

## Exhibit A WORK STATEMENT

### TECHNICAL TASK LIST

Task #	CPR	Task Name
1		Administration
2		Synthesize and Characterize Nanoadditives
3		Perform Screening Test
4		Perform Laboratory Dewatering Tests Using Los Angeles County Sanitation District (LACSD) Sludge
5		Perform Laboratory Tests with Sludge from Multiple Treatment Plants
6	X	Perform Field Demonstration at LACSD Facility in Carson, CA
7		Measurement and Verification Process by Local Electric Utility
8		Technology Transfer Activities
9		Production Readiness Plan

### KEY NAME LIST

Task #	Key Personnel	Key Subcontractor(s)	Key Partner(s)
1	Ganesh Rajagopalan – Kennedy/Jenks Consultant, Mathew Higgins - Bucknell University, Ganesh Skandan - NEI Corporation	--	Robert Morton - LACSD
2	Runquing Ou – NEI Corporation	--	--
3	Runquing Ou – NEI Corporation Ganesh Rajagopalan – Kennedy/Jenks Consultant	--	--
4	Mathew Higgins – Bucknell University Ganesh Rajagopalan – Kennedy/Jenks Consultant	--	--
5	Mathew Higgins – Bucknell University Ganesh Rajagopalan – Kennedy/Jenks Consultant	--	--
6	Ganesh Rajagopalan – Kennedy/Jenks Consultant Robert Morton - LACSD	--	--
7	Ganesh Rajagopalan - Kennedy/Jenks Consultant	Lory E. Larson, Southern California Edison	--
8-9	Ganesh Rajagopalan – Kennedy/Jenks Consultant	--	--

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## GLOSSARY

*Specific terms and acronyms used throughout this scope of work are defined as follows:*

<b>Term/ Acronym</b>	<b>Definition</b>
COD	Chemical Oxygen Demand
CPR	Critical Project Review
Energy Commission	California Energy Commission
JWPCP	Joint Water Pollution Control Plant
LACSD	Los Angeles County Sanitation District
PAC	Project Advisory Committee
PIER	Public Interest Energy Research
RD&D	Research, Development and Demonstration

### **Problem Statement:**

Wastewater treatment consumes about 2000 million kilowatt hours per year in California. Approximately 40% of this energy use is for sludge treatment and disposal. One reason sludge treatment is energy intensive is the large amounts of energy required to remove water after aeration. Water removal is required to lower the volume to reduce hauling and disposal costs. Facilities ship the sludge hundreds of miles by truck for disposal, which significantly increases the carbon footprint of wastewater treatment in addition to the energy used to dewater the sludge.

### **Goals of the Agreement:**

The goal is to improve energy efficiency and reduce the carbon footprint of sludge dewatering/disposal during wastewater treatment. This will be achieved using innovative nanoscale additives during polymer-aided dewatering. A field demonstration study will be performed at Los Angeles County Sanitation District (LACSD), Joint Water Pollution Control Plant (JWPCP) in Carson, CA.

### **Objectives of the Agreement:**

The objectives are to:

- i) Develop and characterize nanoscale additives for dewatering;
- ii) Identify the nanoadditive composition (single or in combination) best suited for different sludges;
- iii) Demonstrate through lab and field studies improvement in energy efficiency during dewatering, reduction in sludge mass (i.e. increase in percent solids) requiring disposal, improvement in supernatant quality, reduction in polymer dose requirement; and
- iv) Develop preliminary cost estimates to show economic viability of the proposed technologies.

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## **Product Guidelines:**

For complete product guidelines, refer to Section 5 in the Terms and Conditions.

## **TASK 1 ADMINISTRATION**

### **Task 1.1 Attend Kick-off Meeting**

The goal of this task is to establish the lines of communication and procedures for implementing this Agreement.

#### **The Recipient shall:**

- Attend a “Kick-Off” meeting with the Energy Commission Project Manager, the Grants Officer, and a representative of the Accounting Office. The Recipient shall bring its Project Manager, Agreement Administrator, Accounting Officer, and others designated by the Energy Commission Project Manager to this meeting. The administrative and technical aspects of this Agreement will be discussed at the meeting. Prior to the kick-off meeting, the Energy Commission Project Manager will provide an agenda to all potential meeting participants.

The administrative portion of the meeting shall include, but not be limited to, the following:

- Discussion of the terms and conditions of the Agreement
- Discussion of Critical Project Review (Task 1.2)
- Match fund documentation (Task 1.6)
- Permit documentation (Task 1.7)

The technical portion of the meeting shall include, but not be limited to, the following:

- The Energy Commission Project Manager’s expectations for accomplishing tasks described in the Scope of Work
- An updated Schedule of Products
- Discussion of Progress Reports (Task 1.4)
- Discussion of Technical Products (Product Guidelines located in Section 5 of the Terms and Conditions)
- Discussion of the Final Report (Task 1.5)

#### **The Energy Commission Project Manager shall:**

- Designate the date and location of this meeting.

#### **Recipient Products:**

- Updated Schedule of Products (no draft)
- Updated List of Match Funds (no draft)
- Updated List of Permits (no draft)

#### **Energy Commission Project Manager Product:**

- Kick-Off Meeting Agenda (no draft)

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## **Task 1.2 Critical Project Review (CPR) Meetings**

The goal of this task is to determine if the project should continue to receive Energy Commission funding to complete this Agreement and to identify any needed modifications to the tasks, products, schedule or budget.

CPRs provide the opportunity for frank discussions between the Energy Commission and the Recipient. CPRs generally take place at key, predetermined points in the Agreement, as determined by the Energy Commission Project Manager and as shown in the Technical Task List above. However, the Energy Commission Project Manager may schedule additional CPRs as necessary, and any additional costs will be borne by the Recipient.

Participants include the Energy Commission Project Manager and the Recipient and may include the Commission Grants Officer, the Public Interest Energy Research (PIER) Program Team Lead, other Energy Commission staff and Management as well as other individuals selected by the Energy Commission Project Manager to provide support to the Energy Commission.

### **The Energy Commission Project Manager shall:**

- Determine the location, date, and time of each CPR meeting with the Recipient. These meetings generally take place at the Energy Commission, but they may take place at another location.
- Send the Recipient the agenda and a list of expected participants in advance of each CPR. If applicable, the agenda shall include a discussion on both match funding and permits.
- Conduct and make a record of each CPR meeting. One of the outcomes of this meeting will be a schedule for providing the written determination described below.
- Determine whether to continue the project, and if continuing, whether or not modifications are needed to the tasks, schedule, products, and/or budget for the remainder of the Agreement. Modifications to the Agreement may require a formal amendment (please see the Terms and Conditions). If the Energy Commission Project Manager concludes that satisfactory progress is not being made, this conclusion will be referred to the Energy Commission's Research, Development and Demonstration (RD&D) Policy Committee for its concurrence.
- Provide the Recipient with a written determination in accordance with the schedule. The written response may include a requirement for the Recipient to revise one or more product(s) that were included in the CPR.

### **The Recipient shall:**

- Prepare a CPR Report for each CPR that discusses the progress of the Agreement toward achieving its goals and objectives. This report shall include recommendations and conclusions regarding continued work of the projects. This report shall be submitted along with any other products identified in this

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scope of work. The Recipient shall submit these documents to the Energy Commission Project Manager and any other designated reviewers at least 15 working days in advance of each CPR meeting.

- Present the required information at each CPR meeting and participate in a discussion about the Agreement.

### **Energy Commission Project Manager Products:**

- Agenda and a list of expected participants (no draft)
- Schedule for written determination (no draft)
- Written determination (no draft)

### **Recipient Product:**

- CPR Report(s) (no draft)

### **Task 1.3 Final Meeting**

The goal of this task is to closeout this Agreement.

### **The Recipient shall:**

- Meet with Energy Commission staff to present the findings, conclusions, and recommendations. The final meeting must be completed during the closeout of this Agreement.

This meeting will be attended by, at a minimum, the Recipient, the Commission Grants Office Officer, and the Energy Commission Project Manager. The technical and administrative aspects of Agreement closeout will be discussed at the meeting, which may be two separate meetings at the discretion of the Energy Commission Project Manager.

The technical portion of the meeting shall present an assessment of the degree to which project and task goals and objectives were achieved, findings, conclusions, recommended next steps (if any) for the Agreement, and recommendations for improvements. The Energy Commission Project Manager will determine the appropriate meeting participants.

The administrative portion of the meeting shall be a discussion with the Energy Commission Project Manager and the Grants Officer about the following Agreement closeout items:

- What to do with any equipment purchased with Energy Commission funds (Options)
- Energy Commission's request for specific "generated" data (not already provided in Agreement products)
- Need to document Recipient's disclosure of "subject inventions" developed under the Agreement
- "Surviving" Agreement provisions, such as repayment provisions and confidential Products

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- Final invoicing and release of retention
- Prepare a schedule for completing the closeout activities for this Agreement

### **Products:**

- Written documentation of meeting agreements (no draft)
- Schedule for completing closeout activities (no draft)

### **Task 1.4 Monthly Progress Reports**

The goal of this task is to periodically verify that satisfactory and continued progress is made towards achieving the research objectives of this Agreement on time and within budget.

The objectives of this task are to summarize activities performed during the reporting period, to identify activities planned for the next reporting period, to identify issues that may affect performance and expenditures, and to form the basis for determining whether invoices are consistent with work performed.

### **The Recipient shall:**

- Prepare a Monthly Progress Report which summarizes all Agreement activities conducted by the Recipient for the reporting period, including an assessment of the ability to complete the Agreement within the current budget and any anticipated cost overruns. Each progress report is due to the Energy Commission Project Manager within 10 days of the end of the reporting period. The recommended specifications for each progress report are contained in Exhibit A, Attachment A-2.

### **Product:**

- Monthly Progress Reports (no draft)

### **Task 1.5 Final Report**

The goal of the Final Report is to assess the project's success in achieving its goals and objectives, advancing science and technology, and providing energy-related and other benefits to California.

The objectives of the Final Report are to clearly and completely describe the project's purpose, approach, activities performed, results, and advancements in science and technology; to present a public assessment of the success of the project as measured by the degree to which goals and objectives were achieved; to make insightful observations based on results obtained; to draw conclusions; and to make recommendations for further RD&D projects and improvements to the PIER project management processes.

The Final Report shall be a public document. If the Recipient has obtained confidential

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status from the Energy Commission and will be preparing a confidential version of the Final Report as well, the Recipient shall perform the following activities for both the public and confidential versions of the Final Report.

### **The Recipient shall:**

- Prepare an Outline of the Final Report.
- Prepare a Final Report following the approved outline and the latest version of the PIER Final Report guidelines published on the Energy Commission's website at <http://www.energy.ca.gov/contracts/pier/contractors/index.html> at the time the Recipient begins performing this task, unless otherwise instructed in writing by the Energy Commission Project Manager. Instead of the timeframe listed in the Product Guidelines located in Section 5 of the Terms and Conditions, the Energy Commission Project Manager shall provide written comments on the Draft Final Report within fifteen (15) working days of receipt. The Final Report must be completed on or before the end of the Agreement Term.
- Submit one bound copy of the Final Report with the final invoice.

### **Products:**

- Draft Outline of the Final Report
- Final Outline of the Final Report
- Draft Final Report
- Final Report

### **Task 1.6 Identify and Obtain Matching Funds**

The goal of this task is to ensure that the match funds planned for this Agreement are obtained for and applied to this Agreement during the term of this Agreement.

The costs to obtain and document match fund commitments are not reimbursable through this Agreement. Although the PIER budget for this task will be zero dollars, the Recipient may utilize match funds for this task. Match funds shall be spent concurrently or in advance of PIER funds for each task during the term of this Agreement. Match funds must be identified in writing and the associated commitments obtained before the Recipient can incur any costs for which the Recipient will request reimbursement.

### **The Recipient shall:**

- Prepare a letter documenting the match funding committed to this Agreement and submit it to the Energy Commission Project Manager at least 2 working days prior to the kick-off meeting. If no match funds were part of the proposal that led to the Energy Commission awarding this Agreement and none have been identified at the time this Agreement starts, then state such in the letter. If match funds were a part of the proposal that led to the Energy Commission awarding this Agreement, then provide in the letter a list of the match funds that identifies the:
  - Amount of each cash match fund, its source, including a contact name,

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address and telephone number and the task(s) to which the match funds will be applied

- Amount of each in-kind contribution, a description, documented market or book value, and its source, including a contact name, address and telephone number and the task(s) to which the match funds will be applied. If the in-kind contribution is equipment or other tangible or real property, the Recipient shall identify its owner and provide a contact name, address and telephone number, and the address where the property is located
- Provide a copy of the letter of commitment from an authorized representative of each source of cash match funding or in-kind contributions that these funds or contributions have been secured.
- Discuss match funds and the implications to the Agreement if they are reduced or not obtained as committed, at the kick-off meeting. If applicable, match funds will be included as a line item in the progress reports and will be a topic at CPR meetings.
- Provide the appropriate information to the Energy Commission Project Manager if during the course of the Agreement additional match funds are received.
- Notify the Energy Commission Project Manager within 10 days if during the course of the Agreement existing match funds are reduced. Reduction in match funds must be approved through a formal amendment to the Agreement and may trigger an additional CPR.

### **Products:**

- A letter regarding match funds or stating that no match funds are provided (no draft)
- Copy(ies) of each match fund commitment letter(s) (if applicable) (no draft)
- Letter(s) for new match funds (if applicable) (no draft)
- Letter that match funds were reduced (if applicable) (no draft)

### **Task 1.7 Identify and Obtain Required Permits**

The goal of this task is to obtain all permits required for work completed under this Agreement in advance of the date they are needed to keep the Agreement schedule on track.

Permit costs and the expenses associated with obtaining permits are not reimbursable under this Agreement. Although the PIER budget for this task will be zero dollars, the Recipient shall budget match funds for any expected expenditures associated with obtaining permits. Permits must be identified in writing and obtained before the Recipient can make any expenditures for which a permit is required.

### **The Recipient shall:**

- Prepare a letter documenting the permits required to conduct this Agreement and

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submit it to the Energy Commission Project Manager at least 2 working days prior to the kick-off meeting. If there are no permits required at the start of this Agreement, then state such in the letter. If it is known at the beginning of the Agreement that permits will be required during the course of the Agreement, provide in the letter:

- A list of the permits that identifies the:
  - Type of permit
  - Name, address and telephone number of the permitting jurisdictions or lead agencies
- The schedule the Recipient will follow in applying for and obtaining these permits.
- Discuss the list of permits and the schedule for obtaining them at the kick-off meeting and develop a timetable for submitting the updated list, schedule and the copies of the permits. The implications to the Agreement if the permits are not obtained in a timely fashion or are denied will also be discussed. If applicable, permits will be included as a line item in the Progress Reports and will be a topic at CPR meetings.
- If during the course of the Agreement additional permits become necessary, provide the appropriate information on each permit and an updated schedule to the Energy Commission Project Manager.
- As permits are obtained, send a copy of each approved permit to the Energy Commission Project Manager.
- If during the course of the Agreement permits are not obtained on time or are denied, notify the Energy Commission Project Manager within 10 days. Either of these events may trigger an additional CPR.

### **Products:**

- Letter documenting the permits or stating that no permits are required (no draft)
- A copy of each approved permit (if applicable) (no draft)
- Updated list of permits as they change during the term of the Agreement (if applicable) (no draft)
- Updated schedule for acquiring permits as changes occur during the term of the Agreement (if applicable) (no draft)

## **TECHNICAL TASKS**

### **TASK 2 SYNTHESIZE AND CHARACTERIZE NANOADDITIVES**

The goal of this task is to synthesize and characterize nanoscale additives to enhance sludge dewatering. The nanomaterials will vary in composition (e.g. silica, alumina, bimetallic), configuration, charge, size, and pore structure. The differences in composition will impact polymer – sludge interactions.

### **The Recipient shall:**

- Synthesize a variety of nanoscale additives (up to 12)

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- Characterize nanomaterials for size, charge, shape and configuration
- Prepare a Memorandum on Nanoadditives Characteristics for 12 different nanoadditives.

### **Products:**

- Nanoadditives Characteristics Memorandum (no draft)

### **TASK 3 PERFORM SCREENING TEST**

The goal of this task is to select six nanomaterials or a combination of nanomaterials for detailed laboratory dewatering evaluation. These nanomaterials will be added individually or in combination to sludge samples obtained from LACSD. The sludge samples mixed with the nanomaterials will be settled and visually evaluated for supernatant clarity, settled-solid volume, and thickness.

### **The Recipient shall:**

- Perform a screening test using sludge samples from LACSD
- Add nanomaterials individually or in combination to sludge samples
- Vary sequence of nanomaterial(s) and polymer addition
- Evaluate supernatant clarity, settled sludge volume, and sludge texture
- Prepare a Screening Test Results Memorandum discussing the impact of six nanomaterials or combination of nanomaterials on sewage sludge samples

### **Products:**

- Screening Test Results Memorandum (no draft)

### **TASK 4 PERFORM LABORATORY DEWATERING TESTS USING LACSD SLUDGE**

The goal of this task is to perform detailed dewatering studies using the six nanomaterials or combination of nanomaterials selected from Task 3. Sludge from LACSD will be used. The tests will measure dewatering efficiency (e.g. filtration rate, filtration time, specific resistance to filtration, capillary suction time), dewatered cake characteristics (e.g. percent solids, nanoadditive levels) and supernatant quality, chemical oxygen demand (COD), nanoscale particles count in supernatant). Dewatering efficiency of polymer-only treatment will be compared with nanoadditive enhanced polymer treatment.

### **The Recipient shall:**

- Perform a laboratory dewatering test using sludge samples from LACSD
- Determine nanoadditive concentration, sequence of addition, and mixing protocol for optimum dewatering
- Evaluate dewatering efficiency, supernatant quality and settled sludge characteristics using Standard Methods (APHA 2710 G)
- Estimate energy savings (kilowatt-hours or therms)
- Prepare a Laboratory Dewatering Tests Technical Memo documenting laboratory dewatering study results, including preliminary energy savings estimates, and

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dewatered sludge mass reduction estimates

### **Products:**

- Laboratory Dewatering Tests Technical Memorandum-LACSD samples (no draft)

### **TASK 5 PERFORM LABORATORY TESTS WITH SLUDGE FROM MULTIPLE TREATMENT PLANTS**

The goal of this task is to perform detailed dewatering studies using various nanomaterials and sludge from different wastewater treatment plants. Together with Task 3, the data from this Task will provide an overview of factors affecting the nanoadditive aided polymer dewatering process. This is critical to develop a broader plan for dewatering sludge from treatment plants using different treatment processes in California. All of the dewatering parameters listed in Task 4 will be evaluated.

### **The Recipient shall:**

- Perform a laboratory dewatering test using sludge samples from the wastewater treatment plants in Selinsgrove, Lewisburg, and Philadelphia PA. These plants are part of an ongoing Water Environmental Research Foundation study.
- Apply nanomaterials or a combination of nanomaterials selected from Task 3 to sludge samples for dewatering studies.
- Determine nanoadditive concentration, sequence of addition, and mixing protocol for optimum dewatering.
- Evaluate dewatering efficiency, supernatant quality and settled sludge characteristics using Standard Methods (APHA 2710 G).
- Estimate energy savings (kilowatt-hours or therms).
- Select four nanomaterials or a combination of nanomaterials for field study, based on results from Tasks 4 & 5.
- Prepare a written Technical Memo documenting laboratory dewatering test results, including preliminary energy savings estimates, dewatered sludge mass reduction estimates and polymer dose reduction estimates for each sludge sample and nanomaterial used.

### **Products:**

- Laboratory Dewatering Test Technical Memorandum–Pennsylvania Samples(no draft)

### **TASK 6 PERFORM FIELD DEMONSTRATION AT LACSD FACILITY IN CARSON, CA**

The goal of this task is to demonstrate the energy efficiency and carbon footprint reduction of the sludge dewatering process through field studies at LACSD JWPCP facility in Carson, CA. This test will be performed over eight weeks under different operating conditions.

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### **The Recipient shall:**

- Participate in a CPR as per Task 1.2 prior to any other work in Task 6.
- Perform a field dewatering test at the LACSD site over a period of eight weeks.
- Use four nanomaterials or a combination of nanomaterials for field demonstration.
- Vary operational conditions (e.g. mixing sequence, time, speed, feed location, nanoadditive and polymer dosage) for each nanoadditive/combination of nanoadditive.
- Measure filtration rate, optimum polymer dose, percent solids in the dewatered cake, supernatant COD, supernatant sub-micron particles count, and odor potential in the dewatered cake.
- Use a polymer-only control test for each operating condition.
- Measure energy use during polymer-only and “polymer + nanoadditive” treatment using the International Performance Measurement and Verification Protocol (IPMVP) Option B (to be performed independently by Southern California Edison in Task 7).
- Evaluate dewatering efficiency, supernatant quality and settled sludge characteristics using Standard Methods (APHA 2710G).
- Determine the nanomaterial / combination of nanomaterials that is most suited for LACSD sludge dewatering.
- Project the nanomaterial / combination of nanomaterials most suited for different types of sludges.
- Estimate the energy efficiency and carbon footprint reduction for various sludge treatment and disposal options (e.g. dewatering, thermal drying, biofilters, sludge hauling and other odor control measures) at LACSD.
- Perform a similar projection for different types of sludges (i.e. a simplified model for dewatering and energy efficiency estimate for different conditions).
- Estimate the energy savings using the proposed technology for the State of California.
- Prepare a Field Demonstration at LACSD Report documenting the nanomaterials or combination of nanomaterials most suited for LACSD sludge dewatering, projected nanomaterials or combination of nanomaterials most suited for different types of sludges, and an estimate of energy and carbon footprint reduction for various sludge treatment options (e.g. dewatering, thermal drying, biofilters, sludge hauling and other odor control measures) at LACSD.

### **Products:**

- Draft LACSD Field Demonstration Report
- Final LACSD Field Demonstration Report

### **TASK 7 MEASUREMENT AND VERIFICATION PROCESS BY LOCAL ELECTRIC UTILITY**

The goal of this task is to perform measurement and verification of energy savings by

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the proposed technology during field demonstration.

### **The Recipient shall:**

- Perform measurement and verification to validate energy savings during field demonstration according to the IPMVP identified in Task 6
- Prepare a Measurement and Verification Study Protocol Report discussing at a minimum the findings and energy use during polymer only and polymer + nanoadditive treatment.

### **Products:**

- Draft Measurement and Verification Protocol Report
- Final Measurement and Verification Protocol Report

## **TASK 8 TECHNOLOGY TRANSFER ACTIVITIES**

The goal of this task is to develop a plan to make the knowledge gained, experimental results and lessons learned available to key decision-makers.

### **The Recipient shall:**

- Prepare a Technology Transfer Plan. The plan shall explain how the knowledge gained in this project will be made available to the public. Conduct technology transfer activities in accordance with the Technology Transfer Plan. These activities shall be reported in the Progress Reports.

### **Products:**

- Draft Technology Transfer Plan
- Final Technology Transfer Plan

## **TASK 9 PRODUCTION READINESS PLAN**

The goal of the plan is to determine the steps that will lead to the manufacturing of the technologies developed in this project or to the commercialization of the project's results.

### **The Recipient shall:**

- Prepare a Production Readiness Plan. The plan shall include, as appropriate, but not be limited to:
  - Identification of critical production processes, equipment, facilities, personnel resources, and support systems.
  - Internal manufacturing facilities, as well as supplier technologies, capacity constraints imposed by the design under consideration, identification of design critical elements and the use of hazardous or non-recyclable materials. The product manufacturing effort may include "proof of production processes."
  - A projected "should cost" for the product when in production.

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- The expected investment threshold to launch the commercial product.
- An implementation plan to ramp up to full production.

### **Products:**

- Draft Production Readiness Plan
- Final Production Readiness Plan