

# Project Summary

Project: Spuds

Scenario: take 4

Type B: RNG Greenfield

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## Project Overview

Spuds is a Type B (RNG Greenfield) project located in Moses Lake, Washington, Grant County. Williams pipeline located on-site no easement required, Semi-arid high desert climate; cold winters with temperatures well below freezing; insulation and heating design considerations for digester and tanks processing 170,000 tons/year of Mixed food processing residuals (mostly potatoes, some fruit and vegetables) and 35,000 tons/year of Packaged food waste. The facility is designed to produce 748 SCFM of RNG. Total project cost is estimated at \$74,563 with annual operating expenses of \$6,108.

Feedstock Type	Volume	Unit
Mixed food processing residuals (mostly potatoes, some fruit and vegetables)	170,000	tons/year
Packaged food waste	35,000	tons/year

## Financial Returns (Key Metrics) — amounts in \$000s

Metric	Value	Metric	Value
IRR	N/A	Total CapEx	\$74,563
NPV @ 10%	(\$51,238)	ITC Proceeds	\$26,246
MOIC	0.4x	Total 20-Year Revenue	\$252,960
Payback Period	N/A	Avg Annual EBITDA	\$944

## Equipment Summary

Process	Equipment	Qty	Key Specs
Feedstock Receiving	Receiving Hopper / Tipping Floor	1	power: 5 HP, capacity: 842 TPD
Feedstock Preparation	Macerator / Grinder	1	power: 281 HP, throughput: 702 TPD
Feedstock Preparation	Depackaging Unit	1	power: 40 HP, rejectRate: 15-20 %
Equalization	Equalization Tank	1	power: 7 HP, volume: 192,305 gal
Equalization	Feed Heat Exchanger	1	duty: 20.70 MMBTU/hr, power: 2 HP
Digester Feed	Digester Feed Pump	2	tdh: 40 ft, power: 5 HP
Anaerobic Digestion	CSTR Anaerobic Digester	2	hrt: 25 days, power: 73 HP
Anaerobic Digestion	Digester Mixer	4	power: 37 HP, totalPower: 147 HP
Anaerobic Digestion	Digester Heating Boiler	1	duty: 26.92 MMBTU/hr, fuel: Natural gas / biogas
Solids-Liquid Separation	Decanter Centrifuge	1	power: 1,471 HP, cakeSolids: 28 %
Solids-Liquid Separation	Centrate Collection Tank	1	power: 3 HP, volume: 40,067 gal
Liquid Cleanup	Dissolved Air Flotation (DAF) Unit	1	power: 17 HP, flowRate: 55.6 GPM
Biogas Conditioning	Prodeval VALOGAZ® Condenser	2	model: VALOGAZ® FU 100 (800 SCFM) , power: 24 HP
Biogas Conditioning	Prodeval VALOGAZ® Blower	2	model: VALOGAZ® FU 200 (800 SCFM) , power: 40 HP

Process	Equipment	Qty	Key Specs
Biogas Conditioning	Prodeval VALOPACK® Activated Carbon Filter	2	model: VALOPACK® FU 300 (800 SCFM) , power: 2 HP

See Appendix for full list

## CapEx Summary (\$000s)

Item	Amount
Equipment Cost	\$47,853
Installation Cost	\$60,834
Contingency	\$4,563
Total Direct Cost	\$6,507
Engineering (0%)	\$0
Total Project Cost	\$74,563

## OpEx Summary (\$000s)

Item	Amount
Total Annual OpEx	\$6,108
Labor	\$1,800
Energy	\$0
Chemicals	\$613
Maintenance	\$0
Disposal	\$1,639

## Appendix A - Mass Balance Details

### Mass Balance Summary

Parameter	Value	Unit
Cake Solids	28	%
Daf Effluent	80,134	GPD
Rng Flow S C F M	513.6	SCFM
Vs Destroyed	115,041	lb VS/day
Daily Feed Rate	561.6	TPD
Dewatered Cake	156.1	TPD
Rng Production	748.4	MMBTU/day
Total V S Loading	198,346	lb VS/day
Biogas C H4 Content	60	%
Biogas Production	864.6	SCFM
Rng Production Annual	273,180	MMBTU/yr
Total Feedstock Input	205,000	TPY
Biogas Production Daily	1,245,056	SCFD

### Full Equipment List

Process	Equipment	Qty	Description	Design Basis
Feedstock Receiving	Receiving Hopper / Tipping Floor	1	Covered receiving area with tipping floor and receiving pit, 1,685 ton storage capacity	1.5x design throughput, 3-day covered storage
Feedstock Preparation	Macerator / Grinder	1	Twin-shaft macerator for particle size reduction to 10-20 mm	125% of design throughput for particle size reduction
Feedstock Preparation	Depackaging Unit	1	Mechanical depackaging for packaged food waste streams	Mechanical separation of packaging from organic fraction
Equalization	Equalization Tank	1	Insulated EQ tank with continuous mixing, 192,305 gal capacity	1.5 day retention, continuous mixing
Equalization	Feed Heat Exchanger	1	Shell-and-tube heat exchanger for feed pre-heating to digester temperature	Heat feed from ambient to 98°F mesophilic digester temperature
Digester Feed	Digester Feed Pump	2	Progressive cavity pump for digester feed (duty + standby)	Progressive cavity pump rated for high-solids slurry (duty + standby)
Anaerobic Digestion	CSTR Anaerobic Digester	2	Mesophilic CSTR digester with gas collection dome, 1,794,843 gal each	25-day HRT, mesophilic (98°F), 12% gas headspace
Anaerobic Digestion	Digester Mixer	4	Top-entry mechanical mixers for digester contents mixing	6 W/m³ mixing intensity, 2 mixers per digester
Anaerobic Digestion	Digester Heating Boiler	1	Hot water boiler for digester heating loop	Maintain digester at 98°F, 130% of steady-state heat loss
Solids-Liquid Separation	Decanter Centrifuge	1	High-solids decanter centrifuge, 490.2 TPD capacity	Decanter centrifuge with polymer conditioning
Solids-Liquid Separation	Centrate Collection Tank	1	Collection tank for centrifuge centrate before DAF treatment	0.5-day buffer between centrifuge and DAF
Liquid Cleanup	Dissolved Air Flotation (DAF) Unit	1	DAF unit for centrate polishing, 80,134 GPD capacity	3 gpm/ft² hydraulic loading, 90% TSS removal, 95% FOG removal
Biogas Conditioning	Prodeval VALOGAZ® Condenser	2	Refrigerated condenser for biogas moisture removal -- Prodeval FU 100 Drying module, 2 train(s)	Biogas cooling and moisture knockout to dew point

Process	Equipment	Qty	Description	Design Basis
Biogas Conditioning	Prodeval VALOGAZ® Blower	2	Positive displacement blower for biogas transport -- Prodeval FU 200 Blower module, 2 train(s)	Low-pressure transport at 2.32 psig outlet
Biogas Conditioning	Prodeval VALOPACK® Activated Carbon Filter	2	Activated carbon adsorption for H <sub>2</sub> S, siloxane, and VOC removal -- Prodeval FU 300 Filtration module, 2 train(s)	Lead-lag activated carbon configuration, 2 x 4 m <sup>3</sup> vessels per train
Biogas Conditioning	Prodeval Dust Filter	2	Particulate filter downstream of activated carbon to protect membrane system	Protection of downstream membrane modules from particulates
Gas Upgrading	Prodeval Mixing Bottle	1	Gas mixing vessel combining 2 conditioning train(s) before compression	Buffer vessel for flow equalization before membrane compressor
Gas Upgrading	Prodeval VALOPUR® Biogas Compressor	2	Multi-stage biogas compressor for membrane feed -- Prodeval FU 500 Purification module	Compression from 2.18 psig to 202 psig for membrane feed
Gas Upgrading	Prodeval VALOPUR® HP Filtration	1	High-pressure coalescing filter upstream of membrane modules	Protect membrane from oil and particulate carryover
Gas Upgrading	Prodeval VALOPUR® Membrane System	1	3-stage membrane separation for CO <sub>2</sub> removal and CH <sub>4</sub> enrichment -- Prodeval FU 500 Purification	3-stage membrane with 97% CH <sub>4</sub> recovery, product "e97% CH <sub>4</sub> "
Gas Upgrading	Prodeval VALOPUR® RNG Compressor	1	High-pressure compressor for RNG pipeline injection -- Prodeval FU 800 Compression module	Pipeline injection at 200 psig
Emergency Gas Management	Enclosed Flare	1	Enclosed ground flare sized for 951 SCFM (110% of max biogas)	110% of maximum biogas production, "e99.5% destruction"
Solids Management	Cake Storage / Loadout	1	Covered cake storage pad with front-end loader access	7-day cake storage capacity
Effluent Management	Effluent Storage Tank	1	Effluent storage tank, 240,401 gal (3-day storage)	3-day effluent storage before discharge/hauling

## Process Stages Detail

### Stage 1: Feedstock Receiving & Storage (receiving)

Parameter	Input	Output
flow Lb Per Day	1,089,726.0 lb/d	1,089,726.0 lb/d
flow Tons Per Day	561.6 TPD	-
total Solids Pct	19.3 %	-
flow Tons Per Year	205,000.0 TPY	-
total Solids Lb Per Day	210,034.0 lb/d	210,034.0 lb/d

### Stage 2: Feedstock Preparation (maceration)

Parameter	Input	Output
flow Lb Per Day	1,089,726.0 lb/d	1,089,726.0 lb/d
total Solids Pct	19.3 %	-
particle Size	-	15.0 mm

### Stage 3: Equalization Tank (equalization)

Parameter	Input	Output
flow G P D	128,203.0 GPD	128,203.0 GPD
flow Lb Per Day	1,089,726.0 lb/d	-
total Solids Pct	19.3 %	12.0 %

Parameter	Input	Output
temperature F	-	98.0 °F

#### Stage 4: Anaerobic Digestion (CSTR) (digester)

Parameter	Input	Output
flow G P D	128,203.0 GPD	-
flow Lb Per Day	1,089,726.0 lb/d	-
total Solids Lb Per Day	210,034.0 lb/d	-
volatile Solids Lb Per Day	198,346.0 lb/d	-
biogas Flow	-	864.6 SCFM
biogas Scfd	-	1,245,056.0 SCFD
ch4 Content	-	60.0 %
co2 Content	-	40.0 %
h2s Content	-	1,500.0 ppmv
digestate Ts Pct	-	8.0 %
biogas Mmbtu Per Day	-	756.0 MMBTU/day
digestate Lb Per Day	-	980,437.0 lb/d

#### Stage 5: Solids-Liquid Separation (Centrifuge) (solidsSeparation)

Parameter	Input	Output
digestate Ts Pct	8.0 %	-
digestate Lb Per Day	980,437.0 lb/d	-
cake Ts Pct	-	28.0 %
cake Lb Per Day	-	312,122.0 lb/d
centrate Lb Per Day	-	668,316.0 lb/d

#### Stage 6: Liquid Cleanup -- Dissolved Air Flotation (DAF) (daf)

Parameter	Input	Output
centrate G P D	80,134.0 GPD	-
centrate Lb Per Day	668,316.0 lb/d	-
effluent G P D	-	76,127.0 GPD
float Lb Per Day	-	33,416.0 lb/d

#### Stage 7: Biogas Conditioning -- Prodeval VALOGAZ® + VALOPACK® (gasConditioning)

Parameter	Input	Output
ch4	60.0 %	60.0 %
co2	40.0 %	-
h2s	1,500.0 ppmv	7.5 ppmv
avg Flow Scfm	864.6 SCFM	856.0 SCFM
pressure Psig	0.5 psig	2.2 psig

#### Stage 8: Gas Upgrading to RNG -- Prodeval VALOPUR® (gasUpgrading)

Parameter	Input	Output
ch4	60.0 %	-
avg Flow Scfm	856.0 SCFM	-

Parameter	Input	Output
pressure Psig	2.2 psig	-
rng Ch4	-	97.0 %
btu Per Scf	-	1,012.0 BTU/SCF
rng Flow Scfd	-	739,563.0 SCFD
rng Flow Scfm	-	513.6 SCFM
rng Pressure	-	200.0 psig
rng Mmbtu Per Day	-	748.4 MMBTU/day
rng Mmbtu Per Year	-	273,180.0 MMBTU/yr

#### Stage 9: Emergency/Backup Gas Management (gasManagement)

Parameter	Input	Output
max Biogas Flow Scfm	951.1 SCFM	-

## Appendix B - CapEx Detail

### CapEx Line Items (\$000s)

Category	Description	Qty	Unit Cost	Total Cost
Major Equipment	Prodeval Gas Upgrading Unit (GUU)	1	\$5,674	\$5,674
Major Equipment	Enclosed Ground Flare	1	\$142	\$142
Major Equipment	Product Gas Compressor	1	\$492	\$492
Feedstock Receiving	Receiving Hopper/Tipping Floor	1	\$700	\$2,100
Feedstock Preparation	Macerator/Grinder	1	\$400	\$800
Feedstock Preparation	Depackaging Unit	1	\$650	\$1,625
Equalization	Bolted Steel EQ Tank	1	\$700	\$1,750
Equalization	Shell-and-Tube Heat Exchanger	1	\$450	\$900
Digester Feed	Progressive Cavity Pump	2	\$30	\$120
Anaerobic Digestion	CSTR Digester Tanks	2	\$3,200	\$19,200
Anaerobic Digestion	Top-Entry Mixers	4	\$100	\$800
Anaerobic Digestion	Hot Water Boiler	1	\$1,500	\$3,750
Solids-Liquid Separation	Decanter Centrifuge	1	\$2,800	\$7,000
Solids-Liquid Separation	Centrate Collection Tank	1	\$200	\$500
Liquid Cleanup	DAF Unit	1	\$350	\$875
Solids Management	Cake Storage/Loadout	1	\$250	\$750
Effluent Management	Effluent Storage Tank	1	\$550	\$1,375
Construction Directs	Engineering	1	\$774	\$774
Construction Directs	Civil / Structural	1	\$1,074	\$1,074
Construction Directs	Process Piping / Mechanical	1	\$1,279	\$1,279
Construction Directs	Process Electrical	1	\$1,244	\$1,244
Construction Directs	Instrumentation / Controls / Automation	1	\$755	\$755
Construction Directs	Non-Process Infrastructure	1	\$485	\$485
Construction Directs	General Requirements	1	\$895	\$895
Construction Mgmt & Indirects	Construction Management & Indirects	1	\$2,428	\$2,428
Interconnect	Pipeline Interconnect	1	\$4,047	\$4,047
Burnham Internal Costs	Project Management	1	\$1,363	\$1,363
Burnham Internal Costs	Operations During Construction	1	\$426	\$426
Burnham Internal Costs	Builder's Risk Insurance	1	\$913	\$913
Burnham Internal Costs	Fixtures & Furnishings	1	\$247	\$247
Burnham Internal Costs	Spare Parts	1	\$654	\$654
Burnham Internal Costs	Utilities	1	\$245	\$245
Burnham Internal Costs	Ribbon Cutting	1	\$75	\$75
Commercial / Owner's Costs	Commercial Items	1	\$6,638	\$6,638
Commercial / Owner's Costs	CPI Escalation	1	\$3,169	\$3,169

## Appendix C - OpEx Detail

### OpEx Line Items (\$000s)

Category	Description	Annual Cost	Notes
Maintenance	Annual maintenance & repairs (4% of equipment CapEx)	\$1,914	
Energy	Electrical power (3083 kW installed, 75% load factor, \$0.08/kWh)	\$1,621	
Labor	Plant manager (1 FTE)	\$210	Role covers finance, safety, and stakeholder management
Labor	Plant operators (8 FTE)	\$760	Includes OT and rotating shifts
Labor	Receiving/logistics personnel (3 FTE)	\$240	Handles scheduling and contamination checks
Labor	Lab and environmental compliance (2 FTE)	\$190	Supports WWTP pretreatment and gas QA/QC
Labor	Admin/office support (1 FTE)	\$85	Shared services for site operations
Feedstock & Logistics	Inbound feedstock hauling (25% of 205k TPY @ \$12/ton)	\$615	Short-haul average ~25 miles
Feedstock & Logistics	Feedstock testing and analysis	\$75	Includes sample shipping and preservatives
Chemicals & Consumables	Ferric chloride 40% for H2S control	\$158	Dosed to digesters for sulfide precipitation
Chemicals & Consumables	Antifoam (silicone-based)	\$60	Used as-needed during foaming events
Chemicals & Consumables	pH control and DAF chemicals (caustic/acid, coagulant, polymer)	\$100	Covers pH trim and solids capture to meet WWTP limits
Chemicals & Consumables	Activated carbon media (VALOPACK lead-lag)	\$120	Includes exchange service and spent media handling
Chemicals & Consumables	VALOPUR membrane cartridge replacement (annualized)	\$120	Annual reserve for periodic element changeout
Chemicals & Consumables	Lubricants and compressor oil	\$30	Includes filters and oil analysis
Chemicals & Consumables	Laboratory supplies and reagents	\$25	Excludes labor already captured
Digestate Management	Digestate hauling and land application (56,976 wet tons/yr @ \$25/ton)	\$1,420	Assumes nearby permitted fields
Digestate Management	Dewatering polymer (emulsion)	\$219	Dose optimized for 28% cake solids
Insurance & Regulatory	Property and liability insurance	\$522	Includes general liability and property
Insurance & Regulatory	Air permits and environmental compliance fees	\$75	Includes stack testing/consulting allowance
Insurance & Regulatory	RIN/LCFS verification and reporting	\$120	Excludes monetization services
Administrative & Overhead	RNG interconnect O&M and pipeline fees	\$315	Covers metering, balancing, and maintenance
Administrative & Overhead	Gas quality monitoring and reporting	\$40	Includes annual analyzer service
Administrative & Overhead	Office, IT, and training	\$80	Covers software, phones, PPE, and training
Administrative & Overhead	Site security and monitoring	\$50	Includes 24/7 remote monitoring
Revenue Offsets	Tipping fee revenue - food processing residuals (170,000 tpy @ \$10/ton)	(\$1,700)	Long-term contracts assumed
Revenue Offsets	Tipping fee revenue - packaged food waste (35,000 tpy @ \$55/ton)	(\$1,925)	Includes contaminant disposal surcharge in fee

## Appendix D - Pro-Forma Financial Projections

### Financial Assumptions

Assumption	Value
Inflation Rate	2.5%
Project Life	20 years
Construction Period	18 months
Uptime	98.0%
Revenue Market	D3 RINs
RIN Price	\$3/RIN
RIN Brokerage	20.0%
Natural Gas Price	\$4/MMBtu
Wheel/Hub Cost	\$1/MMBtu
Discount Rate	10.0%
ITC Rate	40.0%
45Z Credits	Enabled
45Z CI Score	24.0 gCO <sub>2</sub> e/MJ
45Z Target CI	50.0 gCO <sub>2</sub> e/MJ
45Z Credit Price	\$1/gal
45Z Monetization	90.0%
45Z End Year	2029

### Pro-Forma Projections (\$000) — D3 RIN Market

Year	Cal Year	RNG (MMBtu)	45Z Rev	Revenue	OpEx	EBITDA	Net CF	Cumul CF
1	2028	267,703	1,144	11,717	9,164	2,553	27,681	-46,882
2	2029	267,703	1,144	11,898	9,393	2,506	1,359	-45,523
3	2030	267,703	0	10,940	9,628	1,312	137	-45,386
4	2031	267,703	0	11,129	9,868	1,260	56	-45,330
5	2032	267,703	0	11,322	10,115	1,207	-28	-45,358
6	2033	267,703	0	11,519	10,368	1,151	-115	-45,473
7	2034	267,703	0	11,720	10,627	1,093	-204	-45,677
8	2035	267,703	0	11,925	10,893	1,032	-297	-45,974
9	2036	267,703	0	12,135	11,165	970	-393	-46,367
10	2037	267,703	0	12,349	11,444	905	-492	-46,860
11	2038	267,703	0	12,567	11,730	837	-595	-47,454
12	2039	267,703	0	12,791	12,024	767	-701	-48,155
13	2040	267,703	0	13,018	12,324	694	-810	-48,965
14	2041	267,703	0	13,251	12,632	619	-923	-49,888
15	2042	267,703	0	13,489	12,948	541	-1,040	-50,928
16	2043	267,703	0	13,732	13,272	460	-1,160	-52,088
17	2044	267,703	0	13,979	13,604	376	-1,285	-53,373

<b>Year</b>	<b>Cal Year</b>	<b>RNG (MMBtu)</b>	<b>45Z Rev</b>	<b>Revenue</b>	<b>OpEx</b>	<b>EBITDA</b>	<b>Net CF</b>	<b>Cumul CF</b>
18	2045	267,703	0	14,233	13,944	289	-1,413	-54,786
19	2046	267,703	0	14,491	14,292	199	-1,545	-56,331
20	2047	267,703	0	14,756	14,650	106	-1,682	-58,013