



39 River Rd, BURNIE, Tasmania, 7320, Australia

Phone: 61 3 6431 6333, email: burnielab@alsglobal.com

GRAVITY ASSESSMENT
OF
RAZORBACK TAILS
FOR
STELLAR RESOURCES LTD

Technical Report T1171
J R Glen
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DATE

JUNE 2019

BRIEF

- Prepare and perform a direct spiral separation of a bulk Razorback tails sample.
- Assess and perform gravity upgrading and dressing of concentrate.
- Classify and scavenge tin values from spiral tails.
- Assess and report results.

SUMMARY

A single bulk sample of Razorback Tails was received for basic characterisation and gravity tin recovery assessment. The material contained 0.26% Sn, 20.4%Fe, 9.0%MgO and 46.7%SiO₂.

Sizing and fraction analyses indicate the tails have a p₈₀=150um and that the tin is mainly resident between 212 and 20um. The sizing also shows that around 43% (tin between 34 and 106um) would be amenable to spiral separation. Previous assessments have indicated that there is no free tin grains above 75um, this then limits the tin recoverable by spiral separation to around 35% of tailings tin. Two spiral runs were performed yielding 28% and 34% recovery respectively.

The spiral concentrate was tabled to generate a medium grade concentrate for dressing by magnetic separation. Tabling results indicate a concentrate of 24% Sn can be generated at a recovery of 41% from table feed. The release curve indicates a large middling stream (some 36% of table feed tin) is generated indicating a regrind stage in the gravity circuit is required.

Table concentrate was the dressed to grade by a cross belt magnetic separator. Magnetics were easily removed with a 7300 gauss setting and a non-mags of 43.4%Sn generated without tin loss.

The spiral tails were sized to indicate the tin distribution. Results indicate that 77% of tin is in the <36µm range while some 45% of mass is in the >36µm range.

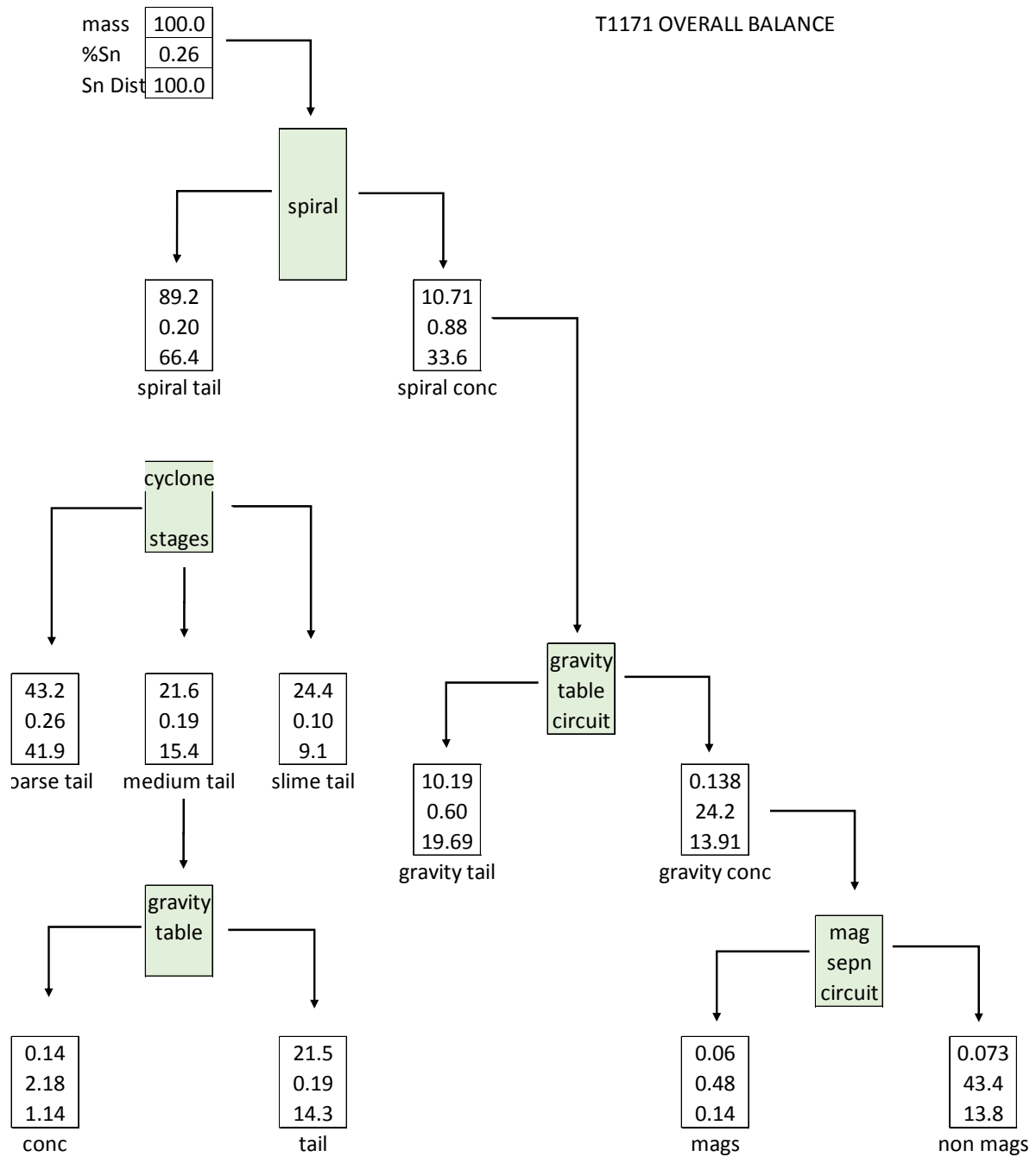
The spiral tails were cycloned in two stages:

- A coarse cut to remove coarser tails to a final tails product.
- A fine cut of the cyclone OF generated in the first stage to remove slimes and generate a medium size product for re-treatment

Some 20% of tails tin was collected in the second stage underflow. This product was tabled with results indicate almost no additional recovery can be obtained by re-treating primary spiral tails.

The overall testing flowsheet is shown in the diagram below and indicates poor response to simple gravity and dressing routines. An overall recovery of 14% was achieved to a concentrate grade of 43.4%Sn, a further 15-20% recovery is available by including a gravity dressing regrind stage.

TESTING CIRCUIT AND BALANCE



MATERIAL TESTED

A single bulk Razorback Tails sample was received for testing. The sample was blended and sampled for head and sizing analysis. Table 1 details the results.

TEST ROUTINES

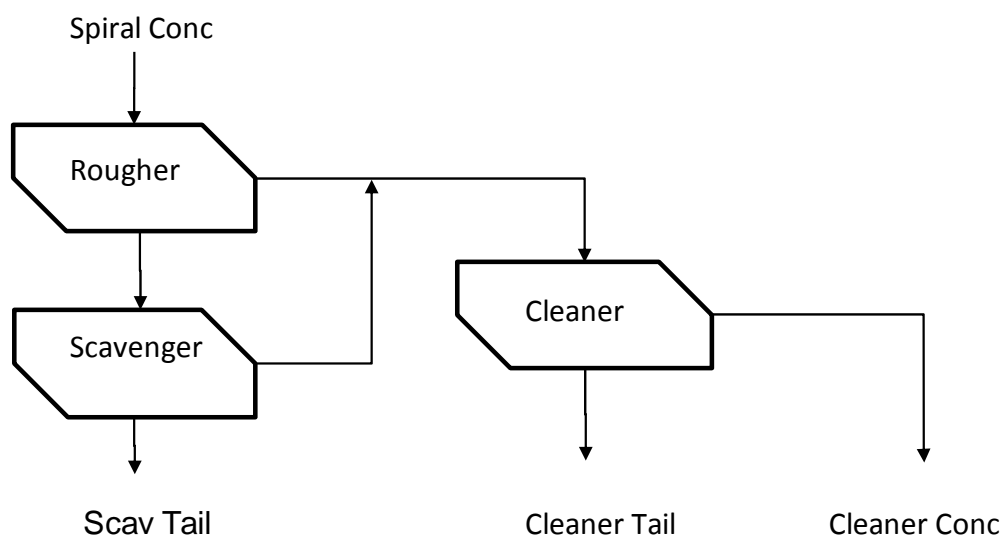
SPIRAL SEPARATION

- Repulp feed material to 30% solids in the spiral feed tank.
- Circulate the slurry around the spiral/feed tank.
- Adjust cutters and wash water flow to optimise separation.
- Allow to equilibrate over five minutes.
- Collect a timed sample of concentrate, middlings and tails exiting the spiral.
- These constitute the spiral survey samples.
- Remove concentrate into a series of buckets in one minute intervals.
- The concentrates can be removed until no further separation is evident.
- Collect all of the remaining slurry from the system, this is the tails product.
- Prepare samples for dry weight and analysis

SHAKING TABLE SEPARATION

Gravity separation was performed on a quarter-size Holman shaking table set to produce three product streams.

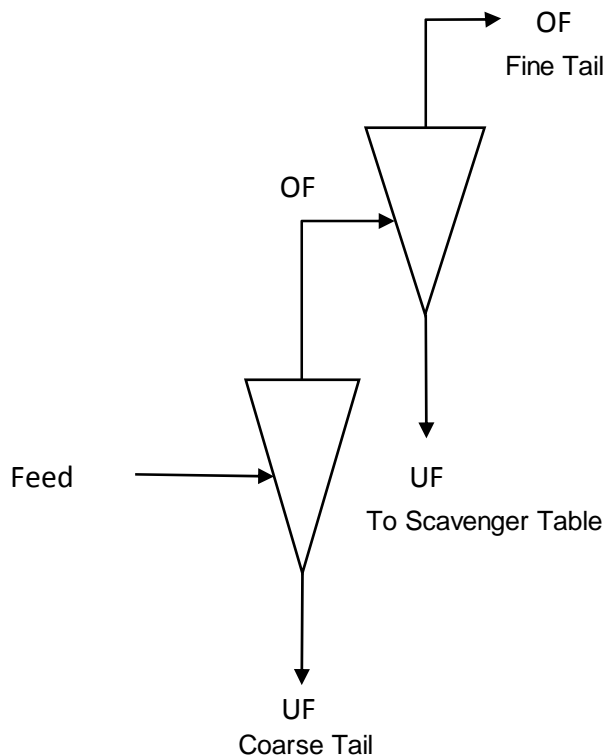
- Feed solids were repulped and agitated in a 100 litre feed tank.
- Table fed via variable speed Verdeflex hose pump.
- Wash water applied at 1lpm across the deck.
- Run to generate a series of concentrates and final tail.
- Products were filtered and dried for weight determination and analysis.
- A second stage of tails scavenging and then cleaning of combined rougher and scavenger conc was performed.



CYCLONE CLASSIFICATION

A Mozley on inch cyclone was used for the classification stages.

- Feed slurry of 10-15% solids.
- Cyclone Pressure 150-200kPa.
- 100L agitated tank and pump in closed circuit with cyclone.
- Cyclone products returned to the tank to recycle.
- Steady state samples of the products are taken for weight and sizing.
- Conditions generating the correct cut point for the duty are selected.
- When in steady the products are removed to generate an OF and UF.
- This was repeated using the cyclone OF to generate:
- Primary UF, secondary UF and secondary OF.



RAPID CROSSBELT MAGNET ROUTINE

- Set the magnet to the target Gauss (field strength) setting by adjustment of the magnet aps setting.
- Run the heated material onto the moving belt, allowing all the material to pass through the magnetic disc.
- Collect and prepare products (Mags 1, Mags 2 and Non Mags) for analysis.
- Three table concentrates were assessed.

RESULTS

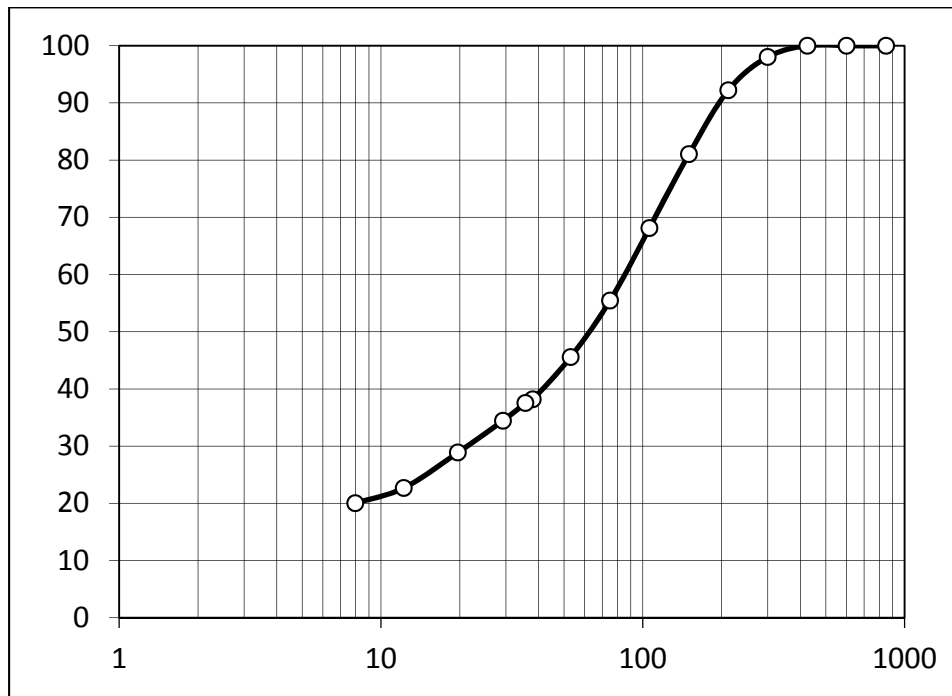
Sizing and fraction analyses indicate the tails have a p80=150um and that the tin is mainly resident between 212 and 20um.

TABLE 1: SIZING OF AS RECEIVED TAILS

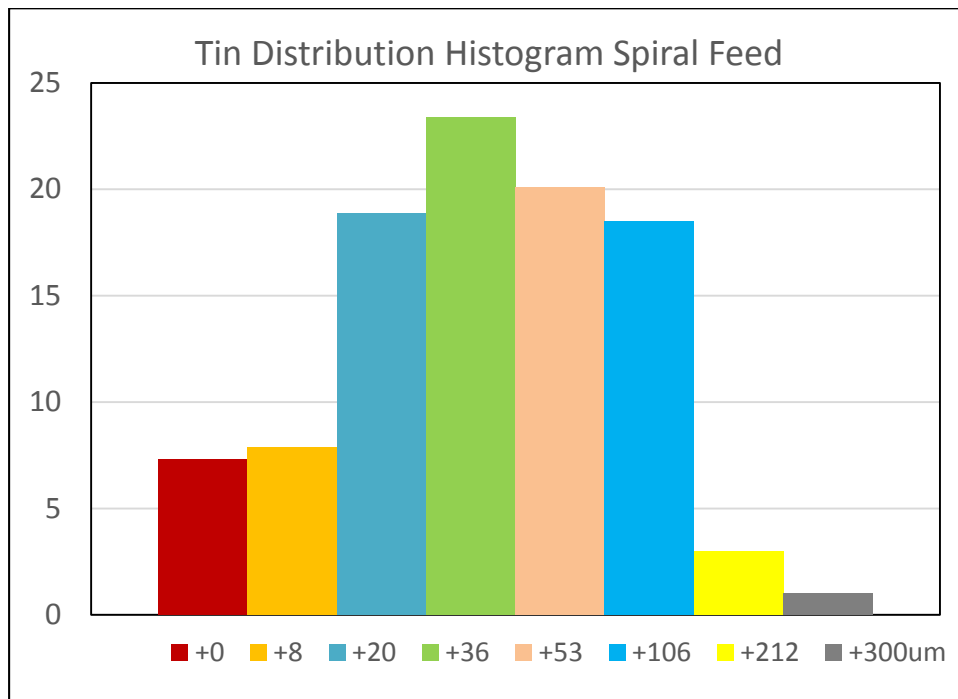
SIZE um	Wt (%)	Sn		Fe		As		MgO		CaO	
		(%)	Dist (%)	(%)	Dist (%)	(%)	Dist (%)	(%)	Dist (%)	(%)	Dist (%)
212	7.78	0.17	5.3	16.70	6.3	0.08	5.9	6.07	5.6	0.04	11.2
106	24.09	0.19	18.3	19.25	22.7	0.10	22.9	6.22	17.8	0.02	17.3
53	22.56	0.22	19.8	21.50	23.7	0.11	23.6	7.13	19.1	0.02	16.2
36	8.03	0.72	23.1	22.40	8.8	0.11	8.4	8.24	7.9	0.03	8.6
20	8.65	0.54	18.6	23.50	9.9	0.12	9.9	7.23	7.4	0.04	12.4
8	8.86	0.22	7.8	18.60	8.0	0.10	8.4	12.50	13.2	0.04	12.7
<8	20.03	0.09	7.2	21.00	20.5	0.11	20.9	12.20	29.0	0.03	21.6
Calc	100.00	0.25	100.0	20.47	100.0	0.11	100.0	8.42	100.0	0.03	100.0
Assay		0.26		20.40		0.11		8.93		0.02	

SIZE um	Wt (%)	SiO2		Al2O3		S		MnO	
		(%)	Dist (%)	(%)	Dist (%)	(%)	Dist (%)	(%)	Dist (%)
212	7.78	55.40	9.2	4.10	8.8	0.14	3.2	1.54	7.1
106	24.09	51.80	26.7	3.64	24.3	0.18	12.6	1.79	25.6
53	22.56	46.80	22.6	3.07	19.2	0.32	20.9	2.00	26.8
36	8.03	43.30	7.4	2.60	5.8	0.65	15.1	2.04	9.7
20	8.65	42.40	7.9	2.76	6.6	0.64	16.0	1.83	9.4
8	8.86	47.70	9.0	2.54	6.2	0.44	11.3	1.17	6.1
<8	20.03	39.90	17.1	5.22	29.0	0.36	20.9	1.29	15.3
Calc	100.00	46.71	100.0	3.61	100.0	0.35	100.0	1.69	100.0
Assay		47.10		3.50		0.30		1.68	

GRAPH 1: RAZORBACK TAILS SIZING



GRAPH 2: TIN DISTRIBUTION HISTOGRAM OF RAZORBACK TAILS



The tails were gravity tested by direct spiral separation. Tables 2 and 3 indicate the results. The survey (rougher spiral) indicate some 29% tin recovery to a low grade concentrate. The kinetic spiral run indicates a total of 34% recovery to a low grade concentrate. These indicate that tin is either locked (in coarse grains) or too fine for spiral recovery.

The histogram below (Graph 2) indicate the tin distribution in spiral feed and shows that around 43% (tin between 34 and 106um) would be amenable to spiral separation. Previous assessments have indicated that there is no free tin grains above 75um, this then limits the tin recoverable by spiral separation to around 35% of tailings tin. Two spiral runs were performed yielding 28% and 34% recovery.

TABLE 2: SPIRAL SURVEY

Product Spiral	Mass (tph)	Wt (%)	Sn (%)	Dist (%)	Fe (%)	Dist (%)	SiO2 (%)	Dist (%)	S (%)	Dist (%)
Conc 1	0.068	2.53	1.46	15.13	39.40	5.02	12.00	0.63	1.52	13.19
Mids 1	0.272	10.04	0.32	13.17	28.90	14.62	36.00	7.52	0.34	11.73
Tail 1	2.364	87.43	0.20	71.70	18.25	80.37	50.50	91.85	0.25	75.08
Calc Feed	2.704	100.0	0.24	100.0	19.85	100.0	48.07	100.0	0.29	100.0

TABLE 3: SPIRAL KINETIC RUN

Product Spiral	Sec	Wt (%)	Sn (%)	Dist (%)	Fe (%)	Dist (%)	SiO2 (%)	Dist (%)	S (%)	Dist (%)
Con1	30	0.39	1.74	2.65	40.40	0.79	9.07	0.07	1.90	2.53
Con2	60	0.34	1.78	2.37	40.80	0.69	8.68	0.06	1.82	2.11
Con3	90	0.33	1.76	2.30	41.10	0.69	9.05	0.06	1.74	1.99
Con4	120	0.32	1.68	2.09	41.40	0.66	9.03	0.06	1.72	1.87
Con5	180	0.64	1.40	3.52	41.70	1.34	9.86	0.13	1.49	3.28
Con6	270	0.91	1.18	4.22	42.40	1.94	10.75	0.20	1.27	3.97
Con7	330	1.58	0.63	3.89	37.60	2.97	21.10	0.69	0.66	3.56
Con8	390	1.37	0.61	3.27	35.90	2.46	23.20	0.66	0.60	2.81
Con9	510	2.53	0.52	5.14	33.50	4.24	27.30	1.43	0.49	4.23
Con10	630	2.31	0.46	4.15	30.40	3.51	32.70	1.57	0.43	3.39
Tail		89.29	0.19	66.40	18.05	80.71	51.20	95.05	0.23	70.26
Calc	Feed	100.0	0.26	100.0	19.97	100.0	48.09	100.0	0.29	100.0

The spiral concentrate was then tabled to generate a medium grade concentrate for dressing by magnetic separation. Results are detailed in Table 4 and Graph 2 below. Results indicate a concentrate of 24%Sn can be generated at a recovery of 41% from table feed. The release curve indicates a large middling stream (some 35% recovery) is generated. Any further assessments should include a regrind stage in the gravity circuit.

TABLE 4: SPIRAL CONCENTRATE TABLE SEPARATION

Product Table	Wt (%)	Sn (%)	Dist (%)	Fe (%)	Dist (%)	As (%)	Dist (%)	SiO2 (%)	Dist (%)	S (%)	Dist (%)
Ro Conc	33.58	1.64	74.5	42.7	40.5	0.22	39.3	6.57	9.9	1.55	67.3
Scav Conc	2.73	0.84	3.1	45.0	3.5	0.22	3.2	6.98	0.9	1.08	3.8
Scav Tail	63.69	0.26	22.4	31.1	56.0	0.17	57.5	31.3	89.3	0.35	28.8
Calc Feed	100.00	0.74	100.0	35.37	100.0	0.19	100.0	22.3	100.0	0.77	100.0
Cl Conc 1	1.29	24.2	41.4	21.9	0.8	0.30	2.0	1.86	0.1	5.04	8.1
Cl Mids 1	1.49	4.51	8.9	33.0	1.4	0.24	1.9	2.35	0.2	5.63	10.5
Cl Mids 2	2.10	1.43	4.0	39.1	2.3	0.20	2.2	2.60	0.2	3.68	9.6
Cl Tail	31.11	0.57	23.6	44.7	39.3	0.22	36.2	6.93	9.7	1.13	43.8
Scav Tail	64.01	0.26	22.1	31.1	56.2	0.17	57.6	31.3	89.8	0.35	27.9
Calc Feed	100.0	0.75	100.0	35.4	100.0	0.19	100.0	22.30	100.0	0.80	100.0
Assay	Feed	0.75		35.2		0.19		22.60		0.76	

GRAPH 3: TABLE SEPARATION RELEASE ANALYSIS

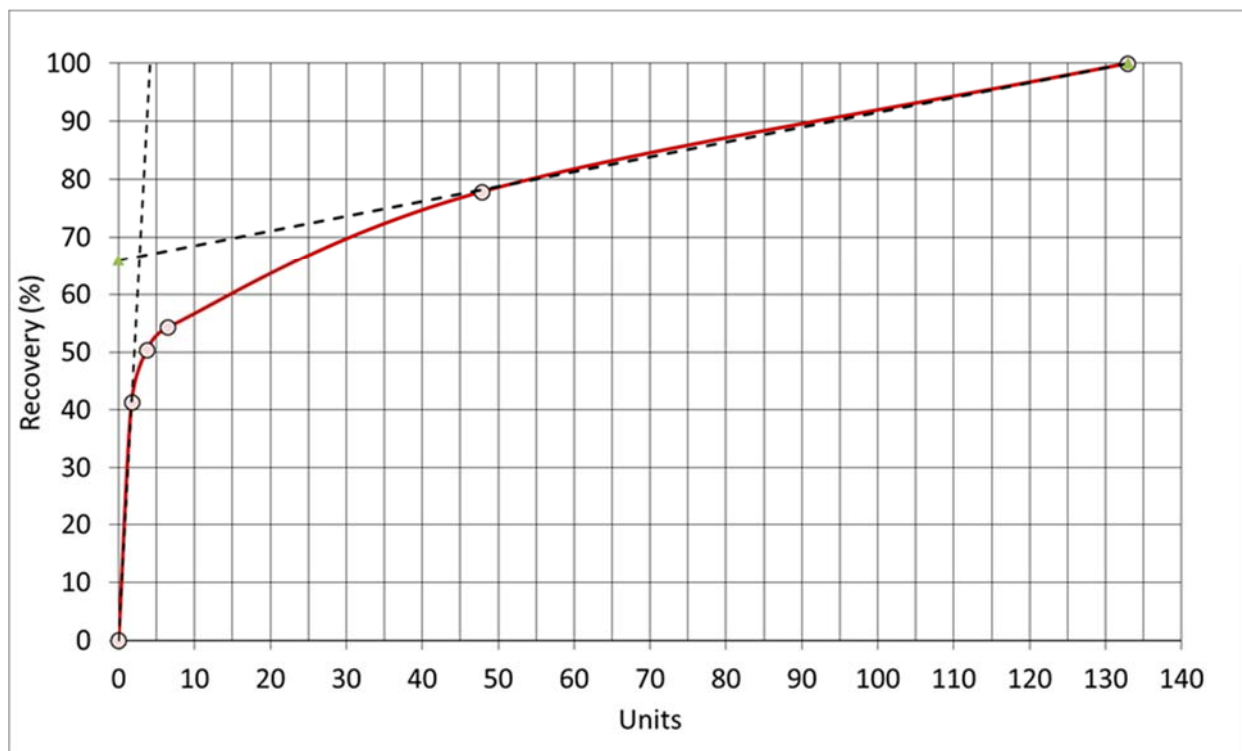


Table concentrate was the dressed to grade by a cross belt magnetic separator. Magnetics were easily removed with a 7300 gauss setting. Table 6 indicates an almost doubling of the tin grade by removal of magnetics.

TABLE 5: TABLE CONCENTRATE MAGNETIC SEPARATION

Product	Wt (%)	Sn (%)	Dist (%)	Fe (%)	Dist (%)	SiO2 (%)	Dist (%)	S (%)	Dist (%)	As (%)	Dist (%)
7300 Mags	46.82	0.48	1.0	29.90	63.7	2.16	55.6	0.56	5.1	0.11	18.7
Non Mags	53.18	43.40	99.0	15.00	36.3	1.52	44.4	9.08	94.9	0.42	81.3
Calc Feed	100.0	23.31	100.0	21.98	100.0	1.82	100.0	5.09	100.0	0.27	100.0
Assay Feed		24.20		21.90		1.86		5.04		0.30	

Bulk spiral tails were sized to indicate the tin distribution. Results indicate that 77% of tin is in the <36µm range while some 45% of mass is in the >36µm range.

TABLE 6: SPIRAL TAILS SIZING

SIZE um	Wt %	Sn		Fe		As		SiO2		S	
		%	dist	%	dist	%	dist	%	dist	%	dist
212	3.92	0.11	2.0	9.90	2.3	0.07	2.6	67.70	5.0	0.12	1.4
106	15.94	0.12	8.8	13.00	12.1	0.10	15.1	62.50	18.6	0.10	4.6
53	17.14	0.11	8.7	15.60	15.7	0.11	17.8	57.60	18.4	0.30	14.8
36	7.44	0.11	3.8	17.10	7.5	0.11	7.7	54.50	7.6	0.30	6.4
20	10.33	0.37	17.6	19.90	12.0	0.12	11.7	48.40	9.3	0.61	18.1
8	12.45	0.45	25.8	22.00	16.0	0.12	14.1	45.70	10.6	0.56	20.0
<8	32.77	0.22	33.2	17.90	34.4	0.10	31.0	49.80	30.5	0.37	34.8
Calc	100.00	0.22	100.0	17.07	100.0	0.11	100.0	53.56	100.0	0.35	100.0
Assay		0.19		18.05		0.11		51.20		0.23	

The spiral tails were cycloned in two stages:

- A coarse cut to remove coarser tails to a final tails product.
- A fine cut of the cyclone OF generated in the first stage to remove slimes.

The middle size range material was then spiral separated to determine if tin could be scavenged for further treatment. Table 7 indicates the results. Some 20% of tails tin was collected to the second stage underflow.

TABLE 7: CYCLONE CLASSIFICATION

Product Cyclone	Dist (%)	Sn (%)	Dist (%)	Fe (%)	Dist (%)	SiO2 (%)	Dist (%)	S (%)	Dist (%)
T06 UF	47.7	0.26	54.8	16.40	43.1	55.30	53.7	0.22	45.3
Calc T06 OF	52.3	0.20	45.2	19.74	56.9	43.51	46.3	0.24	54.7
T07 OF	27.7	0.20	24.5	21.40	32.7	39.10	22.0	0.20	23.9
T07 UF	24.6	0.19	20.7	17.88	24.2	48.47	24.3	0.29	30.8
Calc Feed	100.0	0.23	100.0	18.15	100.0	49.13	100.0	0.23	100.0
Assay Feed		0.19		18.05		51.20		0.23	

The secondary cyclone UF product was tabled, results are presented in Table 8. Results indicate that almost no additional recovery can be obtained by re-treating primary spiral tails.

TABLE 8: CYCLONE UNDERFLOW TABLE SEPARATION

Product Table	Wt (%)	Sn (%)	Dist (%)	Fe (%)	Dist (%)	SiO2 (%)	Dist (%)	As (%)	Dist (%)	S (%)	Dist (%)
Table Conc	0.65	2.18	7.41	37.0	1.34	17.8	0.24	0.21	1.48	1.51	3.41
Mids 1	0.72	1.07	4.04	37.3	1.50	19.9	0.30	0.21	1.64	1.28	3.20
Mids 2	1.13	0.29	1.72	27.5	1.74	38.2	0.89	0.15	1.84	0.48	1.89
Tail	97.50	0.17	86.83	17.5	95.41	49.0	98.57	0.09	95.04	0.27	91.50
Calc Head	100.0	0.19	100.0	17.88	100.0	48.47	100.0	0.09	100.0	0.29	100.0

APPENDICES: TEST RESULTS