EXHIBIT G
MATERIALS ANALYSIS

OAR 345-021-0010(1)(g)

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G.1 INTRODUCTION

This Exhibit provides an inventory of the industrial materials proposed for use during Madras Solar Energy Facility (Facility) construction and operation, and a description of how Madras PV1, LLC (Applicant) plans to manage hazardous and nonhazardous substances.

G.2 INDUSTRIAL MATERIALS ANALYSIS AND INVENTORY

OAR 345-021-0010(1)(g) *A materials analysis including:*

OAR 345-021-0010(1)(g)(A) *An inventory of substantial quantities of industrial materials flowing into and out of the proposed facility during construction and operation.*

Response: The primary industrial materials to be used during Facility construction and operation are rock and gravel aggregate, water, concrete, steel, and assorted electrical equipment, along with smaller quantities of other materials, including fuels and oils.

In addition to these construction materials, the Facility will include photovoltaic (PV) solar modules composed of poly- or mono-crystalline cells supported on galvanized steel and aluminum components. The modules are inert and will not introduce any hazardous materials to the Facility. The Applicant is considering one of two battery options – lithium-ion batteries or a flow battery technology. Materials used to construct the battery storage components include steel and concrete. Use of either battery option will introduce the metals and chemicals discussed in this Exhibit. Regardless of the technology selected, batteries will be manufactured offsite and will be shipped to the site as self-enclosed prefabricated modules, which will be installed and electrically connected onsite.

Battery storage is included in the Application for Site Certificate to enable the Applicant to implement this technology after the Site Certificate is issued. This is a common approach in the industry as battery technology continues to evolve. If the Applicant decides to include battery storage in the final design of the Facility, the type of battery storage technology, chemistry, and quantities will be determined at that time. More specifically, the Applicant will provide materials estimates to ODOE in coordination with relevant authorities, including the Jefferson County Fire District, once it is known which chemistry will be deployed and what quantity of batteries will be needed to achieve the desired storage duration. Until that point, it is not possible to determine which materials and in what quantities, including electrolyte solution and any solutions associated with fire suppression systems, might be present onsite. The Applicant will provide an estimate of both hazardous and nonhazardous materials before construction as a condition of approval of the Site Certificate.

Table G-1 presents a representative inventory of materials flowing into and out of the Facility during construction. Table G-2 presents a representative inventory of materials flowing into and out of the Facility during operation. The actual quantities may vary.

Construction will include: land clearing; minimal grading; installation of concrete foundations for a Facility substation; construction of the point of interconnection switching station; construction of pads for transformers, inverters, and battery storage containers (if needed); construction of an operations and maintenance (O&M) enclosure; installation of electrical controls and associated components; and construction of the three new points of access from SW Elk Drive as shown on the conceptual site plans (see Figures C-2A and C-2B). As described in Exhibit B, service roads are not anticipated to be required throughout the Facility, given that site conditions should allow the site to be accessible by maintenance vehicles year-round; however, the final configuration of any potential service roads will be determined in conjunction with Jefferson County Fire District #1.

During construction, temporary trailers and storage facilities will be required and most materials not in use will be stored in the temporary staging area. Industrial materials flowing into the Facility include fuels and lubricants associated with construction equipment, paints, and solvents. These materials will be stored within the temporary staging area. Oils, lubricants, paint, and solvents will be stored within covered containers such as work trailers and conex boxes to prevent incidental spills or drips from reaching the environment. Fuels will be stored in mobile, double-walled tanks to be parked in the construction staging area. The primary location for fueling will occur offsite at

local gas stations, and the mobile tanks will only be used to fuel equipment that cannot travel offsite (such as excavators). Onsite refueling will occur only within the staging areas.

The major categories of material that will be flowing into the Facility site are rock and gravel to be used in road and parking area construction. Water will be used in civil construction and site preparation including dust suppression and concrete production. The solar PV modules and steel racking will also be part of the material brought to the site. Depending on the foundation system, either aggregate for concrete or concrete will be brought into the Facility site.

For the proposed new 24-foot-wide private substation access road section and two other new 20-foot-wide private access road sections from SW Elk Drive, the Facility will require approximately 2,000 tons of aggregate consisting of rock and gravel. Gravel will be obtained from a local commercial gravel source. As described in Exhibit O, construction will require approximately 12.8 million gallons of water over the 9-month construction period. If water alone does not sufficiently address wind erosion or visible dust, the use of additives may be employed. Dust suppression additives will be chosen based on low environmental and human toxicity, such as polyacrylamide (PAM) or magnesium chloride. Both PAM and magnesium chloride are state and local agency-approved dust suppression best management practices, and are widely recognized in the construction industry as low-toxicity dust suppression additives.

The solar PV crystalline silicon modules measure approximately 3.3 feet wide by 6.6 feet long and will be mounted approximately 4 to 5 feet off the ground on a single-axis tracking system. Modules will be installed along with the rest of the associated components to each form 1.05-megawatt module blocks that are 6.4 feet wide and 400 feet long. The number of modules per block will be determined by the power ratings (in Watts) of the specific modules chosen prior to construction. Mounting racks or table frames for the solar PV modules will be constructed of galvanized steel. Each tracker table will be supported by steel posts; post depth will vary depending on soil conditions and the results of a detailed geotechnical investigation to be performed prior to construction. A typical post depth is approximately 8 feet below the ground surface for posts driven in soil. If significant rock is encountered, ground screws extending 4 to 5 feet below the ground surface may be used. If soil conditions require it, a ballasted design may be used for posts, wherein the tracking table will be mounted on foundations embedded in concrete blocks (ballasts) that will rest on the surface of the ground. For the purpose of this analysis, ballasted posts, a high water and concrete usage option, was assumed.

During operation, the Facility will use small amounts of paint, lubrication oils, transformer oil, and aqueous nonpetroleum-based solvents. Aqueous nonpetroleum-based solvents are water-based cleaners that have less than 5 percent volatile organic compounds. They clean by heat, agitation, or soap action rather than by dissolution.

Table G-1. Inventory of Materials to be Used During Facility Construction

Material/Chemical	Purpose	Estimated Quantity Used During Construction	Ultimate Disposition
Rock/gravel aggregate	Road construction material: • Approximately 300 tons for construction of a new, 20-foot-wide private access road sections • Approximately 1,700 tons for construction of a new, 24-foot-wide private access road section	2,000 tons	Permanent installation until the useful life of the Facility has expired
Water	Civil and site preparation	10.53 million gallons of water will be required primarily for dust control and road compaction	Evaporation or seepage into the ground
Water	Concrete – foundations for power conversion stations, point of interconnection, O&M enclosure, substation, and battery storage (if needed)	25,000 gallons	Chemically bonded into concrete during curing; permanent installation until useful life of the Facility has expired

Table G-1. Inventory of Materials to be Used During Facility Construction

Material/Chemical	Purpose	Estimated Quantity Used During Construction	Ultimate Disposition
Water	Drinking and sanitation	50,000 gallons of water	Licensed haulers will remove sewage from portable toilets
Water (if needed)	Concrete – ballasts for solar module trackers	2.2 million gallons of water will be needed for post ballasts.	Chemically bonded into concrete during curing; permanent installation until useful life of the Facility has expired
Concrete	Foundations for power conversion station, point of interconnection, O&M enclosure, substation, and battery storage (if needed)	200 cubic yards (assuming 1.5-foot thickness of foundation)	Permanent installation until useful life of the Facility has expired then recycle including belowground material within 3 feet of ground surface
Concrete (if needed)	Ballasts for solar module trackers	20,000 cubic yards (maximum, assuming 2 cubic feet per ballast)	Permanent installation – to remain onsite within 3 feet of ground surface after decommissioning of the Facility
Steel	Steel posts supporting solar modules	2,500 tons (approximately 50,000 posts, 100 pounds per post)	Permanent installation until useful life of the Facility has expired – to remain onsite within 3 feet of ground surface after decommissioning of the Facility
Steel	Battery storage containers (up to 120 containers) and battery racks for lithium-ion battery technology	225 tons (approximately 3,750 pounds per battery container)	Permanent installation until useful life of the Facility has expired
Solar PV modules, steel mounting racks, and steel trackers	Solar PV modules to generate electricity	The solar PV modules will be installed aboveground to form approximately 60 module blocks of approximately 1.05 MW of alternating current each. A full-sized row within a given array is 400 feet long and 1,960 millimeters (6.4 feet) wide, with approximately 8 feet of clear space between each row. The crystalline silicon modules themselves will be approximately 6.6 feet long by 3.3 feet wide and approximately 0.13 foot thick.	Permanent installation until useful life of the Facility has expired
34.5-kilovolt electrical cable (underground)	Solar PV underground collection cables	4 miles	Permanent installation until useful life of the Facility has expired – to remain onsite within 3 feet of ground surface after decommissioning of the Facility
Inverters	Convert direct current output from the PV modules into alternating current	19 inverters (aboveground)	Permanent installation until useful life of the Facility has expired
Transformers: main step-up, auxiliary station service transformer, and	Step-up voltage	21 transformers (aboveground) (19	Permanent installation until useful life of the Facility has expired

Table G-1. Inventory of Materials to be Used During Facility Construction

Material/Chemical	Purpose	Estimated Quantity Used During Construction	Ultimate Disposition
power conversion station (PCS) transformers		transformers with PCS and 2 with substation)	
Substation	Step-up voltage to 230 kV	Various aboveground pieces of equipment described in Section B.2 of Exhibit B	Permanent installation until useful life of the Facility has expired
Point of Interconnect	Interconnection of Facility with Portland General Electric (PGE) Pelton Dam to Round Butte 230-kV transmission line	Various aboveground pieces of equipment described in Section B.2 of Exhibit B	Permanent installation until useful life of the Facility has expired
O&M enclosure	Storage of materials and equipment needed for routine maintenance of the Facility	A single, 8.5-foot-tall, 320-square-foot dry-storage shed	Permanent installation until useful life of the Facility has expired
Solar area fencing	Security and safety for the Facility	Security fence, typically consisting of chain-link or notch-style fencing. The security fence will either be 6 feet tall with two strands of barbed wire, or 8 feet tall with no barbed wire	Permanent installation until useful life of the Facility has expired
Paint	Prime and finish painting	50 gallons	Unused paint to be recycled
Fuel	Construction vehicle use; stored onsite in double-walled containers	Up to 500 gallons	Consumed by construction vehicles
Heavy, medium, and light lubrication oils	Heavy and light equipment lubrication	6,000 gallons	Unused oil to be properly recycled or disposed as hazardous waste per Oregon Administrative Rules Chapter 340 Division 111
Ester oil	Pad-mounted transformer in each PCS	10,450 gallons (approximately 550 gallons of ester oil in each of the 19 step-up transformers as part of each PCS)	Ester oil is not hazardous waste and will be recycled if possible, or disposed of at an appropriate facility
Mineral oil	Generator step-up transformer (transformers in the substation)	8,000 gallons (transformers in the substation will have approximately 8,000 gallons of mineral oil)	Unused oil to be recycled if possible or disposed of at an appropriate facility pending waste determination
Aqueous nonpetroleum-based solvents	Cleaning of equipment	20 gallons	Unused solvent to be recycled if possible, or disposed of at an appropriate facility pending waste determination

Table G-2. Inventory of Materials to be Used During Facility Operation

Material/Chemical	Purpose	Estimated Quantity Used During Operation	Ultimate Disposition
Ester oil	Pad-mounted transformer in each PCS	10,450 gallons; approximately 550 gallons of ester oil in each of the 19 step-up transformers as part of each PCS	Ester oil is not hazardous waste and will be recycled if possible, or disposed of at an appropriate facility
Mineral oil	Generator step-up transformer (transformers in the substation)	8,000 gallons (transformers in the substation will have approximately 8,000 gallons of mineral oil)	Unused oil to be recycled if possible or disposed of at an appropriate facility pending waste determination
Light lubrication oil	Small equipment lubrication	50 gallons	Unused oil to be properly recycled or disposed as hazardous waste per Oregon Administrative Rules Chapter 340 Division 111
Water	Solar module cleaning	Approximately 1,650,000 gallons of water per year	Evaporation and infiltration into the ground
Aqueous nonpetroleum-based solvents	General cleaner	50 gallons	Unused solvent to be recycled if possible, or disposed of at an appropriate facility pending waste determination
Vehicle fuel	Maintenance vehicle use, such as Utility Task Vehicles	30 gallons per month	Unused fuels to be disposed of at an appropriate facility

G.3 HAZARDOUS SUBSTANCES

OAR 345-021-0010(1)(g)(B) *The applicant's plans to manage hazardous substances during construction and operation, including measures to prevent and contain spills.*

Response: During Facility construction and operation, it is expected that a minimal amount of hazardous materials will be generated. Hazardous materials are expected to consist of paint, spent oils, and solvents, as listed in Tables G-1 and G-2.

The hazardous materials required for Facility construction and maintenance will be stored in accordance with U.S. Environmental Protection Agency and U.S. Occupational Safety and Health Administration regulations, as applicable. Safety data sheets of each hazardous material will be stored onsite. Facility personnel will receive guidelines and will be trained on the handling, storage, transport, and disposal of hazardous materials.

The Facility will develop a hazardous materials spill prevention program. Hazardous materials will be stored inside and hazardous material containment and cleanup kits will be maintained and available onsite to minimize the impact resulting from a spill.

Disposal practices for hazardous waste materials will follow applicable regulations and will depend on the type of waste. Paint, oil, and solvents will be disposed of during the Jefferson County annual household hazardous waste event, or will be transported to Arlington Landfill.

Regarding battery storage, as stated in Section G.2, the Applicant will provide materials estimates to ODOE in coordination with relevant authorities, including the Jefferson County Fire District, once it is known which chemistry will be deployed and what quantity of batteries will be needed to achieve the desired storage duration. Until that point, it is not possible to determine which materials and in what quantities, including electrolyte solution and any solutions associated with fire suppression systems, might be present onsite. The Applicant will provide an estimate of both hazardous and nonhazardous materials before construction as a condition of approval of the Site Certificate.

G.4 NONHAZARDOUS WASTE MATERIALS

OAR 345-021-0010(1)(g)(C) *The applicant's plans to manage non-hazardous waste materials during construction and operation.*

Response: Solid waste generated during construction will include general construction debris such as scrap steel and packing materials from delivery of components, waste concrete, and excavated soil. Excavated soil will be used onsite as fill or transported offsite for disposal. Recycling programs will be implemented to the extent practical to reduce the volume of material that will be disposed of as solid waste, both during construction and Facility operation. General construction debris will be collected by a local contractor and transported to either Jefferson County Transfer Station or Arlington Landfill.

Waste concrete will be disposed of as solid waste, recycled, or used onsite as fill. Concrete truck chutes will be washed out in a dedicated area onsite, where the concrete will be allowed to harden.

Portable toilets will be provided for onsite sanitary waste management during construction and Facility operation. The portable toilets will be maintained by a local contractor. Water for the Facility will be trucked in and stored in an aboveground water tank.

Sanitary wastewater will be treated offsite. Solar panel and equipment washwater that contains no added cleaning solutions will be discharged by evaporation and seepage into the ground. Nonhazardous solid waste generated during operation will be recycled or disposed of as municipal waste, as described in Exhibit V.

G.5 SUMMARY

On the basis of the information presented above, the Applicant has satisfied the requirements of OAR 345-021-0010(1)(g).