FY2011 Radioactive Liquid Waste Influent Boundary Condition Assessment and Forecast

LA-UR 11-00151

100761-11-000003

Prepared for Integrated Nuclear Planning (INP)
January, 2011

Author
Simon Balkey, AET-2/CS-PCS

Acknowledgements
Chris Del Signore (TA-55-RLW), Lorenzo Trujillo (WES-FFS), Amy Wong (C-DO), Bart Ortiz (MSS-TA-55), William Schwettmann (IPM-1), Edwina Sanchez (WES-WTS), Robert Wingo (C-CDE), Darryl Garcia (WES-WGS), Ken Huff (WX-DO), Stevan Pattillo (MST-7), Terry Singell (PADWP), Judith Eglin (IPM-1), Marcel Torrez (MSS-TA-55), Diane Spengler (NCO-4), Craig Van Pelt (NCO-4), Jennifer Butler (NCO-2), Stephen Schreiber (NCO-DO), Louis Schulte (MET-1), Kari Lier (AET-2), Edward Joyce (MET-1), Edwina Sanchez (WES-WTS), Lia Brodnax (MET-1)

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1. Executive Summary

This report has estimated boundary conditions and forecasts for radioactive liquid waste (RLW) volumes impacting the Los Alamos National Laboratory Radioactive Liquid Waste Treatment Facility (RLWTF) beginning in fiscal year 2011 (FY11) . The RLW stream is defined by two levels of radioactivity: low level (LL) and transuranic (TRU).

The RLW-LL influent stems from multiple sites and buildings across LANL. This report has analyzed historical data and considered future increases and decreases to RLW-LL resulting in an estimated annual flow of 3.5M liters in FY11 with a potential increase to 4.9M liters over the long term. The long term upper boundary condition for the RLW-LL waste stream has been estimated at 5.9M liters. A significant finding in this report is that most of the RLW-LL effluent to be produced by LANL sites is driven by facility equipment or facility support functions. The change in scope to programs has a relatively minimal effect on the total volume of RLW-LL effluent produced. For example, an increase in pit production from a nominal 10 pits to a 50-80 pit mission is estimated to only net a 1-2% increase in total influent volume.

The RLW-TRU waste stream is generated in only one facility at LANL which is PF-4 at TA-55. This report considers future generators, various mission production levels, and has estimated the total RLW-TRU influent volume of approximately 13k liters for FY11 with an upper boundary condition of nearly 30k liters in the short term and up to 60k liters in the long term. An annual forecast for RLW-TRU beyond FY11 is not estimated because of the uncertainty in mission requirements, facility downtime, operational upsets, and administrative constraints. Changes in these matters can drive total RLW-TRU effluent to be generated at the maximum or minimum boundary condition in any given year.

2. Introduction

This report will document the forecast of RLW influent to RLWTF for FY11 and estimate boundary conditions for future RLW generation. Both RLW-LL and RLW-TRU are included in this report. All industrial waste volume expected to be transferred *via* the RLW-LL lines is considered part of the RLW-LL influent.

This report analyzes information such as historical data and current waste generation estimates made by subject matter experts (SMEs) to establish a forecast for influent volume impacting the Radiological Liquid Waste Treatment Facility (RLWTF). Assumptions in waste generator missions, facility alterations, special processing criteria, and waste minimization projects have been documented in order to help forecast annual influent volumes and to establish boundary conditions for each RLW stream.

The RLW-LL waste stream is generated by various sites across LANL. The most significant generator of low level liquid is facility support operations and equipment. Direct mission support unit operations generate a very small fraction of the total RLW-LL effluent. The RLUOB and Nuclear Facility at the CMRR are expected to produce low level liquid waste in the future. The RLW-TRU waste stream is generated at TA-55 and will be generated at the CMRR Nuclear Facility when operational. There are two effluent pipelines that carry RLW-TRU to RLWTF; the acid line and caustic line. The generators producing acid waste inside of PF-4 at TA-55 are the Rich Feed Exchange Line (RFX), the Advanced Testing Line for Aqueous Separations (ATLAS), and the chill water system pumps supporting all of PF-4. Caustic waste is currently produced by the Experimental Chloride Extraction Line (EXCEL) and the Pu-238 aqueous operation line. Future generators of caustic waste include the Chloride Extraction and Actinide Recovery (CLEAR) line which expected to be commissioned in FY11 and the CMRR Nuclear Facility caustic waste system (CWS) assumed to be operational in 2022.

This report establishes boundary conditions and a nominal annual volume forecast for the RLW-LL stream by applying various data analysis methods to historical data and using information related to projects expected to significantly add or reduce volume to the total influent stream in the future. This report establishes boundary conditions for both acid and caustic RLW-TRU at the operation level. The boundary conditions for each operation generating RLW-TRU are established via analyses of three scenarios of potential material throughput. The scenarios included for each operation include a low production level, a short term maximum production level, and a long term maximum production level. The low production level assumes the lowest planned scope for each operation with process upsets and inefficiencies built in from requirements such as the highly restrictive inventories conducted on an 8-week cycle. The short term maximum production level is the estimated maximum throughput of material and processing efficiency that each operation could attain, in a less than a 50 pit scenario, and assuming significant downtime events such as the MC&A inventories, process upsets, and facility unavailability could often be avoided. For the next decade, it is assumed that all operations will produce effluent between the low and short term maximum production levels. The long term maximum production level assumes that on top of the currently planned scope, a 50-80 pit mission or other mission requiring significantly increased aqueous recovery (e.g. NASA mission in 238 operations), would be executed at TA-55.

3. History of RLW Forecasts

In 2007, a report titled "*Radioactive Liquid Waste Treatment Facility-Influent Boundary Condition Assessment*" (LA-UR-07-3788) established forecasts and boundary conditions for both RLW-LL and RLW-TRU waste streams at LANL. This report authored by Shaw Environmental, Inc. is commonly referred to as the "Shaw Report". Since the *Shaw* report was published, two reports including this document have revised and updated the forecasts and boundary conditions for both RLW streams. The first, published in 2008 is titled "*Review of RLWTF Influent Boundary Condition Assessment, Revision 1*" (LA-UR-08-05409) and this document authored in 2010. Both reports have shown significant differences to the estimated volumes and boundary conditions estimated in the Shaw report for both RLW-LL and RLW-TRU.

3.1 History of RLW-LL Forecast

The estimated RLW-LL annual volume in the Shaw Report for the lower boundary condition, nominal volume, and upper boundary conditions were estimated to be 4.9M liters, 9.6M liters, and 13M liters respectively. In this report, the same boundary condition points are estimated at 2.2M, 4.9M, and 5.9M liters respectively over the long term. The differences in the estimates stem mostly from two sources:

first, many of the waste minimization projects that were estimated in the Shaw report are now completed and have produced results different than forecast in the 2007 report; and second, from an overly conservative calculation of nominal volume in the Shaw Report. An extremely conservative nominal volume (9.9M liters) in the Shaw Report was derived by averaging the total influent data observed at RLWTF in fiscal years 2001-2006. Using an average calculated value over the six-year period equally weighted each data point in the set. This calculation method did not represent the downward trend of influent during that time period because the years leading up to 2006 had produced permanent volume reductions from various RLW-LL sources. The data early in the range should have been weighted less than the years nearing 2006. After calculating the conservative 9.9M liter nominal volume, it was then used as a baseline volume to forecast the impact of future increases and decreases of RLW-LL over time; the result was an excessively conservative forecast. Figure 1 below compares the Shaw Report estimates to the estimates made in this report for RLW-LL.

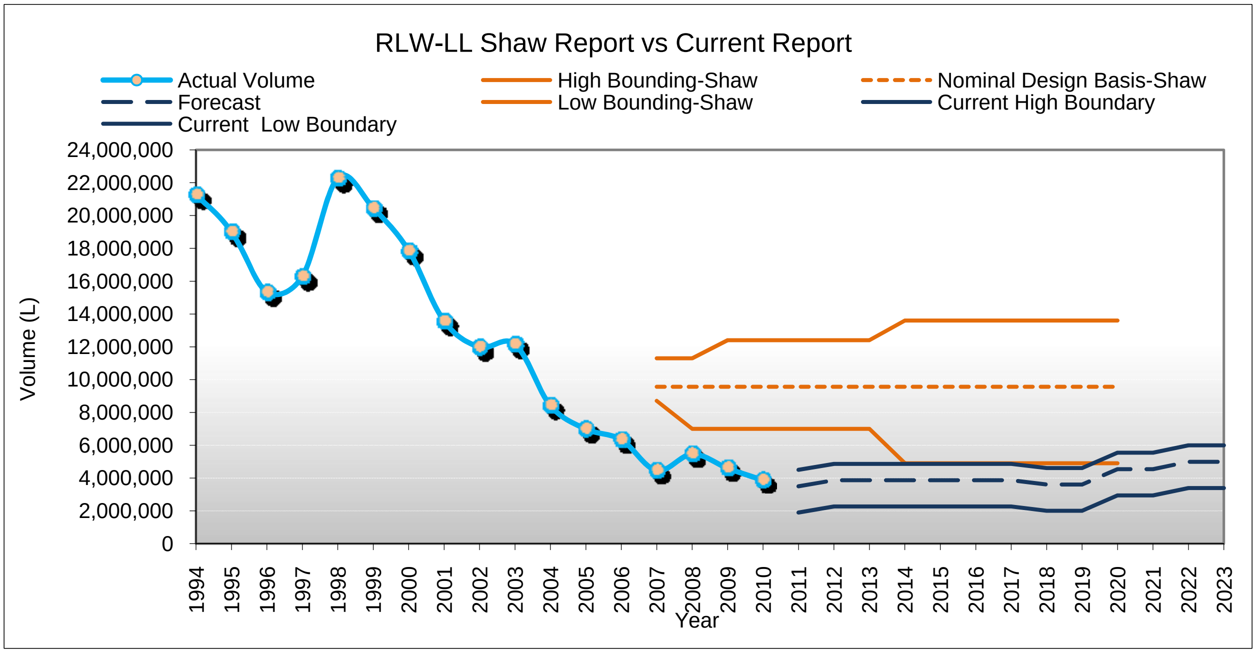

Figure 1 RLW-LL Shaw Report vs Current Report Estimates

3.2 History of RLW-TRU Forecasts

The estimated annual volume for the RLW-TRU stream in the Shaw report is significantly different from current forecasts for both acid and caustic liquid waste as well. The Shaw Report estimated the lower boundary condition and upper boundary conditions at 1.7k liters and 61.9k liters respectively for the acid stream and 4.5k liters and 84.5k liters respectively for the caustic stream.[1] The most recent forecast report estimates the lower boundary condition and upper boundary conditions at 2.5k and 40.6k respectively for acid and 2.6k and 19.3 k respectively for caustic. The figures below show the differences in boundary conditions between the current report and the 2007 Shaw Report.

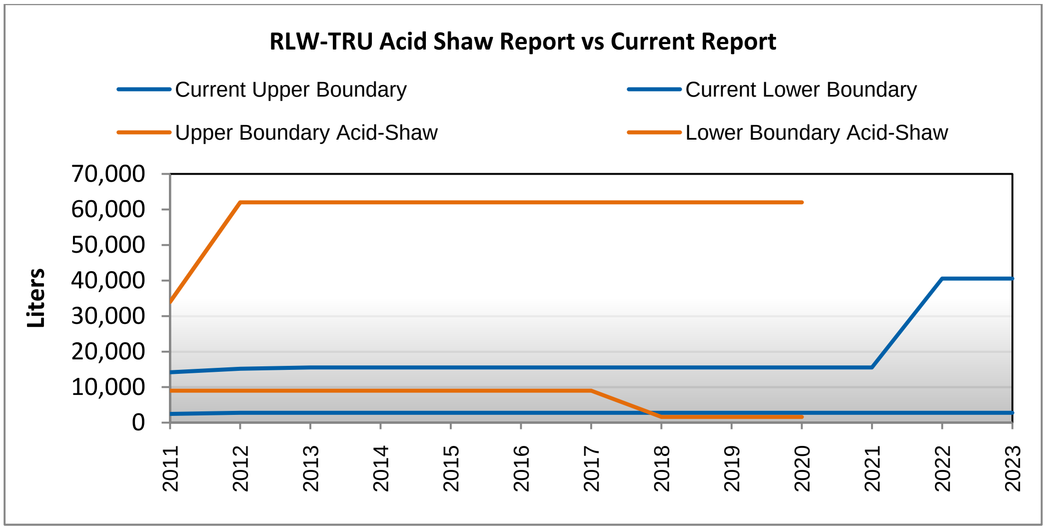

Figure 2 Acid Influent Boundary Conditions-Shaw Report vs Current Report

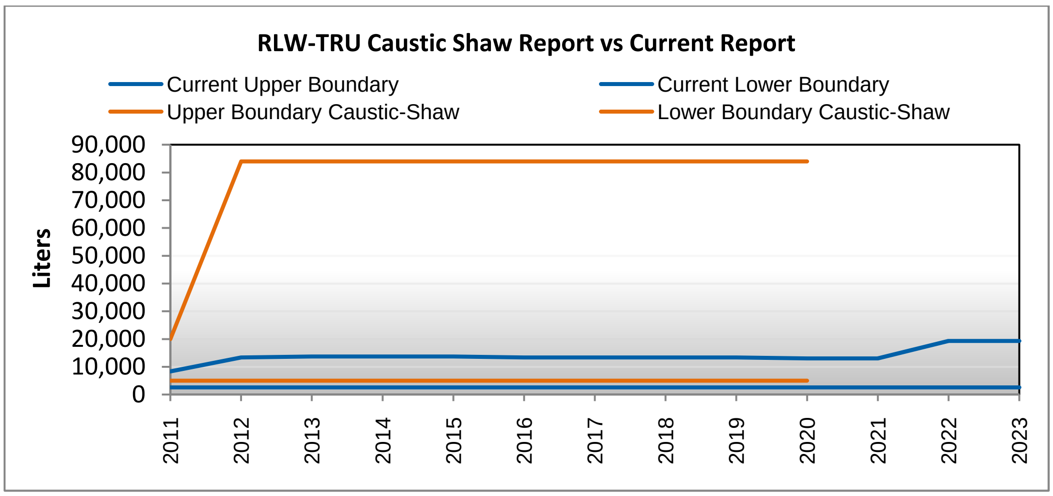

Figure 3 Caustic Influent Boundary Conditions-Shaw Report vs Current Report

The differences in RLW-TRU volumes stem from the assumptions made in each report surrounding the transition from current pit capability to a 50-80 pit scenario. The Shaw report predicts a straight line extrapolation from the effluent produced at an approximate 10 pit scenario to a 50 pit scenario. The extrapolated volume is then used as part of a statistical analysis to demonstrate impact or increase in volume over time. The estimated volumes and assumptions used in the Shaw report are outside of the current set of assumptions and capacities planned for the RLW-TRU generating operations at TA-55 moving forward. This report considers the latest detailed assumptions in equipment capacity, processing constraints, equipment installations, improvements to operations, and feed optimization strategies included in the planning basis for existing programs as well as a 50-80 pit mission scenario.

4. RLW-LL Forecasting

Many facilities contribute to the RLW-LL influent waste stream across LANL. However, a short list of sites: TA-55, TA-03, and TA-48 comprise over 75% of the total expected influent volume to be received at RLWTF. The largest contributor, TA-55 plutonium facility, produces RLW-LL mostly through facility support equipment such as ventilation dryers, steam line condensate, and water seals for vacuum pumps. Three main buildings, CMR, Sigma, and Beryllium Test Facility (BTF), at TA-3 produce the second largest volume of effluent. At CMR, which is by far the largest contributor to TA-3 effluent, volumes are comprised by mostly facility eye wash stations test water, contamination shower test water, mop water, and rinse water for lab ware in support of analytical chemical assay operations. The Sigma and BTF add to effluent volumes from TA-3 at a significantly reduced volume than in the recent past because of successful waste minimization projects. The effluent at these two buildings stems from mostly rinse water and spent cleaning solution from processing metal parts as well as facility maintenance such as mop water.[15] The TA-48 effluent mostly stems from the requirement to reduce perchlorates in the duct system of the facility and, at a lesser volume, rinse water for chemical processing and research operations.

There are significant challenges to forecasting RLW-LL; mostly because of the lack of operable flow meters and monitoring tanks within the collection system. Historical influent data for RLW-LL exists only at the final collection point entering the RLWTF which provides no detail of site specific volume generation. One of the most significant issues regarding the lack of flow meters and tanks involves the collection of rain and snowfall precipitation. Subject matter experts have observed significant influent to the RLWTF during and after rain and snow showers. There is currently no means to accurately identify the drain locations or exact quantities of effluent produced from rain and snow collection. It is estimated that a potential range of 500,000-1,500,000 liters of effluent stems from annual precipitation events.

In this report, an approach combining various sources of information was used to forecast the RLW-LL influent. The approach included trending the available influent data, analyzing waste profile forms for generator volume estimates, and eliciting direct volume estimates, where possible, from subject matter experts at facilities contributing relatively significant volumes to the total influent.

The forecast for RLW-LL is established in this document as follows:

- Sections 4.1-4.5 generate the basis and forecast for the FY11 estimated influent volume.
- Section 4.6 Creates the long term forecast for RLW-LL by using the FY11 forecast as a baseline and adjusting the volume annually for expected out year increases and decreases to influent

4.1 Influent Data RLW-LL

A significant reduction in the influent volume has occurred over the last decade. The most significant reductions have occurred because of concerted efforts to reduce and minimize waste across multiple sites and operations at LANL and not through changes in technical scope. The following table shows the documented historical data for RLW-LL influent from fiscal year 1998 through 2010.

Table 1 Historical RLW-LL Influent Data

Fiscal Year	Liters
1998	22,307,291
1999	20,464,536
2000	17,857,966
2001	13,558,873
2002	11,986,052
2003	12,156,083
2004	8,418,000
2005	6,985,360
2006	6,330,000
2007	4,448,499
2008	5,460,000
2009	4,602,000
2010	3,856,200

Figure 4 below shows the influent data shown in Table 1 as a graph.

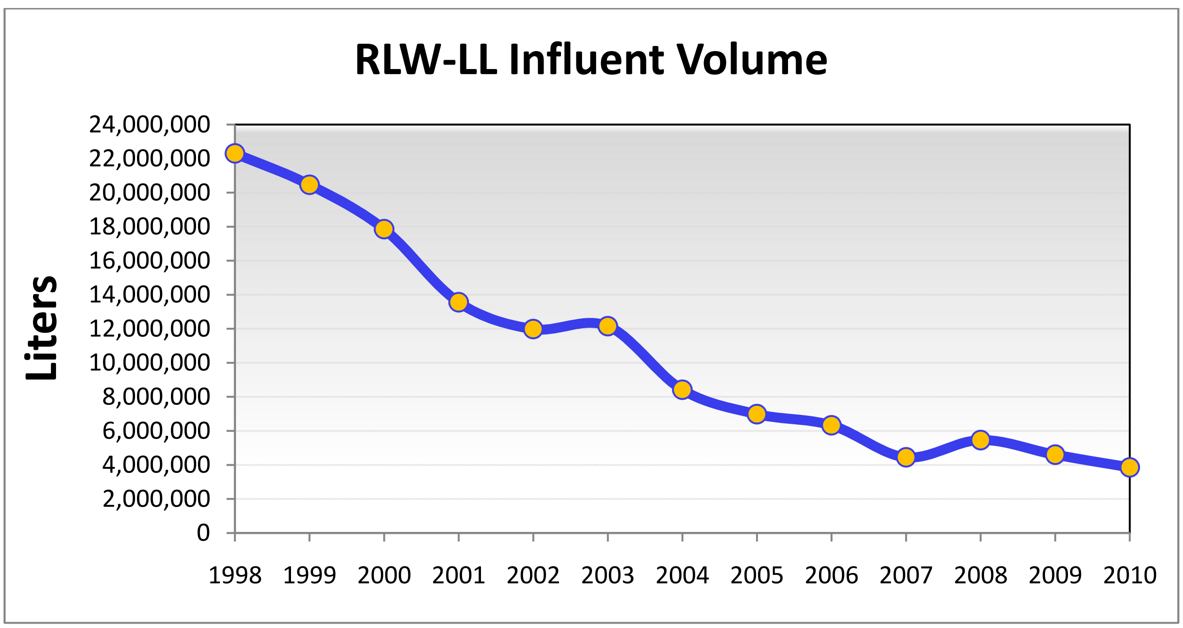

Figure 4 RLW-LL Historical Influent Volume

Approximately 18 million liters of influent has been removed from the RLWTF influent base through various waste minimization projects and improvements to equipment efficiencies. Some examples of significant reductions to influent are estimated in the following[1]:

- Routing of the BTF laundry effluent away from RLWTF (400,000 L) to the appropriate facility (sanitary waste plant) after being analyzed and characterized as non-industrial or non-radioactive waste.
- Replacement of steam driven electroplating heating system at SIGMA facility with solid state electrical heaters reducing condensate effluent (800,000 L)
- Closure of multiple wings at CMR. (1,000,000 L)
- TA-48 Boiler blow down reroute of effluent (2,000,000 L) to the appropriate facility (sanitary waste plant) after being analyzed and characterized as non-industrial or non-radioactive waste.
- TA-48 Physical duct segregation reduced volume of effluent for duct washing (750,000 L)

This list is a very short subset of the efforts that reduced influent to RLWTF over the recent years but is representative of the types of significant reductions in effluent that were made for similar projects. The data in Figure 4 shows the cumulative effect of all factors influencing increases and decreases to RLW-LL influent over time and when analyzed for trends, provides useful data for forecasting.

4.2 Statistical Analysis of RLW-LL Influent Data

Like most projects or operations being optimized, the influent reduction efforts appear to follow a very common trend; large improvements and gains at the beginning of the effort and diminished returns as waste minimization efforts become more difficult to identify or implement. In this case, the trend can be illustrated graphically fitting an exponential trend line to the data. Figure 5 shows the exponential trend line plotted over influent data.

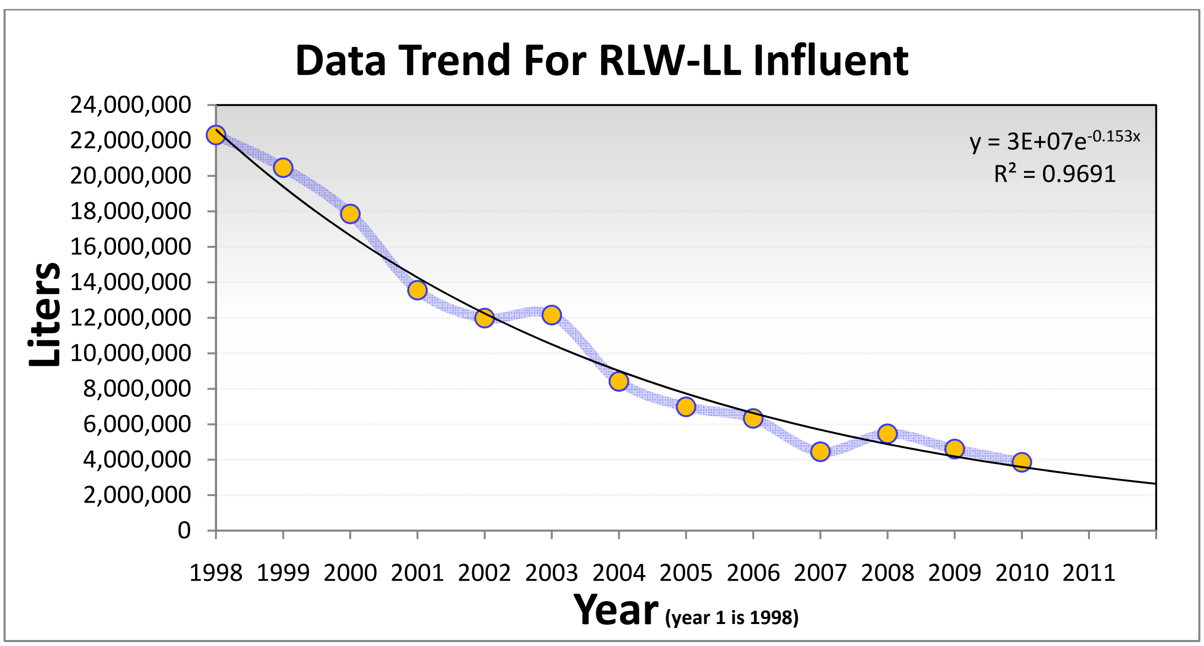

Figure 5 RLW-LL Historical Trend Curve Fit

The curve fit provides useful information in that it shows the slope of the trend changing from an initial steep reduction in effluent per year to a flatter slope meaning lesser annual reduction in total influent in recent years. The curve also provides the first estimate of potential future influent volumes by using the curve fit equation (volume=3E+07e$^{-0.153(year)}$). For FY11 (year 14), the curve fit equation predicts 3,522,593 liters of effluent. The exponential fit equation is best used only one year past the current year because it assumes that volumes can continually be reduced to zero as time progresses when in reality, the formula at some point intersects with a base volume of effluent that LANL operations must generate to remain operational.

A second data point, which weighs heavily on the most recent influent trends, can be derived from the historical data. The last four years of influent have been relatively constant and assuming that no significant projects for influent reduction exist, averaging the four years of data would produce a nominal predicted value for FY11 of 4,591,675 liters of effluent. This prediction also assumes that there is currently no new facility operations expected to significantly increase influent volumes. Figure 6 shows the recent influent historical data that was averaged.

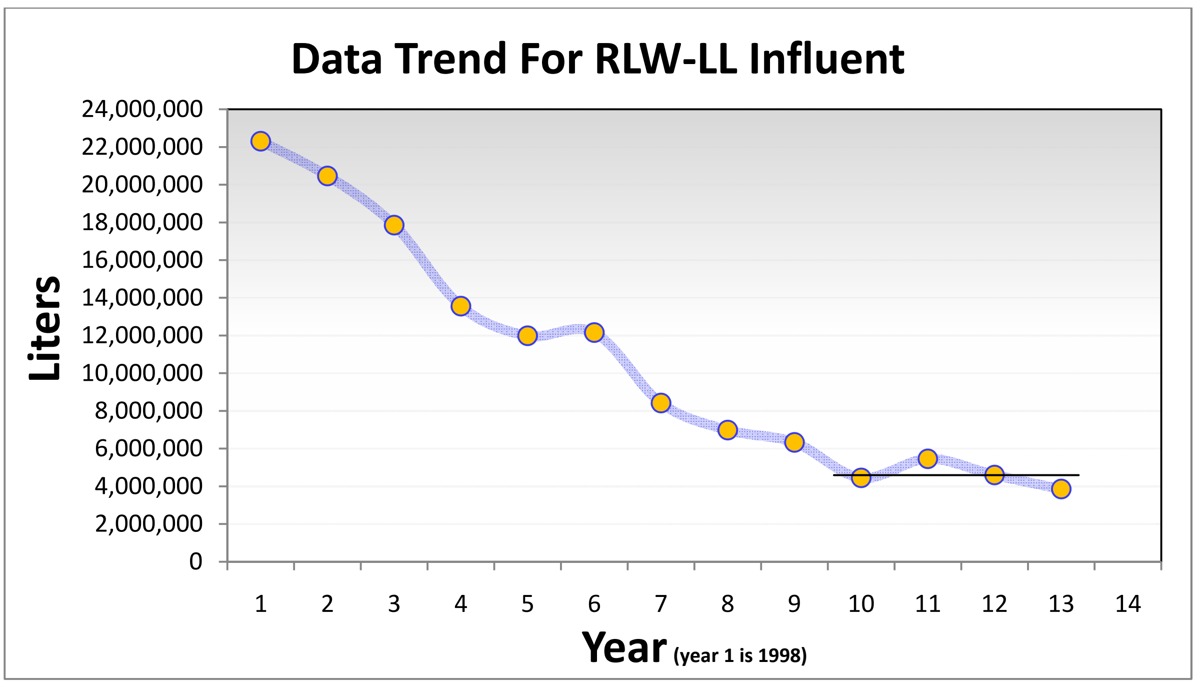

Figure 6 RLW-LL Recent Trend Average

A third forecast data point for RLW-LL can be derived from the available historical influent. The data point would assume that the most recent (i.e. FY10) volume observed at RLWTF would be unchanged into the next year. Thus, the FY11 estimate would be the same as FY10 volume which is 3,856,200 liters. This assumption is not truly realistic because of the significant uncertainty in rain and snow collection but provides a useful reference point for influent to RLWTF. The following sections will provide additional information to establish a forecast for the RLW-LL influent.

4.3 Waste Profile Volume Estimation of RLW-LL

Waste profile forms (WPFs) are used to characterize waste that is expected to be generated at LANL. These forms contain fields such as the description of waste, generator information, and waste volume estimates. The estimated waste volumes found on WPFs are usually very conservative (i.e. on the high side of actual expected waste production volumes) for two reasons: first, because generators must often consider many uncertainties in operations efficiency and facility availability, and second because a function of the WPF estimates is to help determine downstream waste processing requirements where overestimation can be managed much easier than underestimation with regard to compliance and resource matters. Waste profile form volume estimates were analyzed and compiled for RLW-LL. Table 2 shows detail for WPFs that are active, pending review, and that expired within two years from Oct 1, 2010.

Table 2 Waste Profile Form Effluent Estimate

Status	Technical Area	Liters
ACTIVE	55	2,912,323
	03	462,995
	21	378,500
	54	259,954
	48	250,424
	50	149064
	35	83,270
	15	37,850
	16	7475
	59	3,256
	53	2,971
	18	1,219
	00	927
	72	246
ACTIVE Total		**4,550,475**
EXPIRE	50	65,560
	15	60,560
	55	43,648
	48	30,728
	54	28,388
	43	10,137
	03	4,036
	53	2,271
	21	833
	59	15
	00	
EXPIRE Total		**246,176**
PENDING REVIEW	59	1000
PENDING REVIEW Total		**1000**
Grand Total		**4,797,651**

Expired WPFs are included in this analysis because of the potential for reactivation. A WPF can be in multiple "non-official" states of expiration such as the following:

- One year approval for WPF has expired but in many cases is still needed and is quickly reactivated; an expired or voided profile can be reactivated with minimal startup approval within a two year window from date expired.
- WPF is allowed to expire until next campaign. For example work relating to waste stream characterized in WPF is generated in campaign modes such as in D&D and construction projects
- WPF is allowed to expire by generator because waste stream no longer produced

There may be additional causes for a WPF to show up as expired but because of the first two reasons listed above, the expired WPF volumes will be included to establish a conservative RLW-LL volume estimate by generators. The use of the estimates from the WPF is considered to be significantly conservative according to SMEs.

4.4 Subject Matter Expert Estimation of RLW-LL

Subject matter experts (SMEs) provided input on the effluent stemming from specific sites at LANL. When available, this input was useful in that it provided a site specific estimate of effluent and validated or corrected assumptions made on waste profile forms. Not all SMEs were able to provide correction or direct estimates because of the lack of historical data for reference, so in those cases the value in the WPF estimate was used. The following information describes adjusted effluent volume estimates from specific sites as provided by SMEs:

- TA-55 is adjusted down from the WPF estimate of 2.9M liters for several reasons. The first is that the Nitric Acid Recycle System (NARS) has not been used for programmatic use in some time and is not expected to come up anytime soon. Projections for NARS effluent if brought up is only in the 10,000 liter range compared to the WPF of 100,000 liters.[5] Also, because TA-55 increased efficiency in the steam line use and physical configuration, there is a significant reduction in condensate volumes sent down the RLW-LL (i.e. industrial) line. TA-55 is one of the only sites where effluent flow meter data is available.[16] The data for TA-55 shows an average of approximately 1.2M liters from FY08 through FY10 with a range from maximum to minimum effluent in those three years of approximately 130,000 liters. Subject matter experts on LANL flow meters caution the use of flow meter data for two reasons: first is the lack of recent calibration and second is that the LANL flow meters are assumed to work only when there is a sufficient amount of liquid flow down the pipe to trigger the flow meter count. There is a potential for a trickle or any amount less than the trigger volume to flow down the pipe without being metered. Considering this information in addition to TA-55 facility SME input, a conservative estimate of approximately 1.8M liters of effluent is made for the TA-55 contribution to RLWTF influent.
- CMR is building 29 within TA-3. Table 1 above shows 462,995 liters estimated for TA-3 buildings of which 421,387 liters is attributed to CMR. The remainder is mostly attributed to TA-3 Bldg 66 and 141 (i.e. Sigma and BTF respectively). Subject matter experts provided a correction to the CMR value by extrapolating the amount of waste observed through a monitoring tank for Wing 5 across the remaining Wings 7 and 9. An estimate of 181,000 liters for Wing 5 is predicted each year. This wing is the only active aqueous processing wing at CMR and produces far more

effluent than Wings 7 and 9. A total of only 10,000 gallons (approximately 38,000L) is expected to be produced in Wings 7 and 9 total. However, to be conservative, the other two wings were estimated at a total of approximately 75,000 liters per year combined.[6] Total expected effluent is 256,000 liters.

- TA-48 SMEs had recently estimated their duct washing requirement cycle and processing needs producing RLW-LL as part of the FY11 waste cost recovery model. The volume estimated was 174,000 liters versus the 250,000 in the WPF.
- Sigma and BTF were assumed to produce at the levels estimated in the active WPFs.
- TA-54 SMEs reduced the nearly 250,000 liter WPF estimate down to approximately 10,000 liters. The reduction came from moving the respirator washing capability to an offsite vendor. The remaining 10,000 liters was kept for rain water and snow melt collection in floor sump pumps at domes and any onsite drilling activities.
- TA-35 SME reduced RLW-LL effluent estimates from the active WPFs showing an 83,720 liter volume down to nearly 1,000 liter estimate. The reduction was because of the end to a short term metal plating project.[17]
- TA-21 is expected to produce a one-time volume for final disposition of RLW-LL of up to 80,000 gallons. However, the RLW-LL is expected to be treated by a facility other than the RLWTF at TA-50. No TA-21 influent contribution is expected at RLWTF in the future.
- Waste profile form estimates that were made on expired forms were assumed to be expired for the long term and reduced the potential influent by approximately 246,000 liters.

Table 3 summarizes the adjusted estimates made *via* SME elicitation.

Table 3 SME Adjusted Estimates

Technical Area	Liters
55	1,800,000
03	298,647
54	10,000
48	174,000
50	149,064
35	10,000
15	37,850
16	7,475
59	3,256
53	2,971
18	1,219
00	927
72	246
Total	2,495,655

The amount of effluent stemming from anomalies such as rain and snowfall collection is not estimated this section. The assumption in this section is that the difference between any actual generation recorded and the estimate of 2.5M liters shown in Table 3 would stem from rain and snowfall events.

4.5 RLW-LL Forecast for FY11

The influent forecast range for RLW-LL expected at RLWTF in FY11 is defined by the five data points established in the previous subsections. Table 4 summarizes the influent estimates for FY11 for the various forecasting methods.

Table 4 Influent Forecast Methods and Results

Forecast Method	Influent Forecast
12 Year Trend	3,522,893
4 Year Recent Average	4,591,675
Last Year Baseline	3,856,200
Waste Profile Form Estimates	4,797,651
Site Specific Adjusted Estimates	2,495,655

The plot of historical information against the influent forecasts for FY11 from Table 4 is shown in Figure 7.

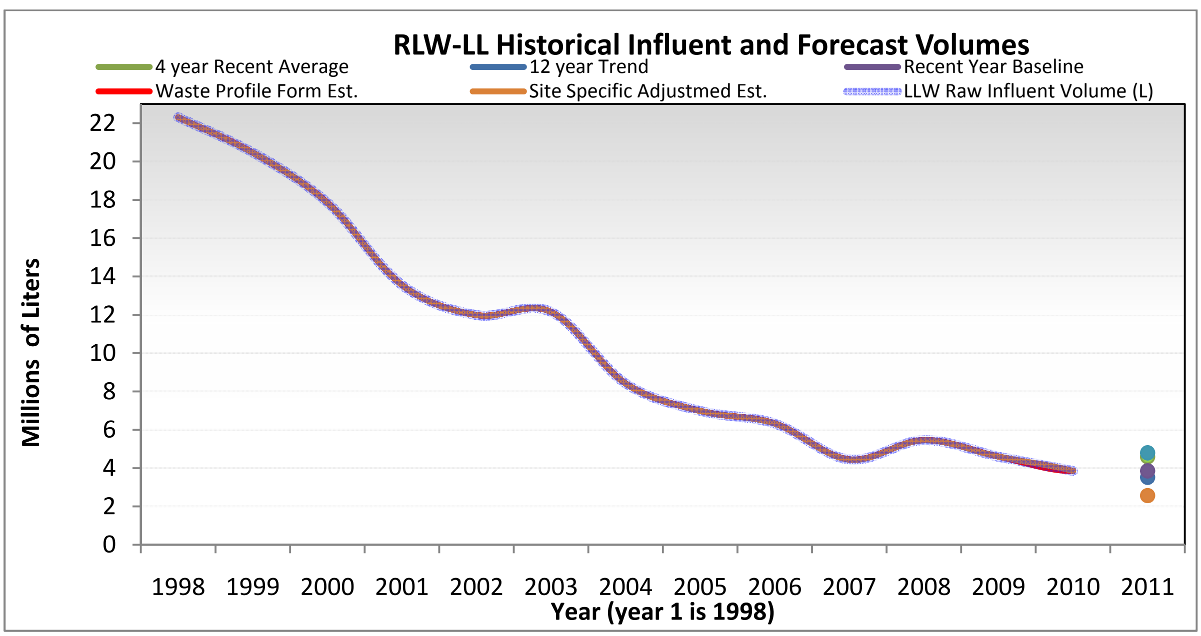

Figure 7 RLW-LL Historical and Forecast Volumes

The maximum predicted value for RLW-LL effluent is approximately 4.8M liters. This value, derived from the WPF, is considered to be a significant over estimation according to subject matter experts. The lowest expected value for RLW-LL, approximately 2.5M liters, stems from the direct estimates of SMEs with site specific knowledge of effluent production. These estimates are the least likely to represent the expected influent volume from the set of potential forecast values in Table 4. The reason being is that the adjustments made to volume estimates by SMEs (2.5M) is based on facility and operational related issues only. Until understood and controlled, the unpredictable quantities of rain and snowfall entering the RLW-LL system through site-wide drain lines, manhole collection systems, and other input locations will continue. The estimate predicted from the WPFs is conservative by nature and significantly exceeds the FY10 recorded volume influent. Exceeding the FY10 influent volume is considered by SMEs as a low probability because no significant increases to facility effluent is planned anywhere at LANL, and in midyear FY10 there was a successful waste minimization project that will provide decreased influent in FY11. The four year average calculated volume (4.6M liters) is also excluded for the same reason. The "12 year trend" (3.52M liters) and the "last year baseline" (3.86M) provide the most appropriate basis for establishing the FY11 forecast for RLW-LL. Both forecasts weigh heavily on recent reductions in influent, they both approach the RLWTF subject matter expert estimate of "FY10-like" volumes, and they are a result of the long history of increases and decreases to influent. Furthermore, when considering the midyear FY10 Sigma facility (bath heater) effluent reduction project, the reduction of 400,000 liters from the "last year baseline" volume (3.85M-.4M=3.45M liters) calculates to a nearly equal amount of influent as the "12 year trend" curve at 3.52M liters. Thus, the forecast for FY11 is a nominal influent volume of 3.5M liters. This value will be used as the starting point for the forecast of RLW-LL beyond FY11 in Section 2.5.

4.6 RLW-LL Boundary Conditions and Forecast Beyond FY11

Understanding influent volumes into the future is vital to capacity planning at the RLWTF. Potential significant increases and decreases to the RLWTF have been documented where available. Table 5 shows the assumptions for the potential changes in RLW-LL over time.[14]

Table 5 Future Increases and Decreases to RLW-LL

Project Title for RLW-LL	Volume (LPY)	Revised Volume (LPY)	Estimated Year of Implementation	Increase or Decrease to RLWTF	Basis for Volume Revision
CMRR Radiological Lab Utility Office (RLUOB)	811,688	362,880	2012	Increase	Factor of two for surge capacity of current CMR Wing 5 RLW-LL Production (Current 181,440L/yr x 2=362,880). Source: Communication w/Lorenzo Trujillo CMR, Amy Wong CMRR POC
CMRR Nuclear Facility	936,563	936,563	2020	Increase	Shaw, 2007 with August 2008 validation by CMRR-DO[2].
Pit Manufacturing/50 Qualified Pits	900,000	450,000	2022 (CMRR Nuc Fac Operational)	Increase	Increase in manufacturing rate would only affect RLW-LL production if steam line utilized more than current. Bringing up NARS and operating a swing shift could potentially create more RLW-LL. However, at maximum only 25% more than current volume (1.8M L) is predicted to be produced. Source: WPF information, current volume production rates, communication with Bart Ortiz TA-55 Facility Rep
CMR Decommissioning	2,078,436	257,040	2018	Decrease	Current CMR Wing 5 RLW-LL Production + Wing 7&9 (Current 181,440L/yr+75600). Source: Communication with Lorenzo Trujillo CMR, Amy Wong CMRR POC

The potential changes to RLW-LL influent documented in Table 5 only describe the most recent assumptions for significant impact to RLW-LL for major projects that are currently within LANL planning scope. There is a potential for significant reductions be made to RLW-LL influent when the rain and snowfall drain collection matter is better understood. Installation of flow meters and tanks at key points in the system might be a strategy to better define the source of the extraneous precipitation volumes and provide potential pipeline rerouting options.

The historical RLW-LL influent data was plotted with the RLW-LL forecast for FY11 and beyond in Figure 8. The FY11 forecast of 3.5M liters is used as the starting point for the forecast. Adjustments to the 3.5M liters were made per the assumed increases and decreases to volume described in Table 5 to create a forecast beyond FY11. To provide an upper boundary limit to the forecast, an uncertainty margin of 1 million liters above the annual forecast was used. One million liters represents nearly 30% of the FY11 forecast volume and is comparable to the highest increase in volume observed in RLW-LL influent in the last decade. As a lower boundary limit, the volume forecast predicted in Section 4.4 was used. However, theTA-55 facility contribution was assumed to be at the least conservative volume of 1.2M liters as described in Section 4.4 instead of the 1.8M liter volume. A total volume of 1.9M liters was calculated as the lower boundary in FY11 and adjusted for outyear predicted increases and decreases shown in Table 5. Any influent stemming from anomalies such as rain and snowfall was ignored for the lower boundary limit. Figure 8 shows the estimated RLW-LL long term forecast and boundary conditions.

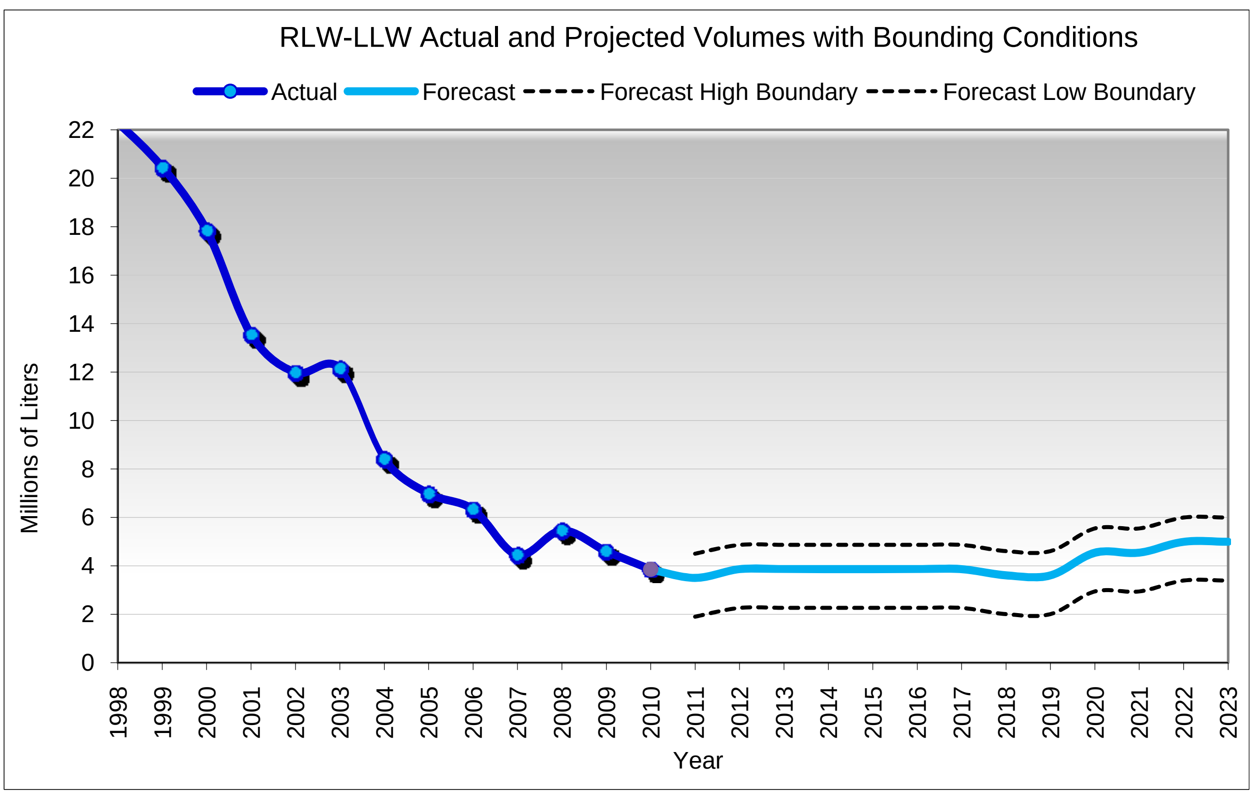

Figure 8 RLW-LL Long Term Forecast

5. RLW-TRU Generators

Only one facility, PF-4 at TA-55, currently produces significant quantities of RLW-TRU at LANL. There is a volume of RLW-TRU that is expected to be generated at the CMRR Nuclear Facility when it becomes operational. The PF-4 waste stream stems from aqueous recovery operations and chill water pumps. There are currently three nitrate aqueous recovery operations, one chloride operation, and ten total pumps supporting negative and positive pressure chill water lines. The CMRR waste volumes will be generated by a caustic waste system supporting processes and facility operations.

5.1 Nitrate Operations

The first nitrate line known as the Rich Feed Exchange (RFX) line is used for manufacturing residue recovery support and vault residue cleanout efforts. The RFX line has the capability to process feeds in large and small batch sizes. Rich feeds can be dissolved in a continuous manner through air-lift dissolvers which significantly increase the amount of material processed. Lean feeds, which are usually more difficult to process, are dissolved in finite volume reflux vessels and throughput less quantity than the air-lift dissolvers. The second nitrate recovery line is known as the Advanced Testing Line for Aqueous Separations (ATLAS). This line is usually reserved for extremely rich feeds to ensure higher probability of success when a polished product is required and to minimize the potential cross contamination between projects. This line uses small reflux vessels for batch processing and is capable of throughputs similar to that of the first nitrate line when run as small batches. The ATLAS line often produces more liquid waste effluent than the other nitrate operations because of the excessive wash volumes used to ensure high purity products. The third nitrate line is a bench-scale operation that supports the plutonium-238 operations. This recovery operation has a low throughput rate relative to the other two operations because of physical size of the unit operation and difficulties inherent in dissolving the available plutonium-238 matrices. The nitrate operations utilize an Ion Exchange resin for the separation of actinide from other constituents.

5.2 Chloride Operations

The chloride based operation, known as the Experimental Chloride Extraction Line (EXCEL) is ideal for recovering plutonium from residues that are created in support of metal production processes. The production and refinement of plutonium metal often involves the use of chloride containing constituents which cause problems within a nitrate system. The chloride operation is capable of recovering actinide material through an Ion Exchange resin or through a solvent extraction process. The dissolution of materials within the chloride line is performed in small vessels as a batch process.

The Chloride Extraction and Actinide Recovery (CLEAR) line will be included when establishing the RLW-TRU forecast. This unit operation has not yet been fully installed and approved within PF-4, but when in use can potentially create significant quantities of RLW-TRU. The CLEAR line will use extraction chromatography technology to recover actinide materials. The CLEAR line was originally intended as a waste minimization process in reducing the radioactivity in effluent stemming from a residue treatment step within the EXCEL line. Recently, a potential mission appropriate for the capabilities of the CLEAR line, involving recovery of americium as a product, has been proposed. As a waste minimization step the

CLEAR line was expected to increase effluent approximately 10%, however, it is estimated to produce similar volumes to EXCEL running as a recovery line for americium extraction.

Forecasting RLW-TRU effluent stemming from the nitrate and chloride recovery operations is difficult because the output of waste is dependent on the specific method that each operation is run; for instance, as batch or as continuous operation. The method of operation is dependent on the desired product purity, dissolution efficiency of feed, and amount of throughput desired which is all driven by the requirements set by programs and projects. Various production scenarios will be analyzed for each recovery operation to establish a forecast for FY11 and boundary conditions into the future.

5.3 Chill Water Pumps

The pumps to be flushed out in PF-4 primarily support negative pressure chill water systems. Historically, each pump was flushed out directly to the RLWTF approximately every nine months to manage radioactivity levels in the system. More recently, the pumps have been flushed out on a significantly reduced schedule and dumped into the evaporator process associated with the RFX line for management of radioactivity. PF-4 maintenance plans on resuming the practice of flushing each pump on a nine month cycle directly to RLWTF.[12] The effluent generated by these pumps is established through subject matter expert estimation of the average pump volume produced.

5.4 CMRR Nuclear Facility

The caustic waste system at the planned CMRR Nuclear Facility has not yet been fully defined in its support function. Preliminary estimates made by subject matter experts on the design of the facility function have provided conservative volume estimates for the CWS effluent volumes.

The following sections will show historical influent data for RLW-TRU and analyze various scenarios of production for each operation to establish a forecast.

6. RLW-TRU Forecasting

Forecasting RLW-TRU effluent stemming from the nitrate and chloride recovery operations is difficult because the output of waste is dependent on the specific method that each operation is run; for instance, as batch or as continuous operation. The method of operation is dependent on the desired product purity, dissolution efficiency of feed, and amount of throughput desired which is all driven by the requirements set by programs and projects. Various production scenarios will be analyzed for each recovery operation to establish a forecast for FY11 and boundary conditions into the future.

6.1 Influent Data RLW-TRU

The historical total influent for RLW-TRU received at RLWTF is shown in Figure 9 below. Note that the gap in data for 2005 and 2006 coincides with the RLWTF being unavailable to receive RLW.

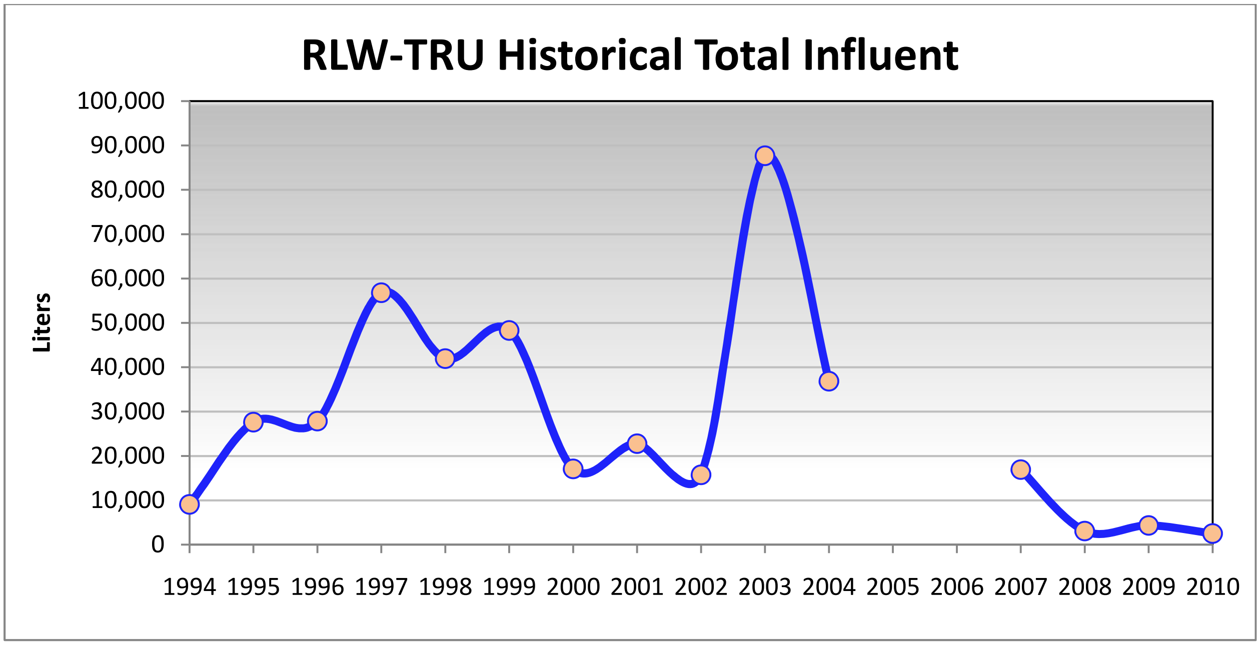

Figure 9 Historical Total Influent (Acid & Caustic)

The total influent of RLW-TRU is comprised of the acid and caustic streams generated at TA-55 from. Figure 10 below shows the detail for the acid and caustic influent.

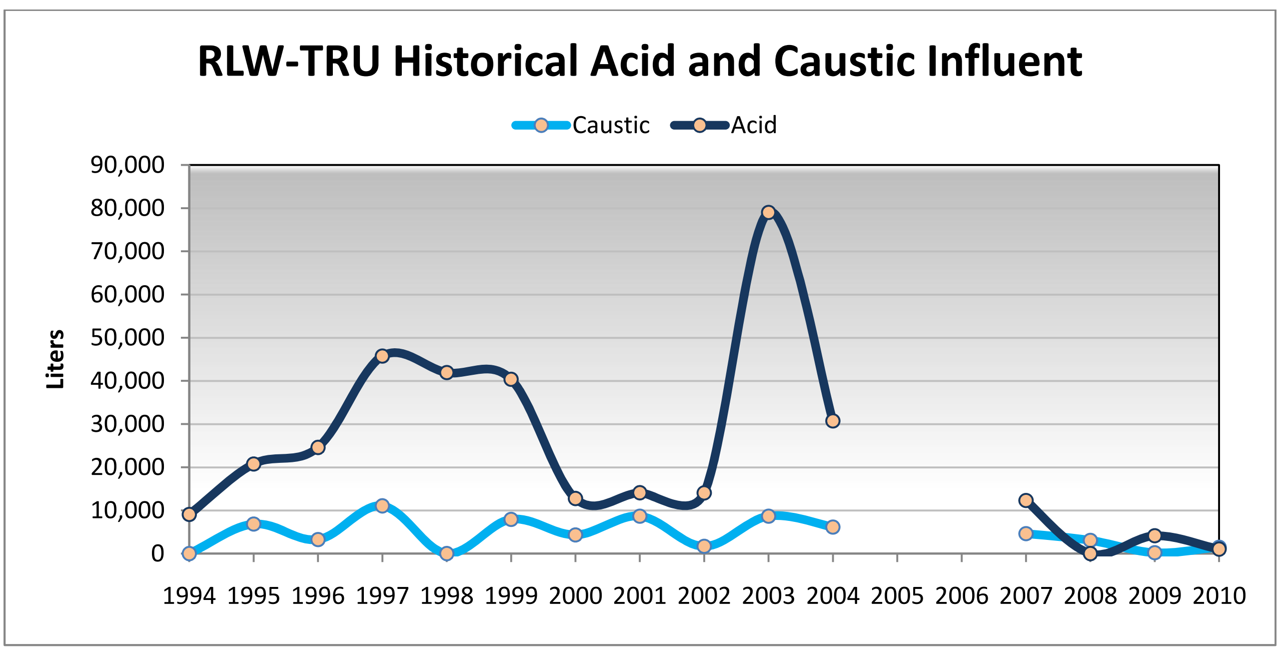

Figure 10 Historical Influent Acid and Caustic Detail

6.2 Production Scenarios for Forecasting

6.2.1 RFX Production Levels

The RFX line is currently working on processing vault residue items. This line is able to transition between its current mission of vault residue processing and current generation residue recycling in support of manufacturing missions. The RFX line is currently running the feed dissolution step as a batch process. Batch dissolution in a reflux vessel is better suited for dissolving lean feeds with multiple contaminants than the continuous feed air lift dissolvers available in the RFX line. The RFX nitrate recovery line will alternate between batch processing and air lift dissolution as the feed stream dictates. The amount of effluent produced in RFX is affected by both the method of dissolution and the amount of total throughput of the system. Three production scenarios are assumed for the RFX line.

The lowest production level scenario for RFX is similar to the current levels of vault residue recovery with minimal support of manufacturing missions. At this level of production, 2,000 liters of effluent is estimated. The 2,000 liters of effluent considers the reduced processing time from MC&A inventory requiring a full shutdown cleanout effort on an 8 week cycle and reduced capacity because of dissolution cycle time. The short term maximum production levels would require the RFX line to increase its manufacturing support while continuing with recovery of vault residues. The effluent volume at the short term production level is estimated at a maximum of 13,000 liters. The long term maximum production level scenario for the RFX line would be in support of a 50-80 pit mission or similar. Upgrades and installation of equipment would be required to support a 50-80 pit mission while continuing to support the vault residue processing requirements. The RFX line is estimated to generate an approximate maximum of 26,000 liters of effluent under this scenario. [2, 7] An assumption is made that the Nitric Acid Recycle System (NARS) would be available to support the RFX line under the short term and long term maximum production scenarios.

6.2.2 ATLAS Production Levels

The ATLAS line is currently in capacity maintenance mode. This line has historically been reserved for high purity feeds and is not used in support of current missions involving residue recovery. The last program to process material in ATLAS was the Mixed Oxide Polishing program (MOX) which generated the largest annual quantity of effluent of any aqueous operation at TA-55 in recent history. There is no major campaign, including another polishing project, currently planned for the ATLAS line. Furthermore, it is estimated that even if another project such as MOX was processed through the ATLAS line, the effluent volumes would be significantly reduced because of optimization in the washing volumes for the product; possibly by 75%.[7] The ATLAS line is very similar in processing capability and effluent volume to that of RFX when RFX is run as a batch process. The ATLAS line is expected to supplement the RFX line capacity as the requirements for manufacturing support increases.

The production scenarios for ATLAS include a low production rate that is only for capability maintenance of the process, a short term maximum production level as the overflow support for the RFX line capacity, and a potential long term maximum production level as an RFX supplement in support of a 50-80 pit mission. At the lowest production rate, ATLAS would run up to five batches per year. Assuming minimal wash volumes, the five batches would equate to approximately 300 liters of effluent. The vault residue processing and manufacturing mission is expected to exceed the capacity of RFX for short periods of time because of process upsets, difficult feed, and schedule overlap. The ATLAS line is expected to supplement the RFX capacity at an estimated short term maximum of 1000 liter per year level. For the long term maximum production levels, which in this case would be under a 50-80 pit mission, ATLAS would supplement the RFX capability to an estimated maximum of 13,000 liters. The support would most likely come as manufacturing mission support residue recycle and oxide feed production capacity while RFX would balance between vault residues and manufacturing mission support.

6.2.3 Pu-238 Production Levels

The plutonium-238 operations use bench scale aqueous operations to recover and polish actinide materials. The effluent estimated for Pu-238 operations is based on the number of batches run. The Pu-238 operations are expecting a minimum of 3,500 grams of material per year to be run through the recovery line. It is estimated by SMEs that for every 100g processed, 5 liters of effluent is produced. The lowest production level effluent projected is 175 liters. A short term maximum production campaign of up to 14,000 grams or 700 liters of effluent is expected to be processed in the 2013-2015 range. There is a period before and after this date range that will produce volumes of approximately 300 liters per year. The long term maximum estimated production level decreases back down to the 3,500 gram level in 2019. Hence, effluent for Pu-238 is estimated at 175 liters for the long term. It is assumed that two parallel aqueous recovery lines will be required to meet the short term maximum estimated production levels. Note that although the process is an acid based recovery operation, the treatment of the effluent and activity level requires the volume to be dumped down the caustic line.[8]

Table 6 shows the estimated effluent for the Pu-238 operations.

Table 6 Expected RLW-TRU Effluent from Pu-238 Operations

Low Production	Short Term Maximum Production	Long Term Maximum Production
175 L	700 L	175 L

6.2.4 EXCEL Production Levels

The EXCEL line is a batch process that currently supports multiple program requirements. Each batch processed is assumed to produce approximately 80 liters (i.e. 50 liters raffinate + 30 liters oxalate processing) of effluent. Three separate scenarios have been analyzed for EXCEL.[9]

The first scenario is the expected minimal or lowest production level which is comparable to the current mission. The current mission is currently a balance of vault clean-out items which are difficult to recover and processing of pyrochemical residues in support of metal production operations. Under current mission requirements, a minimum of 25 batches is assumed to be processed each year via the following equation assumptions.[9,10]

40 productive weeks X 1 avg batch a week X 0.625 productive time (MC&A Inventory)=25 batches

The 0.625 factor is based on 5 weeks of available processing time out of an 8 week MC&A inventory cycle that is currently required at TA-55 year round. Two full semi-annual cleanout inventories are included in the 40 productive weeks. Twenty-five batches at 80 liters is equivalent to 2,000 liters of effluent. [9]

The second scenario is one where a shift in feed type is expected and a larger number of batches will be processed. This scenario is the short term maximum production level planned for the EXCEL line. The shift to processing current generation residues as a primary feed source is expected to occur. Residues currently generated are significantly easier to process than the current vault cleanout items being recovered; hence a greater number of batches can be run. An estimated 100 batches per year is planned under this scenario. An assumption made under this scenario is that the eight-week MC&A inventory cycle is reduced back to two semi-annual cleanout inventories per year. The 100 batch scenario is a product of available work time and estimated runs per week as follows [9, 10]:

40 productive weeks X 2.5 avg batches per week =100 batches

One hundred batches producing 80 liters per batch are equal to 8000 liters per year.

The final scenario is where the EXCEL line would be required to support a 50-80 pit mission. At this level of manufacturing support, it is assumed that the full capacity of EXCEL would be utilized. Assumptions are made that the currently planned improvements to the metal casting process and electro-refining recovery efficiency would be completed decreasing the requirements for residue throughput and making it possible for the existing capacity and capabilities of the current EXCEL line to support such a large mission. Under this scenario, it is estimated that EXCEL would be pushed to its long term maximum capacity of approximately 120 kilograms per year.[10] At 120 kilograms, 9600 liters of effluent is estimated.

Table 7 shows the three levels of expected effluent stemming from the EXCEL line into the future.

Table7 Expected RLW-TRU Effluent from EXCEL

Low Production	Short Term Maximum Production	Long Term Maximum Production
2000 L	8000 L	9600 L

6.2.5 CLEAR Production Levels

The CLEAR line is capable of using either solvent extraction (SE) or anion exchange (IX) technology to recover actinide materials. The use of the extraction chromatography technology within the CLEAR line however is, for all practical purposes, consistent with either SE or IX. Each method (SE & IX) varies in recovery efficiency and effluent production. For the purposes of forecasting, it is prudent to use only the IX effluent assumptions as they will bound the lesser producing SE process. Although CLEAR line will remove a significant amount of activity from effluent, the current assumption made is that all effluent stemming from CLEAR line will be dumped to the Radioactive Liquid Waste Treatment Facility (RLWTF) via the caustic line because of radioactive concentration levels or concentration of caustic constituents. In other words, CLEAR effluent is never assumed to be treated as industrial waste but always RLW-TRU.

The CLEAR line was initially planned to be used as a waste minimization step for byproduct effluent in the EXCEL line. As a waste minimization step, an increase of up to 20% (2000 x 0.2=400) in effluent to the EXCEL volumes is estimated. However, the short term production levels currently assumed for CLEAR line are not as a waste minimization step but as an americium recovery and polishing line. At americium recovery production levels it is assumed that CLEAR will produce approximately 200 liters per batch with a max target of 25 batches per year. [3, 11] The total annual effluent expected for CLEAR line in support of an americium recovery mission is approximately 5,000 liters. For the long term maximum production levels, in a 50-80 pit mission scenario, it is assumed that CLEAR line may be required to support EXCEL at some level as a waste minimization step in addition to the americium recovery. It is estimated that beyond the 5,000 liter estimated volume from americium recovery, a potential for up to 10% increase in EXCEL volumes in support of waste minimization could be possible. A total estimate of 5,960 liters (5000L + 9600*0.1) is expected for a 50-80 pit scenario. The expected volumes for CLEAR are in Table 8 below.

Table 8 Expected RLW-TRU Effluent from CLEAR

Low Production	Short Term Maximum Production	Long Term Maximum Production
400 L	5000 L	5960 L

6.2.6 Pumps-Negative and Positive Pressure Line Production Levels

Each pump in support of the negative and positive pressure chill water lines is expected to be flushed on a nine-month cycle. There are ten pumps total in PF-4 and each pump is expected to produce approximately 120 liters of volume when flushed out.[13] At this cycle time, thirteen pump flushes a year are expected. The following equation shows the calculation for volume effluent produced by the pumps each year at expected scenarios of production over time:

Low Production: *4 pumps/yr X 120L/pump = 480 L/yr*
Short Term Maximum Production: *10 pumps/yr X 120L/pump = 1200 L/yr*
Long Term Maximum Production: *13 pumps/yr X 120L/pump = 1560 L/yr*

The expected volumes for the chill water pumps are in Table 9 below.

Table 9 Expected RLW-TRU Effluent from Chill Water Pumps

Low Production	Short Term Maximum Production	Long Term Maximum Production
480 L	1200 L	1560 L

Two pumps are currently non operational and the final approval for dumping schedule has not been approved.[13] It is expected that the pump flush activity will produce at the long term maximum production rate starting in 2013.

6.2.7 CMRR Caustic Waste System (CWS)

The design for the CWS at CMRR is currently under review. Estimates of effluent production have been made for the CWS as part of the review process. The minimum expected volume is approximately 50 liters per month or a total of 600 liters per year. The most likely expected volume is approximately 300 liters per month, which includes rinse and wash volumes, or 3,600 liters per year. The least likely and most conservative volume of 10,000 liters estimated for the CWS is based on the assumption that CMRR operations would have to process their own sample solution residues instead of returning them to TA-55. Subject matter experts estimate that the 3,600 liter per year value is most appropriate to use for forecasting purposes at this time.[13] The volume generated by the CWS is predicated on the assumption that the CMRR Nuclear Facility is built and made operational which is scheduled for completion over a decade from 2010; hence, the 3,600 liter estimate will be part of the long term maximum production level for operations and no other level.

6.3 RLW-TRU Boundary Conditions and FY11 Forecast

The volume of effluent produced by each operation in Section 6.2 will vary annually because of mission requirements, operational uncertainties, facility downtime, and administrative constraints such as MC&A inventory requirements. The goal of the preceding section was to identify expected production levels and establish boundary conditions for each RLW-TRU generating operation for the foreseeable future. Table 10 shows the estimated boundary conditions for each operation described above. The levels of production and effluent are based on the assumption that facility operations are available at TA-55, the RLWTF is available to receive influent, and that all assumptions stated in this report are representative of current planning. Note that the calculated totals in Table 10 assume a snapshot in time when each operation is producing effluent at the respective production level. Each operation has a different schedule for transitioning between production levels which is better represented by Figure 13 below which considers changes over time.

Table 10 Expected Boundary Conditions for RLW-TRU by Aqueous Recovery Line

RLW producer	Low Production (L)	Short Term Maximum Production (L)	Long Term Maximum Production (L)
RFX	2000	13000	26000
ATLAS	300	1000	13000
Pu-238	175	700	175
EXCEL	2000	8000	9600
CLEAR	400	5000	5960
Pumps	480	1200	1560
CMRR	-	-	3600
Total	**5355**	**28900**	**59895**

Each recovery line dumps effluent to the RLWTF *via* either a dedicated acid or caustic waste line. The RFX line, ATLAS line, and chill water pumps will dump effluent down the acid waste line. The EXCEL, CLEAR, and Pu-238 recovery lines, and future CWS at CMRR will dump effluent down the caustic line.

Figures 11 and 12 compare the history of acid and caustic influent received at RLWTF with the estimated boundary conditions into the future.

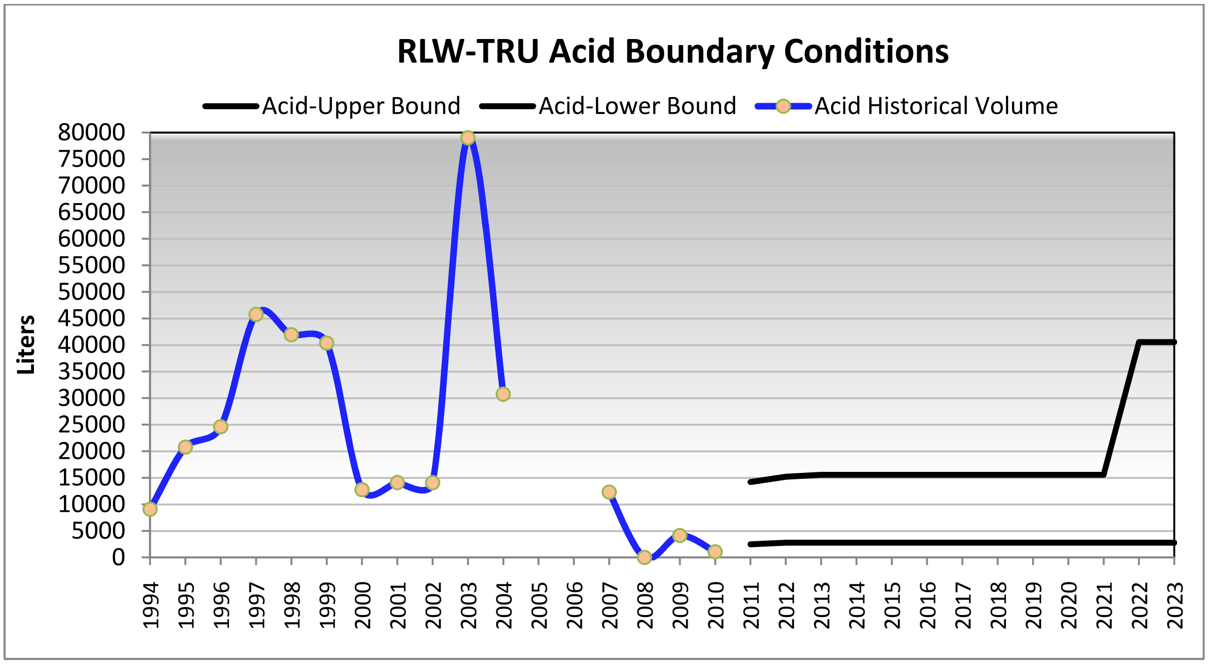

Figure 11 Acid RLW-TRU History and Boundary Condition

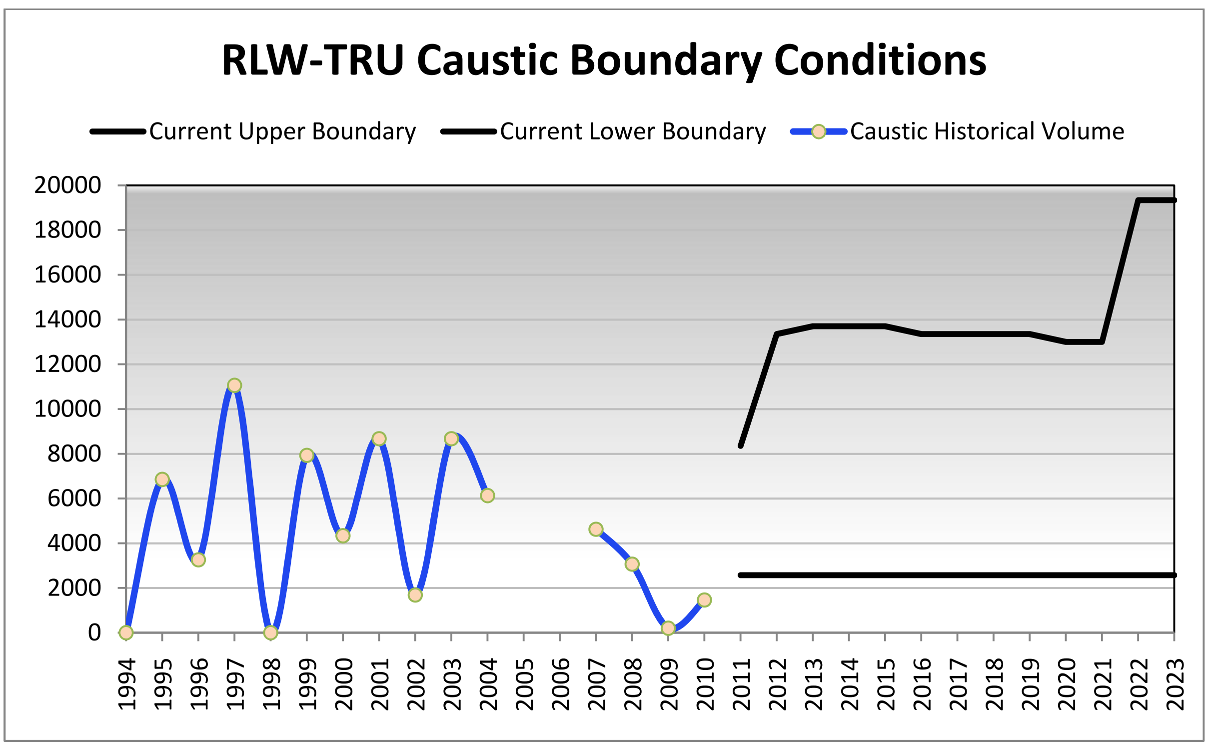

Figure 12 Caustic RLW-TRU History and Boundary Condition

Significant assumptions to consider for the upper and lower boundary conditions for acid and caustic effluent are as follows:

- The RFX line will not support scope that requires ATLAS support until 2012.
- A 50-80 pit mission could not be supported until the CMRR Nuclear Facility is in place. This report assumes that CMRR will be available to support missions in 2022.[4, 10]
- Long term maximum throughput for RFX and ATLAS assumes a combined 200kg of actinide material processed; Short term maximum throughput for RFX and ATLAS assumes a combined 60kg [10]
- Long term maximum throughput for EXCEL line assumes 120kg of actinide material processed; Short term maximum throughput for EXCEL line assumes 100kg
- The CLEAR line is assumed to produce its first significant volume of waste in 2012.[11]
- CLEAR line will primarily be used as americium extraction and polishing production line for foreseeable future[11]
- The Pu-238 missions are expected to begin in 2011 at a nominal throughput of 3.5kg per year, ramp up to a maximum of 14 kilograms per year in 2013-2015, and back down to 3.5 by 2019[8]
- The boundary conditions are established under the assumption that all unit operations at TA-55 are operational without significant process upsets and that RLWTF is able to accept RLW-TRU.
- The short term and long term maximum production scenarios assume that the MC&A inventory requirements are reduced to only two full shutdown cleanout MC&A inventories per year; significantly increasing processing efficiency and available processing time
- The CMRR CWS estimates are preliminary estimates made by SMEs and are expected to be refined as the design criteria matures
- The chill water pumps will continue to be flushed to RLWTF directly starting in 2011.[12]

A long term maximum of 59,895 liters of combined acid and caustic effluent is expected via the analysis in this report. Figure 13 below shows the historical total influent of combined acid and caustic RLW received at RLWTF as well as the combined boundary conditions estimated. The figure also shows an estimated total volume of acid and caustic to be produced in FY11. The FY11 estimate assumes continued MC&A inventories on an 8 week cycle for most of the year and a possible relief from that requirement in the last quarter of operations.

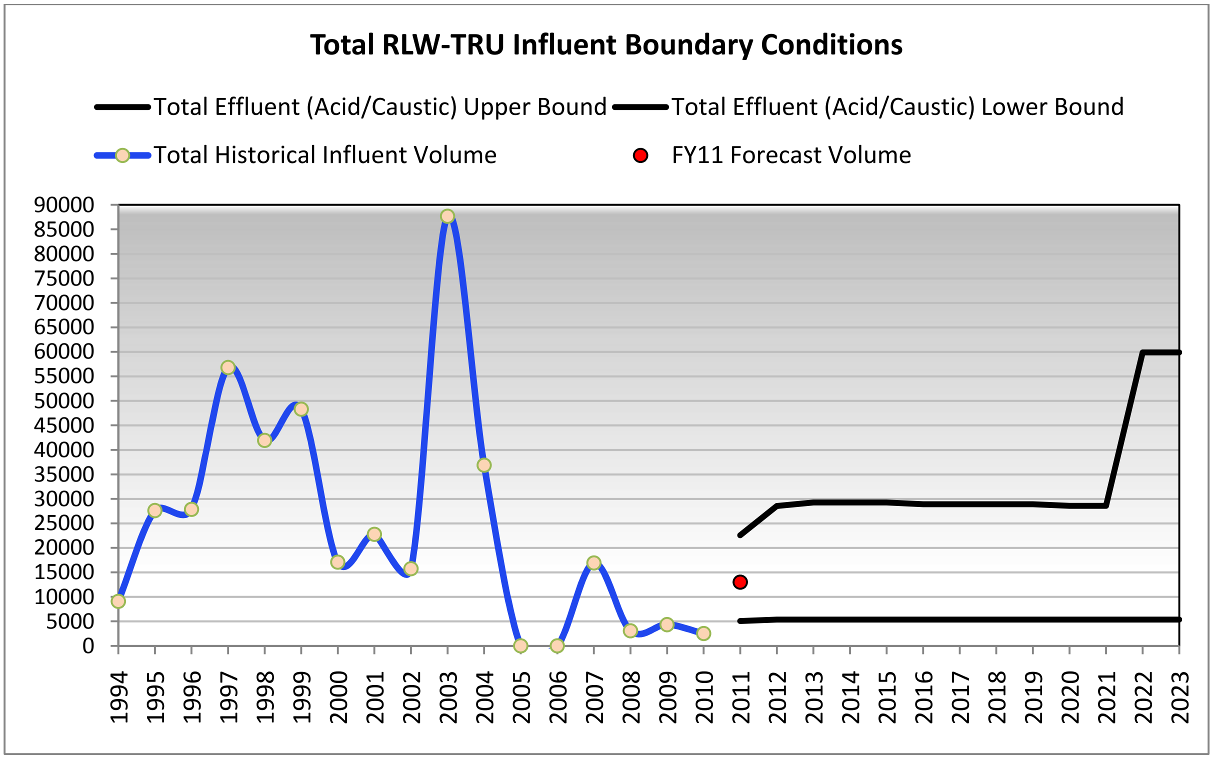

Figure 13 Total Combined Influent Boundary Conditions

7. Final Comments

The results of the analysis in this report show significant differences in volume and boundary conditions than those observed in the Shaw Report (2007). Updated assumptions and completed waste minimization projects show a different outlook for both RLW-LL and RLW-TRU into the future. This document represents the most current information with regard to planning basis, facility constraints, process improvements, process capabilities & capacity, and administrative requirements. The analyses in this report have produced the most current estimate for boundary condition forecasts for both the RLW-LL and RLW-TRU waste streams available.

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