History and Environmental Impacts of DMTS Port Site

Red Dog Operations, Alaska

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Presented by
Exponent

Port Site History – Presentation Outline

- Executive Summary (attached memo)
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- Surface Water Runoff Control Improvements

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Executive Summary

Red Dog is the largest zinc mine in the world, producing approximately 1.2 million tons of lead and zinc ore concentrates per year. Operated by Teck Cominco, the mine is located approximately 50 miles east of the Chukchi Sea in the DeLong Mountains, at the western end of the Brooks Range of northern Alaska. Red Dog is located within an area of local government known as the Northwest Arctic Borough, on land owned by NANA Regional Corporation (NANA).

The Red Dog Mine is linked to a port facility by a 52-mile long, 30-ft wide all-weather gravel-surface overland haul road. The road and the port facility together make up the DeLong Mountain Transportation System (DMTS). The DMTS is owned by Alaska Industrial Development and Export Authority (AIDEA), a public agency that has contracted with Cominco for its use, operation, and maintenance. The port facility is on property owned by NANA, which is leased by AIDEA, and is operated by Teck Cominco.

Ore containing lead and zinc is milled at the Red Dog mine to produce lead and zinc concentrates in a powder form. The lead concentrate is 59 percent lead, and the zinc concentrate is 55 percent zinc. These concentrates are hauled year-round from the mine via the DMTS haul road to two concentrate storage buildings (CSBs) at the Port Site, where they are stored for later loading onto barges during the summer months. Concentrate is moved from the CSBs to barges by conveyors. A surge bin at the dock area provides storage capacity and a steady flow rate for the shiploader boom conveyor. The barges transport the concentrate to deepwater ships anchored offshore.

Initial development of the DMTS began in 1986 with construction of a shallow water dock and staging area at the Port Site. With these facilities in place, road and mine site construction began in July 1987, and was completed by November 1989. Concentrate storage in the CSBs began in November 1989, and barge loading and shipping of concentrate began in July 1990. The second CSB was added as part of a production rate increase between 1996 and 1998.

Teck Cominco contracted for the performance of an environmental baseline study in June 1990, as part of a proactive program developed to minimize operational impacts through early identification of fugitive emissions and implementation of mitigative measures. The study occurred prior to the beginning of shipping of concentrate, but after concentrate transport and storage in the CSBs had begun. The baseline study showed that losses of concentrate had occurred in several areas around the port facility. As a result, a number of engineered improvements and operational practices were implemented to minimize concentrate loss and control fugitive dust. The environmental sampling approach that had begun with the baseline study was continued and converted into an ongoing Port Site Monitoring Program (PSMP).

The objectives of the PSMP were to better identify areas of concentrate loss and sources of fugitive dust; to better understand environmental impacts to the Port Site area; and to track the performance of dust control measures over time. The PSMP included sampling of soil; lagoon and marine sediment; and water from tundra, lagoon, and marine environments in the Port Site area. The areas of primary concern identified by the PSMP were the truck unloading area, the doors at the ends of the CSBs, the conveyor that runs from the CSBs to the dock area, and the surge bin at the dock end of that conveyor. The PSMP also showed that metals concentrations were much lower in samples from outlying areas of the Port Site. Although the PSMP provided valuable baseline data and indicated where the early problem areas were, it was ultimately ineffective as a means of tracking the performance of the various fugitive dust control measures. Teck Cominco wanted to be able to monitor the effectiveness of the improvements it was continuing to make to control fugitive emissions. Therefore, the PSMP program was ended in 1996, and replaced with an air monitoring program, which has continued to the present.

The objectives of the current air monitoring program are to improve the understanding of fugitive dust sources and impacts, and to quantify the effectiveness (year-to-year) of dust control measures implemented at the port facility over time. This program would thereby reduce impacts during operations as well as minimize the cleanup efforts required during the closure and reclamation process in the future. The air monitoring results indicate that the primary remaining sources of fugitive dust are the ends of the CSBs, the road where the trucks exit the CSBs after unloading, and the surge bin in the dock area. No detectable trends in fugitive dust emissions have been identified from the data; however, review of the data is ongoing. Tapered element oscillating microbalance (TEOM) samplers have been installed recently, and are expected to provide hourly air concentration data for comparison with meteorological data and port operations data.

The Port Site has received continuous upgrades since operations began, in an ongoing effort to minimize fugitive metals from the facilities. These improvements include enclosure of all of the conveyors and transfer points, modification and enclosure of buildings, upgrades and additions of baghouses, truck modifications, truck washing procedures, enhanced road management practices, and expanded surface water capture and treatment facilities.

Teck Cominco developed the environmental monitoring, dust control, and surface water control efforts as part of a program to identify sources of concentrate loss and fugitive emissions and to implement mitigative measures, with the objective of minimizing operational impacts. The primary impacts from Port Site operations are contained within localized areas of the facility, and are being addressed on an ongoing basis.

Port Site Monitoring—Overview

The environmental monitoring, dust control, and surface water control efforts are part of a pro-active program developed to minimize operational impacts through:

- Early identification of fugitive emissions, and
- Implementation of mitigative measures

The objective of this program is to reduce impacts during operations as well as minimize the cleanup efforts required during the closure and reclamation process in the future.

Port Site History – General Overview

- 1986 – Shallow water dock construction began
- 1987 – Road construction began
- 1988 – Building construction began
- Nov. 1989 – Ore concentrate storage began
- June 1990 – Baseline environmental monitoring began
- July 1990 – First barge loaded with concentrate

Port Site History – General Overview

1996–1998 Port Site Upgrade (Production Rate Increase – PRI)

- Installed second concentrate storage building (CSB) next to existing building
- Upgraded camp
- Upgraded conveyor system

Port Site History – Environmental Monitoring

June 1990 – Baseline Port Site Sampling Program ("baseline" indicates post-construction, pre-shipping)

- Showed that ore concentrate was being lost in several places around the Port Site
- Engineered dust control improvements were implemented in response to these findings
- Sampling program was continued and converted into an ongoing Port Site Monitoring Program (PSMP)

Port Site History – Environmental Monitoring

1990-1996 PSMP objectives were to:

- Better understand areas of concentrate loss, sources of fugitive dust, and hydrocarbons
- Better understand impacts to Port Site area
- Measure performance of dust control measures over time

Port Site History – Environmental Monitoring

1990-1996 PSMP media sampled included:

- Soil
- Sediment (lagoon and marine)
- Water (tundra, lagoon, and marine)

Port Site History – Environmental Monitoring

1990–1996 PSMP areas sampled included:

- CSB Area
- Road loop and unloading area
- Conveyor
- Dock area
- Fuel storage facility and pipeline

Port Site History – Environmental Monitoring

1990–1996 PSMP areas sampled also included:

- Onshore (tundra) water
- Lagoons
- Nearshore marine area
- Reference sites (tundra, marine, lagoon)

Port Site History – Environmental Monitoring

1990–1996 PSMP analytes included:

- Lead and zinc (including total and dissolved metals for water samples)
- pH, temperature, conductivity for water samples
- Diesel-range organics (DRO)

1990–1996 PSMP Findings

Primary Source Areas (areas most highly affected by lead and zinc – these are essentially areas of ore concentrate loss from the system):

- Conveyor
- Dock area (near surge bin)
- Entry/exit (ends) of CSB
- Unloading area and loop road

1990–1996 PSMP Findings *(continued)*

Lead/Zinc trends during the monitoring period:

- Maximum soil concentrations are generally elevated by 2–5 times 1990 baseline results (essentially from concentrate loss in source areas)
- Soil concentrations generally stabilized by 1996 and decreased in a few areas

1990–1996 PSMP Findings *(continued)*

Lead/Zinc trends during the monitoring period:

- Soil concentrations decrease rapidly with distance from the primary source areas
- Concentrations in lagoon sediments may still have been rising in 1996, although more slowly, but water concentrations were stable

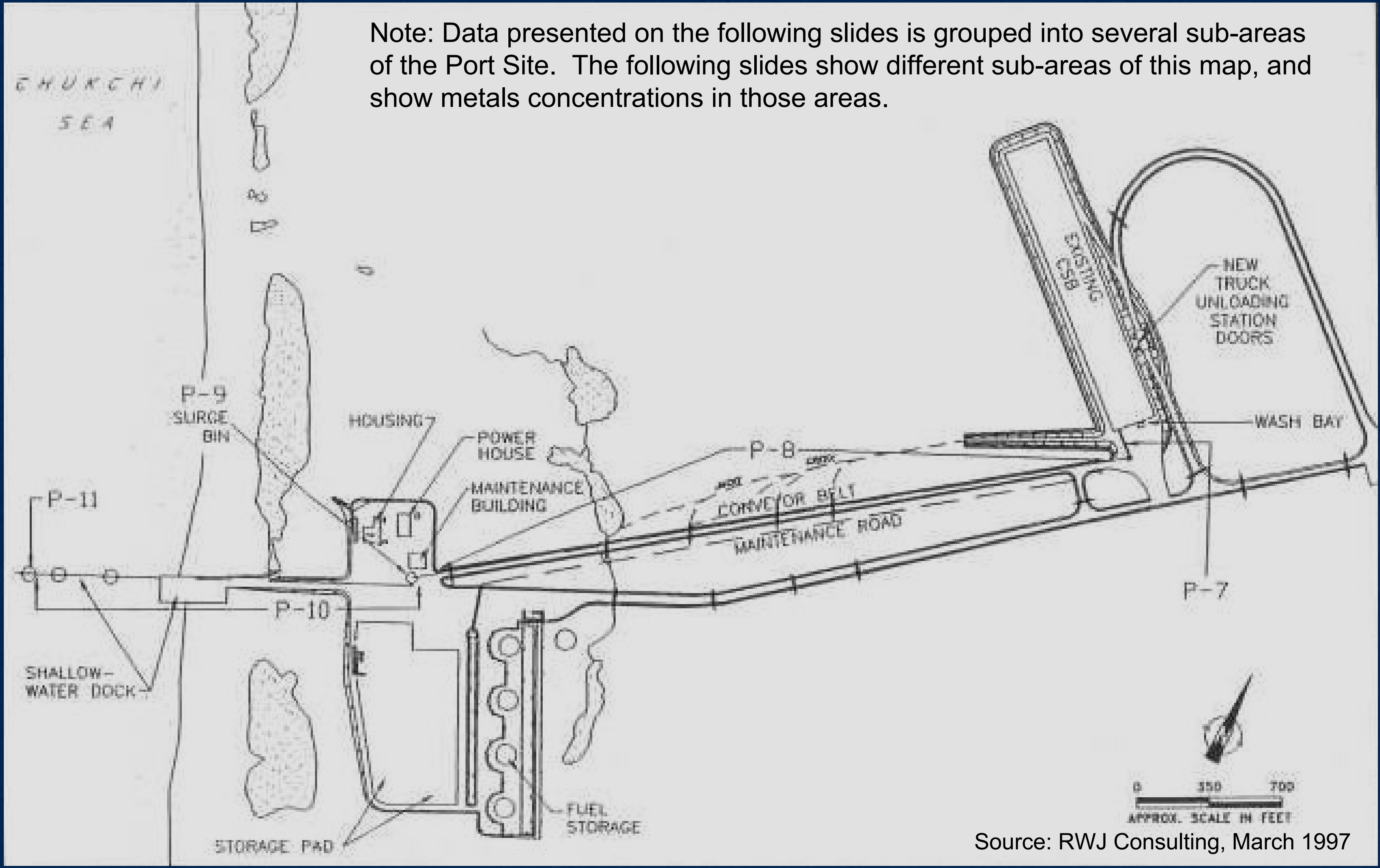
1990–1996 PSMP Findings *(continued)*

Petroleum hydrocarbon (DRO) trends during the monitoring period:

- Concentrations in soil and water samples from the fuel storage area (1993 diesel spill) decreased substantially between 1995 and 1996
  - Degradation probably was occurring

1996 PSMP Findings – Port Map

Note: Data presented on the following slides is grouped into several sub-areas of the Port Site. The following slides show different sub-areas of this map, and show metals concentrations in those areas.

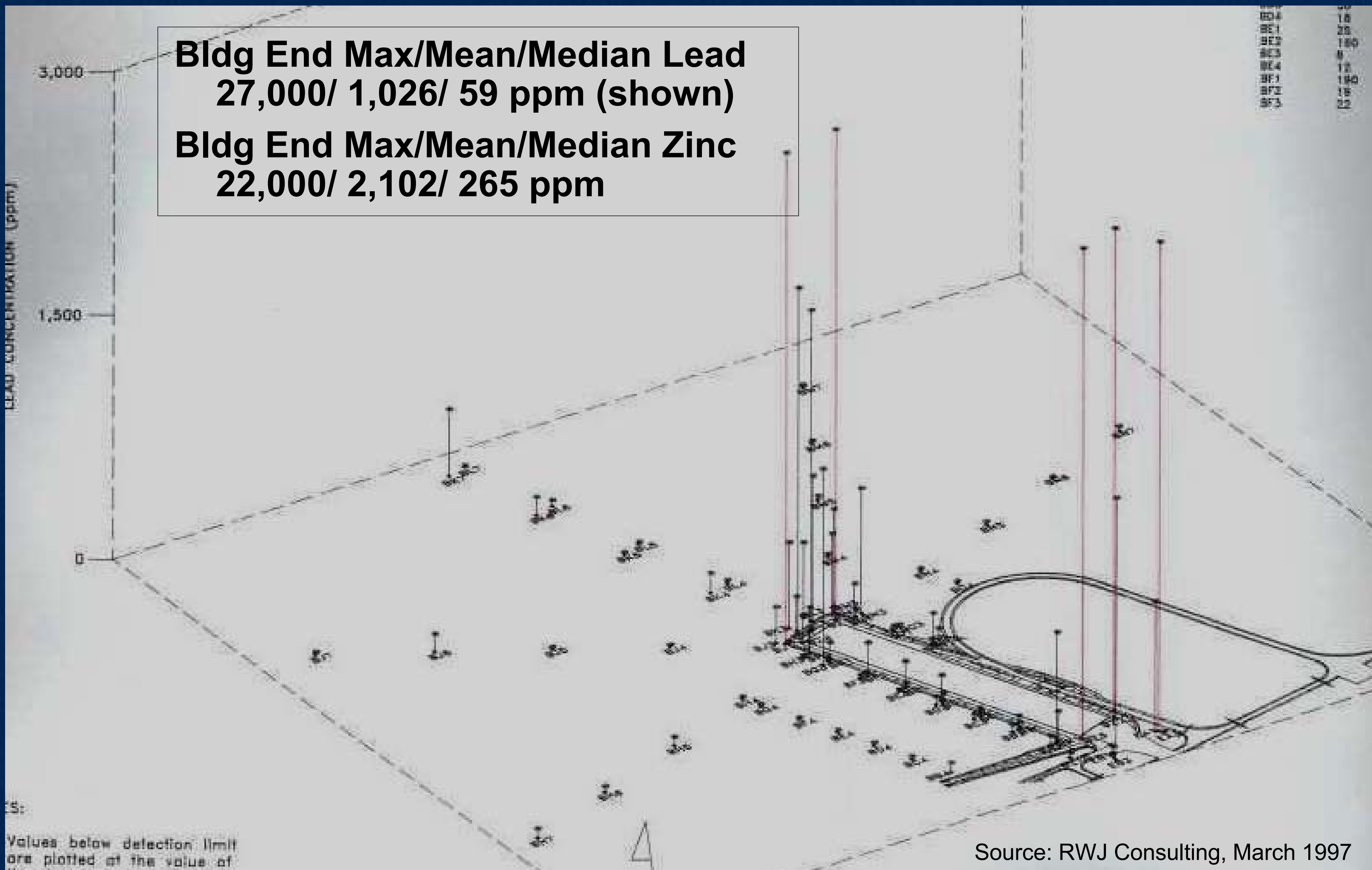


Source: RWJ Consulting, March 1997

1996 PSMP Findings – CSB

Bldg End Max/Mean/Median Lead
27,000/ 1,026/ 59 ppm (shown)

Bldg End Max/Mean/Median Zinc
22,000/ 2,102/ 265 ppm



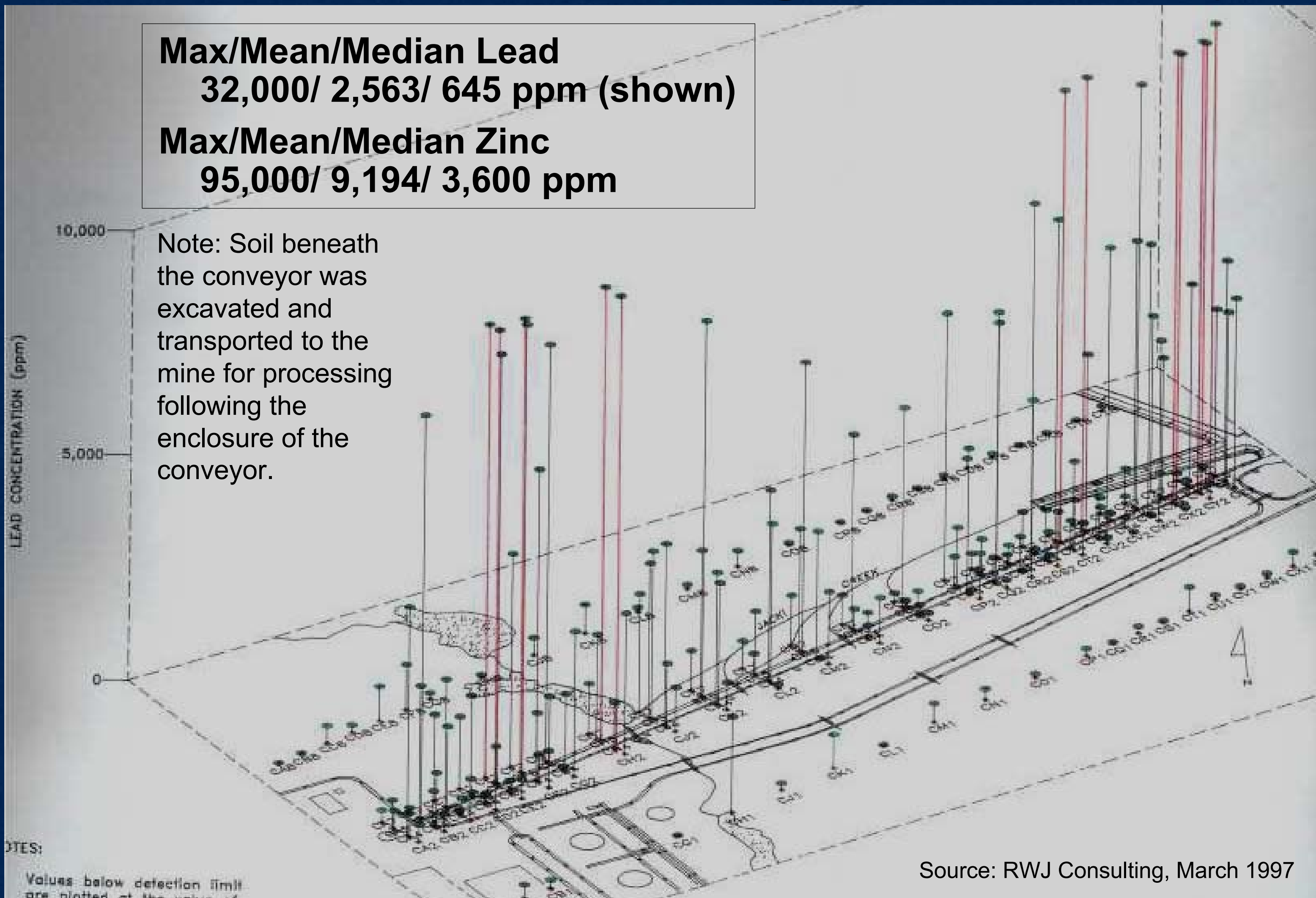
Source: RWJ Consulting, March 1997

1996 PSMP Findings – Conveyor

Max/Mean/Median Lead
32,000/ 2,563/ 645 ppm (shown)

Max/Mean/Median Zinc
95,000/ 9,194/ 3,600 ppm

Note: Soil beneath the conveyor was excavated and transported to the mine for processing following the enclosure of the conveyor.

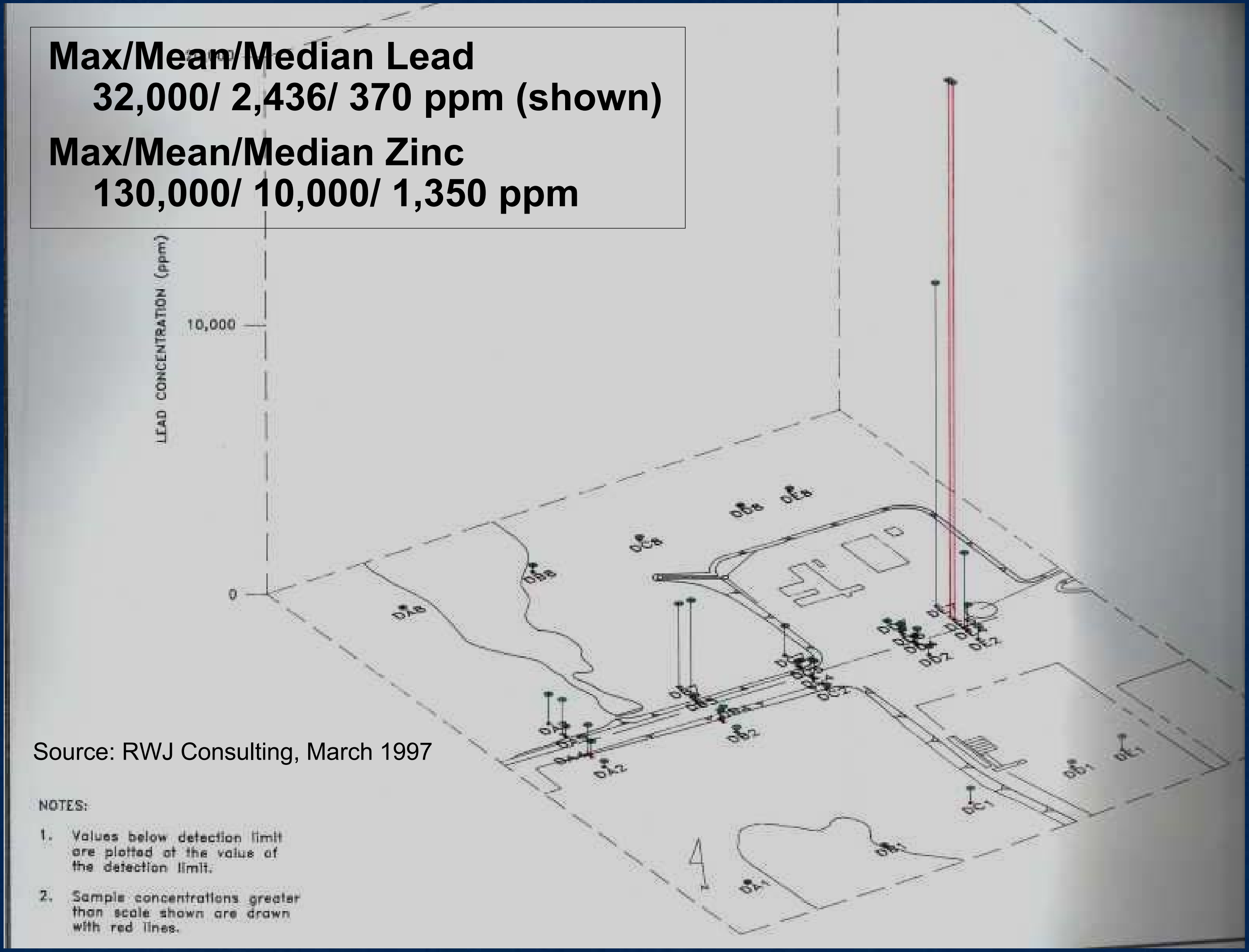


Source: RWJ Consulting, March 1997

1996 PSMP Findings – Dock

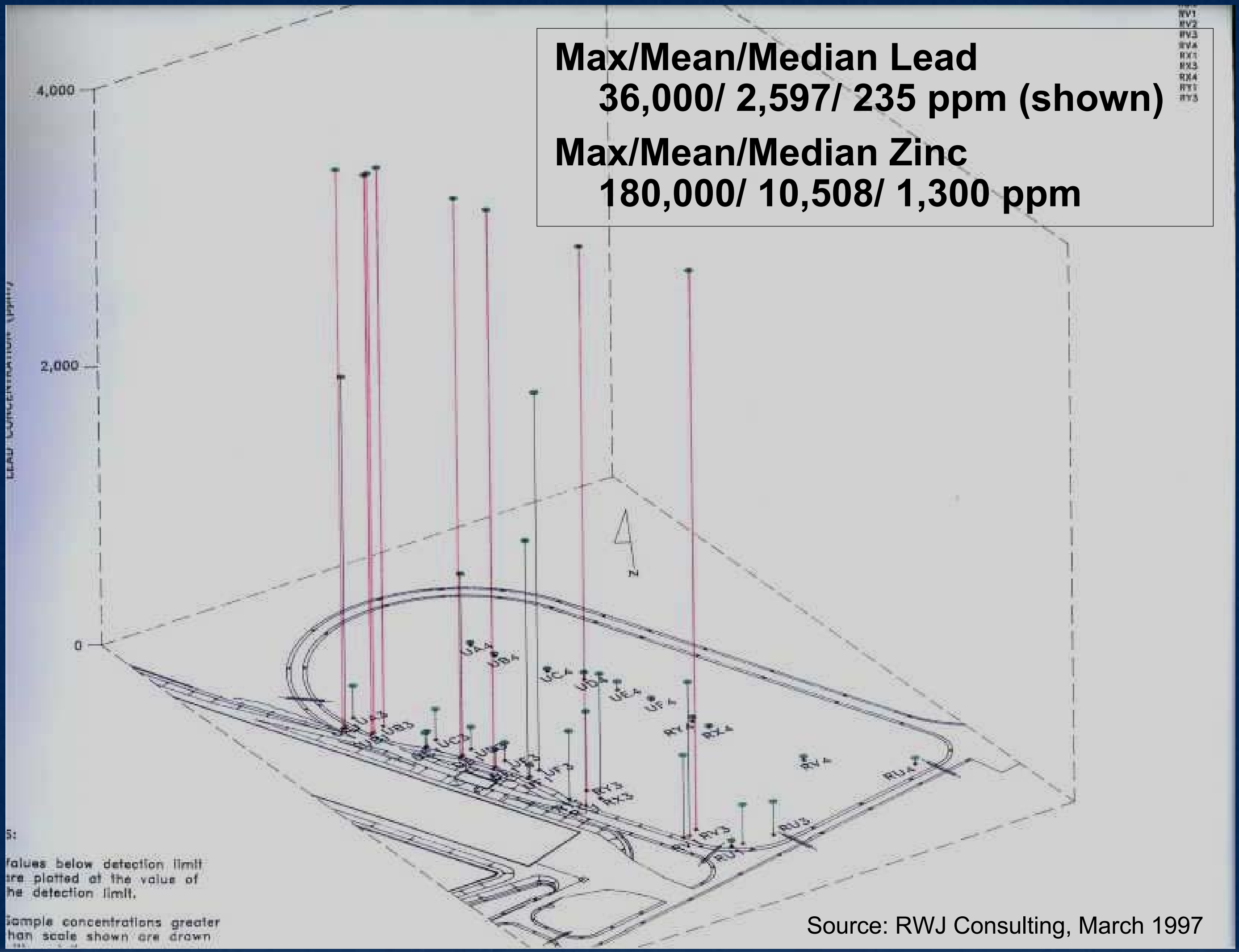
Max/Mean/Median Lead
32,000/ 2,436/ 370 ppm (shown)

Max/Mean/Median Zinc
130,000/ 10,000/ 1,350 ppm



Source: RWJ Consulting, March 1997

1996 PSMP Findings — Unloading



Max/Mean/Median Lead
36,000/ 2,597/ 235 ppm (shown)

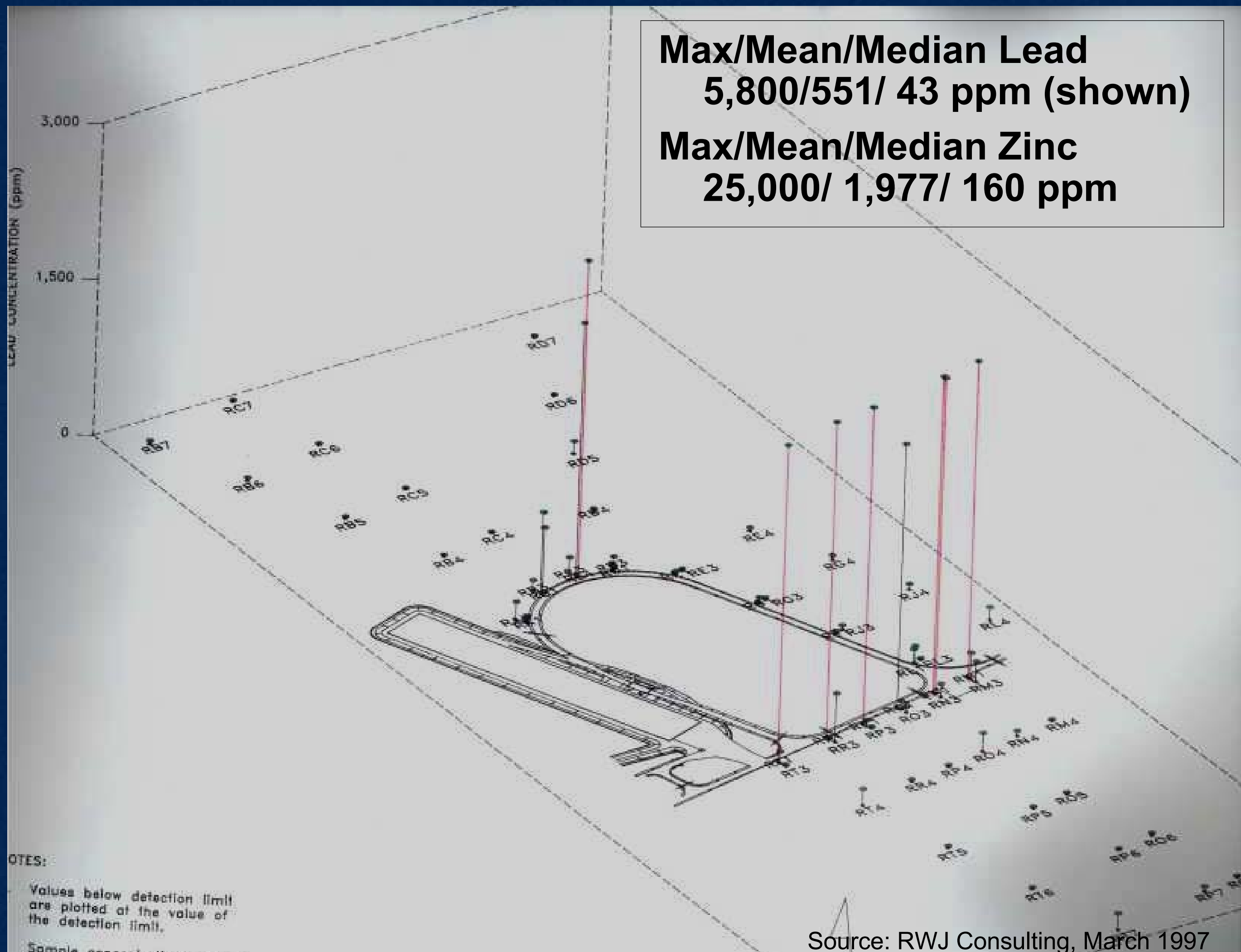
Max/Mean/Median Zinc
180,000/ 10,508/ 1,300 ppm

Source: RWJ Consulting, March 1997

1996 PSMP Findings – Road

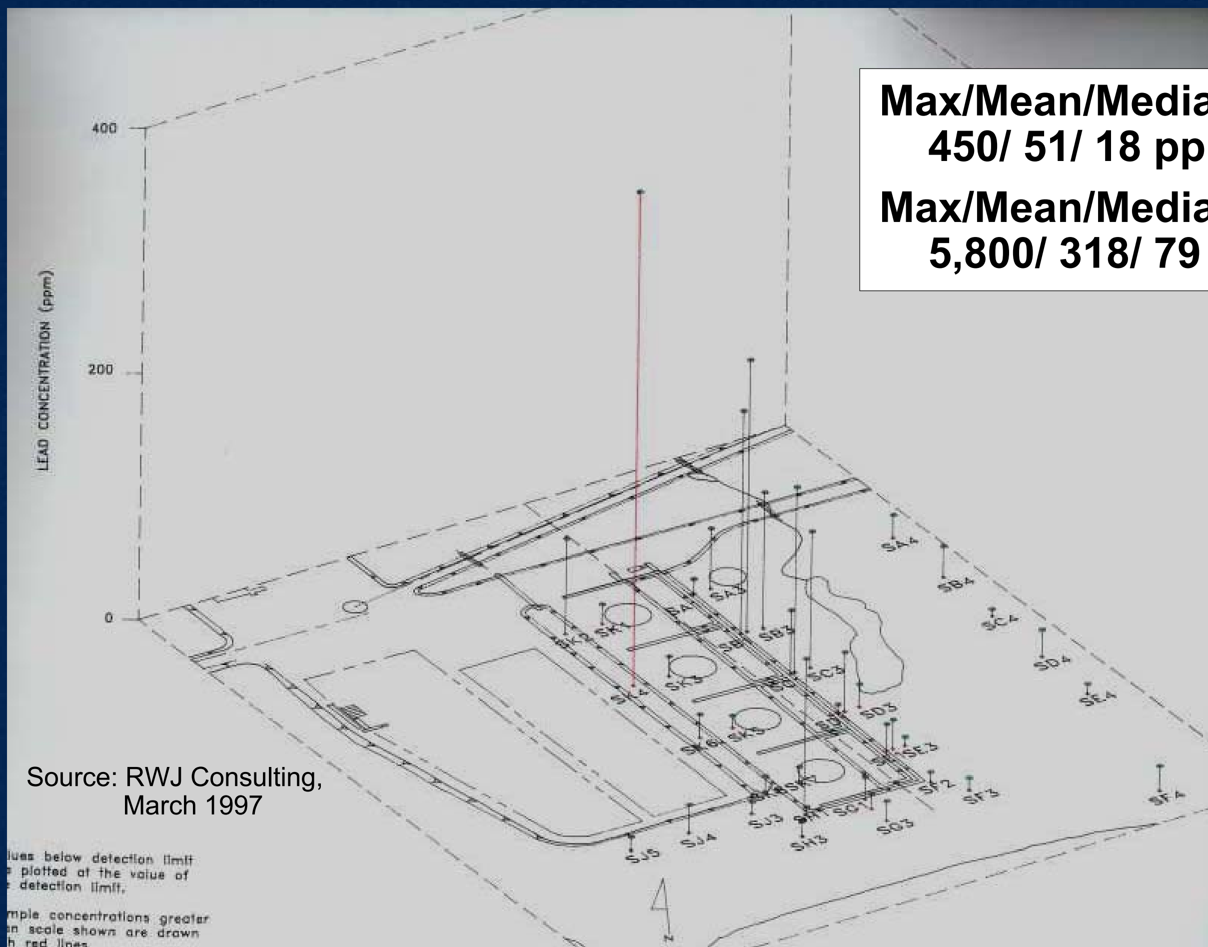
Max/Mean/Median Lead
5,800/551/ 43 ppm (shown)

Max/Mean/Median Zinc
25,000/ 1,977/ 160 ppm



Source: RWJ Consulting, March 1997

1996 PSMP Findings – Fuel Storage

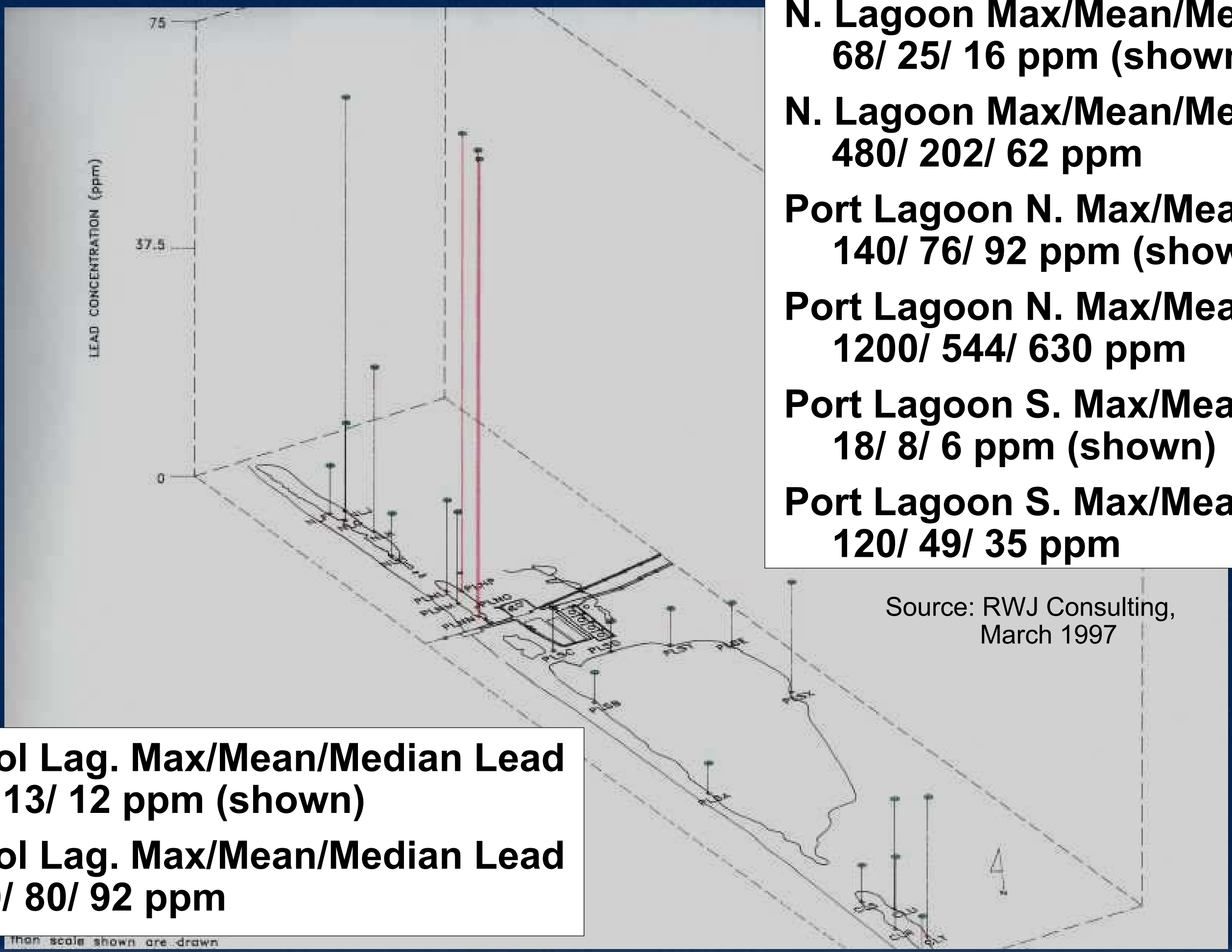


Max/Mean/Median Lead
450/ 51/ 18 ppm (shown)

Max/Mean/Median Zinc
5,800/ 318/ 79 ppm

Source: RWJ Consulting, March 1997

1996 PSMP Findings – Lagoon and Control Sediment



N. Lagoon Max/Mean/Median Lead
68/ 25/ 16 ppm (shown)

N. Lagoon Max/Mean/Median Zinc
480/ 202/ 62 ppm

Port Lagoon N. Max/Mean/Median Lead
140/ 76/ 92 ppm (shown)

Port Lagoon N. Max/Mean/Median Lead
1200/ 544/ 630 ppm

Port Lagoon S. Max/Mean/Median Lead
18/ 8/ 6 ppm (shown)

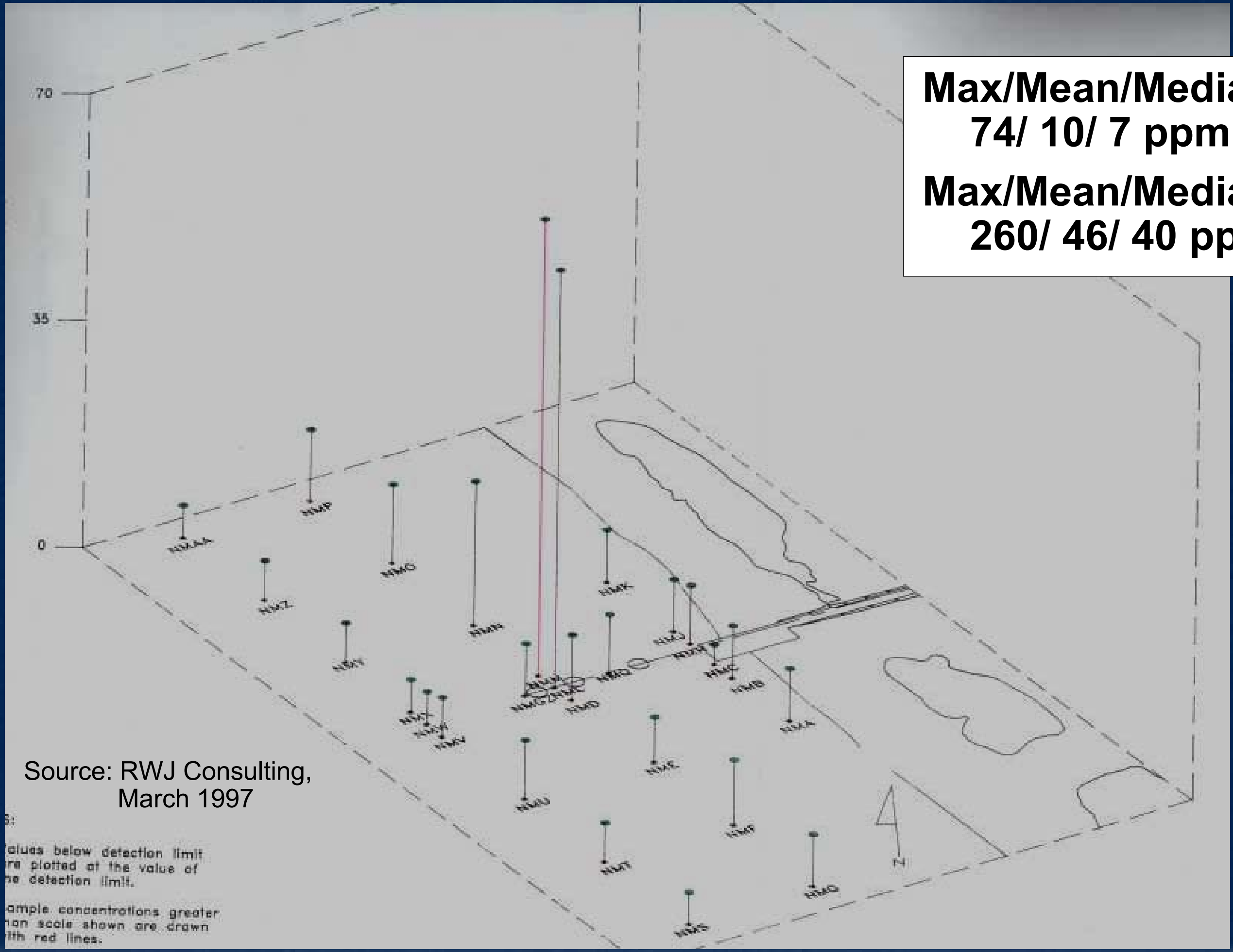
Port Lagoon S. Max/Mean/Median Lead
120/ 49/ 35 ppm

Source: RWJ Consulting, March 1997

Control Lag. Max/Mean/Median Lead
23/ 13/ 12 ppm (shown)

Control Lag. Max/Mean/Median Lead
110/ 80/ 92 ppm

1996 PSMP Findings – Marine Sediment



Source: RWJ Consulting, March 1997

Max/Mean/Median Lead
74/ 10/ 7 ppm (shown)

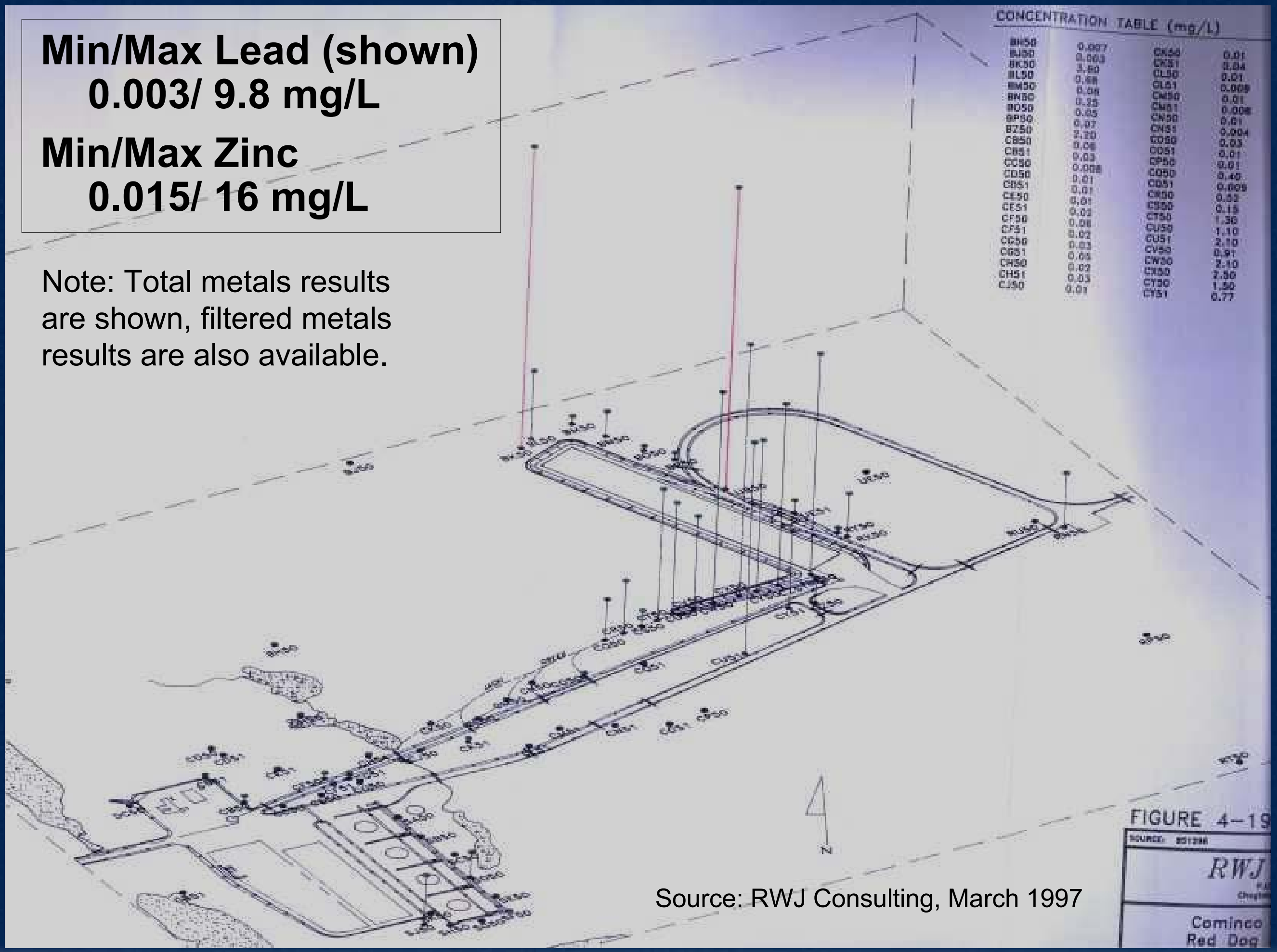
Max/Mean/Median Zinc
260/ 46/ 40 ppm

1996 PSMP Findings – Onshore Water

Min/Max Lead (shown)
0.003/ 9.8 mg/L

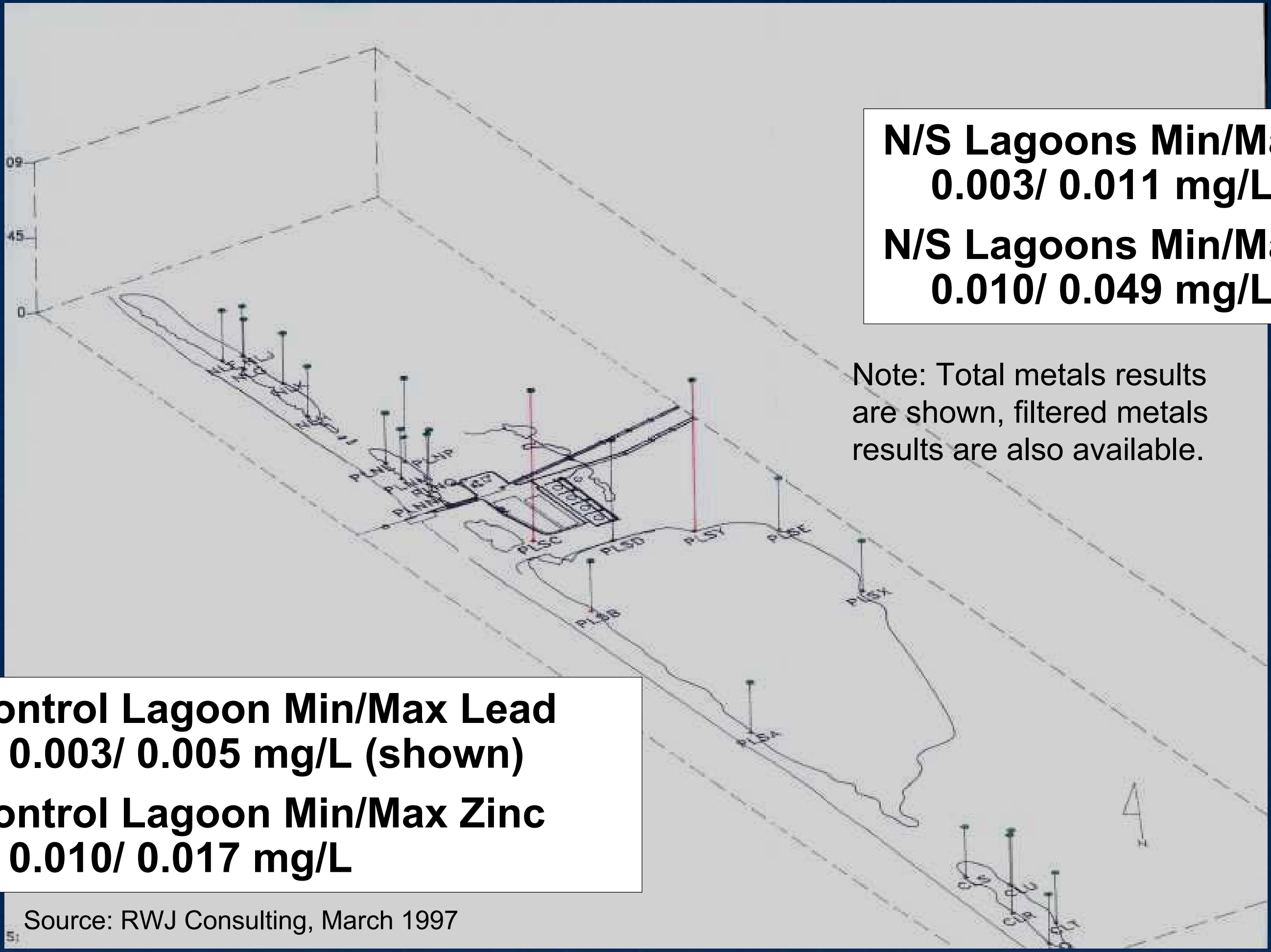
Min/Max Zinc
0.015/ 16 mg/L

Note: Total metals results are shown, filtered metals results are also available.



Source: RWJ Consulting, March 1997

1996 PSMP Findings – Lagoon and Control Water



N/S Lagoons Min/Max Lead
0.003/ 0.011 mg/L (shown)

N/S Lagoons Min/Max Zinc
0.010/ 0.049 mg/L

Note: Total metals results are shown, filtered metals results are also available.

Control Lagoon Min/Max Lead
0.003/ 0.005 mg/L (shown)

Control Lagoon Min/Max Zinc
0.010/ 0.017 mg/L

Source: RWJ Consulting, March 1997

1990–1996 PSMP Findings

- Located the problem areas
- Helped identify concentrate loss issues vs. fugitive dust issues
- PSMP was ineffective for measuring short-term performance of fugitive dust prevention measures
- Program was ended in 1996
- Air monitoring was implemented in its place and continued from 1996 to the present

Air Monitoring Program — 1996 to Present

Elements of the program:

- Dustfall jars
- Snow survey
- High-volume air samplers
- Tapered element oscillating microbalance (TEOM)
- Summary report of 1996 to 2001 monitoring data is being prepared

Air Monitoring Program – 1996 to Present – Preliminary Findings

Sources – primary remaining sources of fugitive dust appear to be:

- Ends of CSBs
- Roadway where trucks exit after being unloaded
- Surge bin

Air Monitoring Program — 1996 to Present — Preliminary Findings *(continued)*

Trends:

- Dustfall jar data showed no conclusive trends
- Total Suspended Particulate (TSP) data is being reviewed by Air Sciences Inc., Boulder, CO
- TEOM samplers have been in place less than 1 year

Air Monitoring Program – Planned Future Work

- Complete review of TSP data from high-volume samplers
- Evaluate hourly TEOM data compared with meteorological data and port operations data

Port Site History – Dust Control Improvements

- Summer 1990
  - Added vibrators to concentrate trailers to reduce carry-out from Truck Unloading Building (TUB)
  - Tested additions of calcium chloride for dust control
- Spring 1991
  - Added drop-tubes at discharge of P11 shiploader to minimize fugitive dust while loading lightering barges

Port Site History – Dust Control Improvements

(continued)

- Summer 1991
  - Installed additional dust collection in gallery and transfer points
  - Enclosed all transfer points
  - Added floor to first level of surge bin
  - Improved truck unloading station ventilation
  - Installed equipment wash bay
  - Installed new doors for existing CSB
  - Installed improved doors for truck unloading station

Port Site History – Dust Control Improvements
(continued)

- Fall 1991
  - Began adding calcium chloride for dust control on Port Road
- Spring 1992
  - Began adding calcium chloride for dust control at Port Site

Port Site History – Dust Control Improvements

(continued)

- Summer 1992
  - Installed fabric covers over conveyors P7, P8, and P10
  - Installed module over P10 conveyor drive unit
  - Installed plywood covers over tail ends of P8 and P10 conveyors
- Fall 1992
  - Installed Phase I of P11 shiploader boom conveyor

Port Site History – Dust Control Improvements

(continued)

- Summer 1993
  - Installed Phase II of P11 shiploader boom conveyor
- 1994
  - Installed additional siding on P9-A and P9-B (surge bin) conveyors for further enclosure
  - Enclosed the bottom of the surge bin

Port Site History – Dust Control Improvements

(continued)

1996–1998 Port Site upgrade (Production Rate Increase – PRI)

- Upgraded conveyor system (all new conveyors enclosed in steel tubes and additional baghouses at P22, P22-A, P23, P23-A, P27, P28)
- Enclosed P7/P8 transfer point in steel building

- Winter 1996–97
  - Changed trailer wing deflectors to stainless steel for reduced adhesion and carry-out from TUB

Port Site History – Dust Control Improvements

(continued)

- Spring 1997
  - H. A. Simons Ltd. produced a dust control report for conveyor P8 and the surge bin
- Fall 1997
  - Air Control Science contracted to evaluate dust control measures for all Port Site concentrate handling processes
- February 1998
  - Anvil Corp. produced a CSB dust collection feasibility study

Port Site History – Dust Control Improvements
(continued)

- Summer 1998
  – Obtained proposal for feasibility evaluation by VECO Engineering for dust collection at both CSBs
- Winter 1998–99
  – Began using Chem-Loc® release agent in concentrate trailers to minimize residual and carry-out following dumping (reduced need for air-lancing trucks)

Port Site History – Dust Control Improvements

(continued)

- **February 1999**
  - H. A. Simons Ltd. produced a concentrate reclamation and CSB ventilation system study
- **Spring 1999**
  - Added a spill deflector gate in TUB and removed deflector wings from concentrate truck trailers (to minimize carry-out from TUB)
  - Obtained feasibility estimate for a modified dust control chute to shiploader P11

Port Site History – Dust Control Improvements

(continued)

- 1998–1999
  - Switched to reinforced covers on concentrate trailers (improved spill control)
- Winter 1998–99
  - Began using Bobcat loader bucket to clean up TUB dumping platform between dump events (reduces concentrate track-out from TUB)
- Fall 1999
  - Slab added to south door of TUB
  - Air Control Science contracted to evaluate dust control options for the TUB

Port Site History – Dust Control Improvements

(continued)

- 1999–2000
  - Upgraded to rotary valves on the baghouses
- Spring 2000
  - Added man-door to TUB control room (personnel can enter/exit building without opening large doors)
- June 2000
  - AGRA/Simons – dust control prefeasibility study and cost estimates

Port Site History – Dust Control Improvements

(continued)

- 2001
  - Completed steel tube enclosure of P8 conveyor 2001
  - Replaced covers on P11 shiploader conveyor
  - Upgraded to motorized conveyor belt scrapers from standard blade scrapers
- Summer 2001
  - Added stilling curtains in TUB
  - Added truck wash outside TUB

Current and Near Future Dust Control Improvements

- 2001 – Obtained new self-dumping trailers with:
  - Hydraulically operated hard covers to minimize spills
  - Fewer exterior surfaces to minimize carry-out from the TUB
  - No side doors to eliminate potential for concentrate leakage

Current and Near Future Dust Control Improvements *(continued)*

- Fall 2001
  - Planned replacement of covers on P10 conveyor
- 2001
  - Planning to replace baghouse at transfer from P22 to P22-A with a dustless transfer system

Port Site History – Surface Water Runoff Controls

- 1990
  - Drainage ditch added around CSB-1 to lower water table and capture surface water runoff
- Fall 1997
  - Tested ion-exchange zeolite treatment, built drop box with weirs (containing zeolite), constructed retention/settling pond
- Spring 1998
  - Enhanced CSB drainage by adding culverts to carry runoff from around the CSB to the outfall line

Port Site History – Surface Water Runoff Controls *(continued)*

- Spring 1998
  - Added a lined containment pond and installed an offshore discharge pipeline allowing discharge of stormwater to the ocean, thereby minimizing impacts of stormwater on onshore water bodies
- Summer 1998
  - Initiated studies to evaluate metals impact on onshore surface water and to evaluate treatment options

Port Site History – Surface Water Runoff Controls *(continued)*

- Summer 2000
  - Conducted pilot studies on ion-exchange for CSB outfall discharge
- Spring 2001
  - Enlarged the CSB-1 stormwater collection ditch and built a full-scale ion-exchange plant to treat outfall discharge