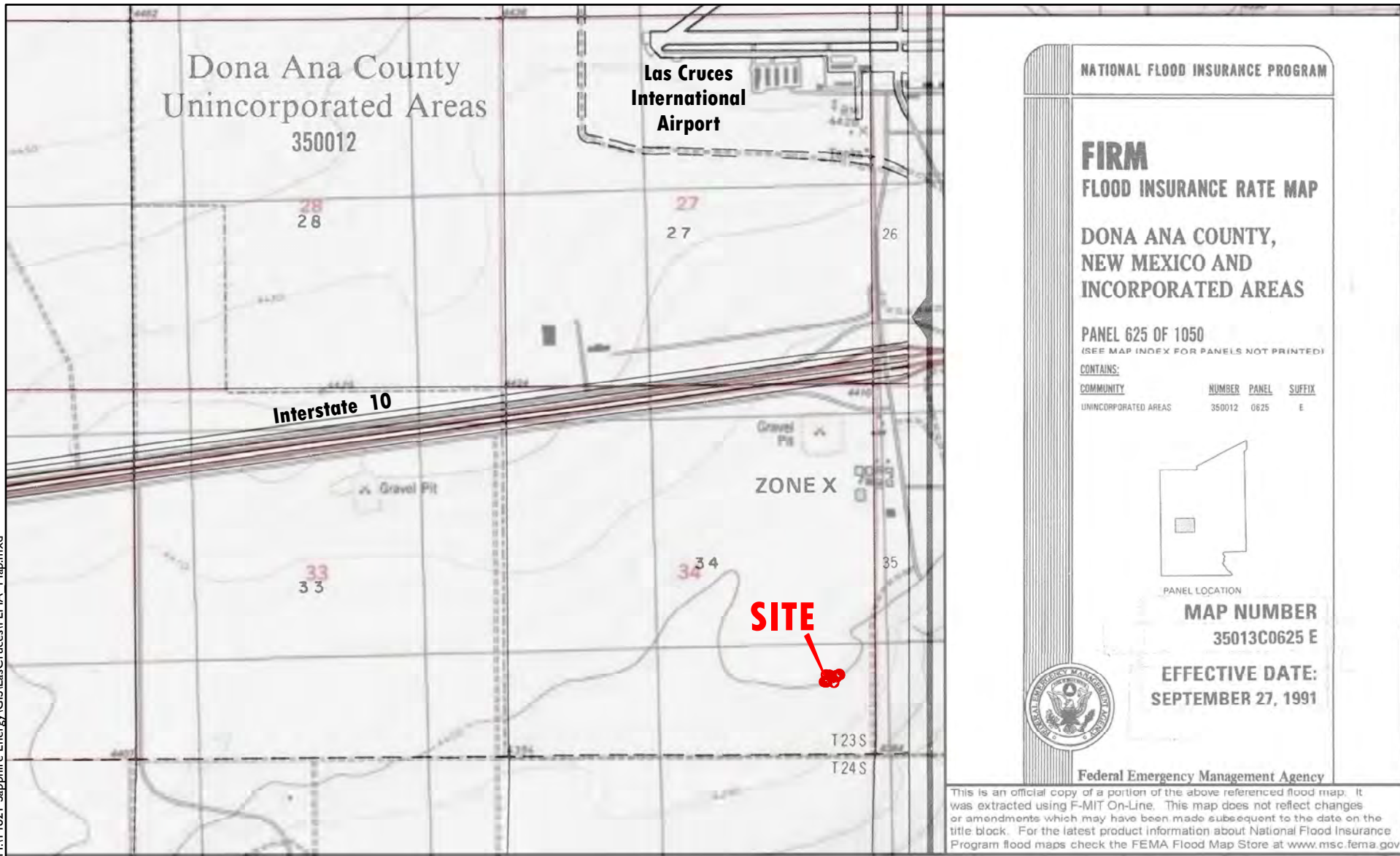
IABR Facility

Site abandonment and closure activities associated with the IABR Facility will be consistent with the description contained in the original EA for the IABR Facility.

Las Cruces Pilot Processing Plant

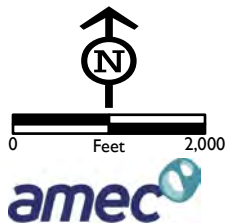
Processing equipment installed at the Las Cruces Facility would remain in service to provide for continued experimentation and refinement of algae processing methods. Decommissioning and closure of the facility would be addressed through compliance with state of New Mexico and local requirements.

H:\14821_Sapphire Energy\GIS\LasCruces\FEMA_Map.mxd



Data Source: FEMA, ESRI - NGS Topographic Map

Proposed Expansion to Las Cruces Site



**FEMA Firmette for Las Cruces Facility
Integrated Algal Bio-Refinery
Las Cruces, New Mexico
FIGURE 8**

WASTE MANAGEMENT

All solid and liquid waste will be managed at the IABR Facility, as outlined in the original Operational Plan (as described in the 2009 EA), with the exception of transport of waste stream from the Las Cruces Facility back to the IABR Facility for recycling. All solid and aqueous waste streams resulting from oil extraction process at Las Cruces will be transported from the Las Cruces Facility back to the IABR Facility. It is estimated that 7 tanker truck loads per day would be used to transport waste from the Las Cruces Facility back to the IABR Facility. There will be no anaerobic digester at the Las Cruces Facility. The anaerobic digester will be located at the IABR Facility as in the original Operational Plan. The size of the digester will remain unchanged from that described in the original EA.

CONCLUSIONS

- The quantity of algae oil produced will remain the same as in the original EA (up to 100 barrels of refined oil per day).
- Waste management practices will remain unchanged as all waste will be transported back to the IABR facility for disposal.
- Water use and water quality will remain the same as in the original EA.
- CO₂ input and consumption will remain unchanged from original EA, 300 acres of pond to produce 100 barrels/day.
- This modification does not propose a significant change from the original Operational Plan in emissions that would affect air quality at either site nor during the proposed transport of algae and products and will be monitored under existing state of New Mexico air quality regulations.
- The proposed modification to the Operational Plan is not expected to have a significant adverse effect to the natural environment or significantly change land use, at either site.
- The proposed modification to the Operational Plan is not expected to have a significant effect to the human environment.

REFERENCES

U.S. Department of Agriculture. 2009. Environmental Assessment for Sapphire Energy, Inc. Integrated Algal Biorefinery (IABR) Facility in Columbus, New Mexico. September.