Free Market Environmentalism: Desalination as a Solution to Limited Water Resources in Northern Chile's Mining Industry

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I. INTRODUCTION

In Chile, an unofficial water policy constrains mining companies' use of Chilean surface and groundwater. Chile's National Commission of the Environment ("CONAMA"), in conjunction with Chile's framework of environmental laws, creates constraints that indirectly force mining companies to bear the true cost of mineral resources development in Chile. This is free market environmentalism at its best. Although Chile's economy is reliant on mining exports, mining companies must evaluate desalination if they are to continue to tap into Chile's vast mineral wealth.

Chile has recognized that it is reliant on its mining industry, but has taken steps to limit its long-term reliance on mining and, in so doing, has shown an unusual amount of forward thinking. Currently:

> Chile is actively cultivating its agriculture and fishing industries to replace mining's dominant role in the Chilean economy, anticipating a time when its mineral resources will be depleted. Until that time, Chile's economic welfare will be dependent on its mineral industry. . . . [I]t cannot afford to enact uneconomic environmental standards that will unreasonably burden the mining industry. Chile, however, cannot afford to ignore its significant air and water quality problems either. It has yet to be seen whether Chile can strike the balance. . . .[1]

Chile attempts to balance these interests by designing economic controls to reign in unwise uses of valuable water resources.

This Note contends that by requiring mining companies to use methods such as desalination to provide the water supply for future projects, Chile will remain true to its free market philosophy while simultaneously revolutionizing environmental protections. Although desalination is expensive and can cause environmental harms, the benefits of desalination outweigh the costs. Desalination will preserve terrestrial water resources for other uses and force mining companies to internalize the costs associated with purely extractive operations. However, desalination plants can also benefit mining companies in the long-run by providing a secure and reliable supply of water for mining operations.

In order to lay the foundation for a discussion of desalination in Chile, this Note surveys relevant economic drivers and Chilean laws. Part I provides an introduction to Chilean geography, its water resources, energy infrastructure, and economic history. Part II explains relevant Chilean laws: La Ley/ Law No. 19,300—Chile's primary environmental

1. Karin Ranta, *Balancing Hardrock Mining and the Environment: The Chilean Model*, 6 COLO. J. INT'L ENVTL. L. & POL'Y 423, 443 (1995).

statute (akin to the United States' National Environmental Policy Act of 1969 ("NEPA")), the Mining Code, Constitutional Law on Mining Concessions, water rights, and the water market. The environmental review process is also discussed; environmental impact statements are required for certain development projects, many of which relate to mining operations. Part III discusses mining in Chile and why water is necessary for project operations; current water use issues are also considered. Increasing water scarcity, in particular, is a growing concern. Mining operations require water; however, increased competition from other economic sectors has resulted in high-priced water rights, which may no longer be the most cost-effective water source option for mines. Part IV analyzes the advantages and disadvantages of desalination as applied to Chilean mining operations and also discusses mitigation of negative impacts.

II. Chilean Geography and Economy

The Republic of Chile is located on the southern coast of South America and is sandwiched between the Pacific Ocean and the Andes Mountains. "Chile has a market-oriented economy characterized by a high level of foreign trade[2] . . . ." Its economy is generally focused on the production of minerals and agricultural products.[3] Chile's economic success is directly linked to its mining industry; "[c]opper alone provides one-third of the government's revenue."[4]

A. Geology and Climate

Chile is geologically blessed. The country sits atop the Pacific Plate's eastern Pacific subduction zone, where oceanic crust collides with the continent. Because of its location, Chile is one of the Earth's major continental igneous rock provinces.[5] Igneous rocks (such as granite), which develop from cooled lava or magma, often harbor rich mineral deposits and ore veins. These deposits are mapped and mined by numerous companies. Chilean hardrock mines produce a number of valuable metals, including: gold, silver, molybdenum, iron, rhenium, and

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2. *Chile, World Factbook*, CENTRAL INTELLIGENCE AGENCY, https://www.cia.gov/library/publications/the-world-factbook/geos/ci.html (last visited November 15, 2011).

3. *Id.*

4. *Id.*

5. STANLEY CHERNICOFF & DONNA WHITNEY, GEOLOGY: AN INTRODUCTION TO PHYSICAL GEOLOGY 83 (4th ed. 2007).

copper, which is Chile's main export.[6] Chile's primary mining district is located in the north of the country, in Regions I–VI,[7] with Region I being the furthest north.[8] These regions stretch from the semi-arid Center-North to the arid Atacama Desert in the North.[9] The Atacama is the driest desert in the world; it is so inhospitable that NASA scientists have used the Atacama as a terrestrial proxy for conditions on the planet Mars.[10] Because of its aridity, problems associated with the distribution and use of water resources have arisen.[11] "Surface and groundwater supplies are increasingly limited and degraded."[12] This is a problem for mining operations, which require a reliable water supply. Desert conditions combined with increased scarcity and government constraints have pushed these companies to consider new water generating technologies to supplement their needs.

B. Water Scarcity and Increased Demand

Mining companies have long been aware of the water resources crunch.[13] Yet the country's most profitable asset, copper, lies underground in this harsh climate. The Atacama desert covers almost a

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6. *See* Ranta, *supra* note 1, at 426; A Special Report on Latin America: It's Only Natural, THE ECONOMIST, September 11–17, 2010, at 5; RESEARCH & POLICY PLANNING DEP'T, CHILEAN COPPER COMM'N, COPPER AND GOLD MINING INVESTMENT IN CHILE: ESTIMATIONS FOR 2010–2015 (2010), *available at* http://www.cochilco.cl/english/productos/doc/Copper_and_Gold_Mining_Investment_in_Chile.pdf (hereinafter ESTIMATIONS FOR 2010–2015).

7. Chile is divided into regions, which are the country's first level of administrative division. Each region is divided into provinces.

8. Ana Zuniga, Water and Energy Management in the North of Chile, Presentation at 8th International Conference: Clean Technologies for the World Mining Industry (April 13–16, 2008).

9. *See* JAIME AMEZAGA ET AL., MINING- AND WATER-RELATED LEGISLATION IN PERU, BOLIVIA, AND CHILE - RESULTS FROM THE CAMINAR PROJECT 3 (2008), *available at* http://www.imwa.info/docs/imwa_2008/IMWA2008_135_Amezaga.pdf.

10. Christopher P. McKay, *Two Dry for Life: The Atacama Desert and Mars,* AD ASTRA, May–June 2002, at 30, *available at* http://quest.nasa.gov/challenges/marsanalog/egypt/AtacamaAdAstra.pdf.

11. *See* AMEZAGA ET AL., *supra* note 9, at 3.

12. *See* Jorge Arrueste, International Conference Water in Mining, 2008, Water Scarcity in Northern Chile for Mining Projects: Present and Future, 1, *available at* http://www.hatch.ca/energy/Articles/water_scarcity_chile.htm; Roberto A. Lastrico, Business Development Latin America, Market and EIR Analysis for Chile (2010) (on file with author).

13. Isaac Aranguiz, *Chairman's Address*, *in* WIM 2008: WATER IN MINING, I INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY VII (Jacques Wiertz. ed., 2008).

third of Chile, "and is also the place where most of the most important copper mining operations in the world are located, all of which consume significant water resources for their processes, taken from underground reservoirs in the central valley, or up in the high Andes."[14] Dwindling resources have led to a conflict between Chile's economic sectors and, most critically, to decreased availability of water for human consumption.[15] After years of use, Chile's water resources are overexploited and pressures have made the status quo unsustainable.[16]

Because the Chilean economy thrives on its natural wealth, it is crucial for the country's economic well- being that mining operations continue despite limited water resources. But mining interests must be balanced with other sectors' welfare. Mining is inherently extractive and ore supplies are limited; one day, there will be no more profitable copper deposits to mine. Chile must find a way to sustain its economy's strength through other avenues. Water is not only a critical resource for mines; it is also the keystone that allows agricultural operations to flourish and urban development to continue.

C. Effects of Water Scarcity

The negative effects of such high demand on the environment and reservoirs have resulted in growing social pressures and the reduction of authorized water rights.[17] Climate change is another variable to consider. One climate model predicts a reduction of approximately seventy percent in net runoff in the alpine watersheds of central Chile, along with marked changes to seasonal weather and hydrologic cycles due to decreased snow pack.[18] Almost all climate models predict significant drying and warming in central Chile if greenhouse gas emissions remain unchecked.[19]

In the agricultural Copiapo Valley, for example, water extraction has resulted in a deficit of more than 110 million cubic meters of water due to overexploitation of the resource.[20] Such water scarcity has

14. *See* Arrueste, *Water Scarcity, supra* note 12, at 1.

15. Ana Zuniga, Water and Energy Management in the North of Chile, Presentation at 8th International Conference: Clean Technologies for the World Mining Industry (April 13–16, 2008).

16. *See* Arrueste, *Water Scarcity*, *supra* note 12, at 1.

17. *Id.*

18. Mark Falvey, Climate Change and Chile's Water Resources, DEPARTAMENTO DE GEOFISICA, UNIVERSIDAD DE CHILE, 24 (October 16, 2007), http://www.dgf.uchile.cl/~rgarreau/ACI6/falvey.pdf.

19. *Id.* at 23.

20. *See* Arrueste, *Water Scarcity, supra* note 12, at 2.

significantly increased the cost of water rights in Chile, which uses a water market system.[21] Prices for water rights in northern Chile have recently "skyrocketed" because "[t]here are no more freshwater rights in northern Chile for mining and an extra liter is really hard to find right now."[22]

D. Agriculture

Chile's major industries include copper and other mineral mining, iron and steel production, as well as production of wood and wood products, agricultural products, transportation equipment, and textiles.[23] Agricultural products, such as wine, fruits, and vegetables, are significant exports.[24] In the north-central part of Chile, there are large cultivable areas that "in times of adequate water supply support a thriving agricultural industry. . . [but] because of the dry climate . . . [are] almost exclusively dependent upon irrigation."[25] As a result, the increased demand for water has fueled competition for water resources between mining operations, growing cities, and agriculture.[26]

E. A Mining-Based Economy

Mining companies are aware of the increased cost of water rights that, when coupled with high metal prices, make water development technologies such as desalination more attractive.[27] Yet the high cost of water is not a foreseeable barrier to future mining projects in the short term. The Chilean Copper Commission ("COCHILCO"), estimates that planned investment in Chilean copper and gold mining, including projects under construction and those likely to begin construction

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21. Eusebio Ingol, *Water Market System: Study Case in Chile*, DEP'T CIV., ARCHITECTURAL, & ENVTL. ENGINEERING, U. TEX., 1 (2008) http://www.ce.utexas.edu/prof/mckinney/ce397/Topics/Markets/Markets(2008).pdf.

22. Victor Henriquez, Scarcity, Demand Cause Water Rights Prices to Skyrocket, BUSINESS NEWS AMERICAS (2010), *available at* http://www.bnamericas.com/news/waterandwaste/Scarcity,_demand_cause_water_rights_prices_to_skyrocket1.

23. *CIA World Factbook*: Chile, *supra* note 2.

24. *Id.*; A Special Report on Latin America: It's Only Natural, THE ECONOMIST, September 11–17, 2010, at 6.

25. John W. Lloyd, The Hydrogeology and Water Supply Problems in North-Central Chile, 30 PACIFIC SCIENCE 91, 91 (1976).

26. *See* Arrueste, *Water Scarcity, supra* note 12, at 2.

27. *See id*.

between 2010–2015, stand at an estimated US$50 billion.[28] COCHILCO estimates that maximum copper production potential will be achieved between 2016–2020, with copper production in 2017 at about 7.58 million tonnes.[29] According to the Ministry of Mining "[i]n 2007, the Chilean mining industry produced the equivalent to 5.5 million tonnes of fine copper, which account[ed] for more than 33% of the world's production.[30] The contribution of the mining business to Chile's GDP was 24% . . . Copper accounted for 58% of total shipments overseas."[31] Chile's economy and people have much to gain from continued copper extraction. Individual mine investment estimates can range from hundreds of millions of dollars (US$) to well over two billion dollars.[32]

In addition to copper, Chile has deposits of gold, silver and other metals. The development of new gold mining projects over the next decade is expected to "place Chile squarely among leading world producers."[33] For example, Cerro Casale is advertised as one of Chile's largest undeveloped gold deposits.[34] Predicted global production from the mine stands at an estimated 1 million ounces of gold, as well as co-production of significant amounts of silver and copper.[35] The estimated investment amount for the Cerro Casale project is US$4.2 billion.[36] Such planned project development depends on two factors: water, the subject of this Article, and, energy availability, briefly discussed below.

F. Energy Imports

While Chile exports a large number of raw materials, energy is not among them. In 2007, Chile imported approximately 1.628 billion kilowatt hours ("kWh") of electricity with no exports.[37] While small amounts of natural gas and oil are produced, consumption outstrips the

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28. ESTIMATIONS FOR 2010–2015, *supra* note 6, at 10.

29. *Id.* at 11.

30. Isaac Aranguiz, *Chairman's Address*, *in* WIM 2008: WATER IN MINING, I INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY VII (Jacques Wiertz. ed., 2008).

31. *Id.*

32. ESTIMATIONS FOR 2010–2015, *supra* note 6, at 1.

33. *Id.*

34. *Id.* at 14; Barack Gold Corporation, *Cerro Casale*, http://www.barrick.com/GlobalOperations/Projects/CerroCasale/default.aspx (last visited Nov. 15, 2011).

35. ESTIMATIONS FOR 2010–2015, *supra* note 6, at 17.

36. *Id.* at 17, 19 (investment estimates are allocated on a per-annum basis).

37. *CIA World Factbook*: Chile, *supra* note 2.

production rate for petroleum hydrocarbons.[38]

As a potential solution to its energy woes, Chile plans to construct a number of new hydroelectric dams in Chilean Patagonia.[39] Patagonia is a famous wild and forested region at the southern tip of South America and encompasses parts of both Chile and Argentina. Endesa, a Spanish utility company, and Colbun, a leading Chilean electric company, plan to construct at least five dams on two of the nation's largest rivers, the Baker and the Pascua.[40] Known as the HydroAisen project, most of the energy would be sent north via massive transmission lines to fuel industry and mining projects.[41]

A greener option is the use of geothermal energy. The Chilean government recently announced the availability of US$400 million to be allocated to "Non-Conventional Renewable Energy" (NCRE) projects.[42] Geothermal energy production—the running of steam naturally produced by the heat of the Earth's core through a turbine to generate electricity—is a clean and renewable source and qualifies as a NCRE.[43] Geothermal energy law is governed by three main documents. The regulation of geothermal energy exploration and exploitation is essentially governed by Law (Ley) No. 19,657; Supreme Decree No. 32/2004 governs the granting of geothermal exploration and exploitation concessions; and, Supreme Decree No. 142/2000 identifies possible geothermal fields where concessions may only be assigned by public bid.[44] Chile's undeveloped geothermal energy potential is estimated at approximately 16,000 megawatts ("MW").[45]

G. Role of the "Chicago Boys" and the Free Market in Recent Chilean History

Chile is one of Latin America's most prosperous nations, which some argue is due the influence of American economics and the "Chicago Boys" who reformed Chilean economic policies during

38. *Id.*

39. Editorial, Patagonia Without Dams, N.Y. TIMES, April 1, 2008, *available at* http://www.nytimes.com/2008/04/01/opinion/01tue3.html.

40. Natural Resources Defense Council, Stop Electrocuting Patagonia, http://www.nrdc.org/international/patagonia/patagonia.pdf (last visited Nov. 15, 2011).

41. *Id.*

42. Paul M. Kiernan et al., International Energy and Natural Resources, 44 INT'L LAW. 367, 369 (2010).

43. *Id.* at 370.

44. *Id.*

45. *Id.* at 371.

General Augusto Pinochet's dictatorship (1973–1990). The "Chicago Boys" were a group of Latin American economists educated at the University of Chicago.[46] The "Chicago Boys" generally advocated widespread deregulation, privatization, and other free market policies. While criticized for working with the divisive dictator, their free market reforms led to a strong period of annual growth in per capita real income from 1985 to 1996 (average of 5%).[47] As a result of a long period of growth, Chileans have become South America's richest people; they also have the continent's lowest level of corruption, the lowest infant-mortality rate, and the lowest number of people living below the poverty line.[48]

The "Chicago Boys" free market thinking also influenced environmental laws and policies in Chile. In 1980, the Chilean government began privatizing the mining industry.[49] The first step was the enactment of the Constitution of the Republic of Chile, which began privatization by providing that (1) the Chilean state owns all mines and minerals within Chilean borders—the basis of mineral law in Chile—and, (2) that new laws be created to regulate public and private extraction of minerals.[50] In 1983, the government passed the Chilean Mining Code and the Constitutional Law on Mining Concessions that allows for mineral concessions to private entities.[51] The privatization and liberalization of Chilean mining laws "immediately attracted the attention of multinational mining companies . . . [which brought] a rapid increase in mineral production and a huge influx of foreign capital."[52]

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46. Gary S. Becker, What Latin America Owes to the "Chicago Boys", HOOVER INSTITUTION, STANFORD UNIVERSITY (Oct. 20, 1997), http://www.hoover.org/publications/hoover-digest/article/7743 (last visited Nov. 15, 2011).

47. *Id.*

48. Bret Stephens, How Milton Friedman Saved Chile, THE WALL STREET JOURNAL (Mar. 1, 2010), http://online.wsj.com/article/SB10001424052748703411304575093572032665414.html?mod=WSJ_hps_sections_opinion (last visited Nov. 15, 2011).

49. Ranta, *supra* note 1, at 427.

50. *Id.*

51. *Id.*

52. *Id.* at 427–28.

III. CHILEAN ENVIRONMENTAL LAW

A. Ley de Bases del Medio Ambiente/ Ley Numero

The General Bases of the Environment (Law No. 19,300, published March 9, 1994)[53] is Chile's primary environmental statute. The law was created by CONAMA in order to organize Chile's environmental laws and to establish clearer standards for environmental quality and control.[54] The law accomplishes three new objectives: (1) it redefines the role of CONAMA while establishing regional environmental authorities; (2) it sets up a formal system of review for the environmental impacts of proposed projects; and (3) it allows for citizen suits to be filed against polluters, including the Chilean government.[55]

General Provision Article 1 of this statute grants Chile's citizens "the right to live in an environment free of pollution," and Article 2 establishes a two-tiered priority system.[56] Human health is the primary concern regarding environmental quality and environmental interests are the secondary concern.[57] Title 2, Paragraph 2, created the Environmental Impact Assessment System ("EIS"), which is similar to the United States' NEPA.[58]

Law No. 19,300 defines "projects or activities susceptible to causing environmental impact, at any of their phases, that shall be subject to the environmental impact assessment system" in Article 10.[59] Such projects and activities include, but are not limited to, aqueducts and other water development projects, high voltage power transmission lines, large (>3 megawatt) electric power generating plants, transportation stations and roads, ports, industrial and real estate projects, mining development plans, mining pipelines, agro-industries, forestry development, and treatment plants or drinking water systems.[60] Law No. 19,300 subsequently defines the standards for environmental impact studies (Title II, Paragraph 2, "EISs"), how communities may participate in the process (Title II, Paragraph 3), and further defines boundaries of

53. *See generally* Law No. 19300, Marzo 9, 1994, DIARIO OFICIAL [D.O.] (Chile).

54. Ranta, *supra* note 1, at 432.

55. *Id.* at 433.

56. Law No. 19300, Marzo 9, 1994, DIARIO OFICIAL [D.O.] (Chile).

57. *Id.*

58. *Id.* tit. 2, ¶ 2.

59. *Id.* art. 10.

60. *Id.*

the EIS process.[61]

B. The Mining Code

Along with the Law on Mining Concessions, the Chilean Mining Code came into effect in 1983.[62] Article 1 of the Mining Code stipulates that the State possesses exclusive and inalienable rights of ownership of all mines, but that concessions may be granted by permit pursuant to Article 2.[63] Once a mining permit has been granted, the concession constitutes a property title. The right is independent from the property of the surface land on which the mining is being carried out.[64] A mining concession may be granted for either exploration or exploitation; a mining concession for exploitation is equivalent to a mining claim in the US, which grants a subsurface title distinct from the surface property right.[65]

C. Organic Constitutional Law on Mining Concessions

The Organic Constitutional Law on Mining Concessions, published on January 21, 1982, fleshes out the Mining Code's basic doctrine.[66] Title I on Mining Concessions, Article 1, provides that mining concessions can be for exploration or exploitation.[67] Article 2 states that mining concessions are "real and immovable rights; different and independent from the surface land ownership."[68] Article 3 outlines which minerals are grantable. Precious metals such as copper and gold are grantable, whereas petroleum hydrocarbons, lithium, and deposits deemed "important to the national security" are not available for mining concessions.[69]

Title II outlines the rights of mining concessionaires. Article 7 grants exclusive prospecting and excavation rights to the mining

61. *See id.*

62. *See* Ranta, *supra* note 1, at 427.

63. Código de Minería [Cód. Min.] arts. 1–2, CHILEAN COPPER COMMISSION, *available at* http://www.cochilco.cl/english/normativa/descarga/mining_code.pdf.

64. AMEZAGA ET AL., *supra* note 9.

65. *See* Law No. 18097, Enero 21, 1982, DIARIO OFICIAL [D.O.] (Chile).

66. *Id.* at art. 1.

67. *Id.*

68. *Id.* at art. 2.

69. *Id.* at art. 3.

concession owner, but a public interest clause reserves rights for the public, providing that ". . . mining concessionaire[s]. . . shall be subject to limitations prescribed in the Mining Code. The limitations shall always be established to prevent damages to the owner of the land or to protect public interest purposes."[70] Article 8 provides that concession owners are entitled to the establishment of easements necessary for mining exploration and exploitations (such as water pipelines and supporting plant operations).[71] Under Title IV, a mining concession for exploration lasts for a four-year term, and exploitation concessions continue indefinitely.[72]

D. Water Rights and Water Law in Chile

The 1980 Constitution established that a water right conferred on a private holder was a property right.[73] Chile uses a water market system, which allows free transfer of water rights to another user.[74] Water rights—as in the Western United States, Australia, and Spain—are separate from the land[75] and can be freely transferred, sold, and bought.[76] Chile implemented its Water Code in 1981, which provided that a water resource specified in a right is essentially private property and can be used anywhere.[77] The Water Code also "abolished all law that undermines the property on water . . . [and] eliminated the possibility of expire [sic] water rights."[78] Lease contracts are also potential options, in which the owner of the water right conserves title but rents water use for an agreed upon time period.[79]

Water rights may be for either consumptive or non-consumptive uses. There are three ways to get a water right in Chile: (1) purchase it on the water market; (2) apply to the Water General Direction (DGA,

70. *Id.* at art. 7.

71. *Id.* at art. 8.

72. *Id.*

73. *See* Ingol, *supra* note 21.

74. *Id.*

75. A prior appropriation system allocates water rights based on quantity, use, time of use, and generally treats the right to use water as private property. In contrast, a riparian system allocates water among landowners adjacent to the surface water source. Under prior appropriation, a water right is not tied to land—in contrast to the riparian system, which ties the right to use water to a land parcel.

76. *See* Ingol, *supra* note 21.

77. AMEZAGA ET AL., *supra* note 9.

78. *See* Ingol, *supra* note 21.

79. *Id.*

Direccion General de Aguas); or (3) make an offer at a water auction.[80]

Legislators foresaw that the water market would play a crucial role in two areas: the allocation of original water rights and the reallocation of rights conceded.[81] The water market increasingly results in water being sold or leased to agricultural buyers during droughts and times of water scarcity, because they have permanent crops such as fruit trees, which must receive a steady water supply.[82] As mentioned in the mining section above, mining companies are aware of the increasing competition and therefore increased cost of purchasing water rights on the market. In addition, the water market system has resulted in some negative outcomes, such as speculation and water monopolies.[83] Because of the changing status quo, mining companies are considering new technologies to supplement or replace water rights. One such technology, desalination, provides a potential solution to mining companies’ water needs.

E. The EIA Process & CONAMA

CONAMA’s mission is to promote environmental sustainability, and “public awareness [of environmental protection] is becoming in Chile . . . one of the main factors to be taken into consideration during the process of project approval, with emphasis on water consumption and contamination.”[84] Although environmental concerns are secondary to human health concerns under Law No. 19,300, communities in Chile are interested in environmental protection and have different concerns and opinions as to how water consumption and contamination should be addressed.[85] Because water resources are already stressed in the north, mining projects are facing water scarcity and social pressures from local interest groups.[86]

As a result, water scarcity has increased the cost of water rights, which has allowed mining companies to justify the use of new technologies to improve water use efficiency or provide new water sources. Options include the implementation of improved tailing dewatering systems and the use of either desalinated or fresh sea water in mining operations.[87] The use of saline groundwater as an alternative for

80. *Id.*

81. *Id.*

82. *Id.*

83. *See* AMEZAGA ET AL., *supra* note 9.

84. *See* Arrueste, *Water Scarcity, supra* note 12, at 4.

85. *Id.*

86. *Id.*

87. *Id.*

mining operations has also been explored in the Andean Highland basins in northern Chile.[88] While it is an additional water source, saline groundwater can be three or four times more salinated than fresh groundwater. It is highly corrosive as well, requiring the use of special equipment and costly maintenance.[89]

It seems unlikely that simple water rights exchanges or saline groundwater reserves will be sufficient in the future. Climate change is expected to increase overall temperatures in Chile and reduce rainfall during the "Bolivian winter"—the season that provides the main source of groundwater recharge to Northern Chile's aquifers.[90] It appears certain that water costs will only continue to rise over the coming decades as pressures on the scarce resource mount.

Since many potential new development projects fall within Law No. 19,300, Article 10's list of projects or activities subject to the EIS process (i.e. desalination plants, pipelines, dams, etc.), CONAMA plays a critical role in the development of future mining projects and the country's overall management of water resources.[91] CONAMA should act as a proposed project gatekeeper. Although these projects require analysis under EIS standards, there are concerns that despite the apparent promotion of environmental legislation, the government's position on the environment is "ambiguous."[92]

One group, the Catchments Management and Mining Impacts in Arid and Semi-Arid South America ("CAMINAR") Project, found that Law No. 19,300's standards have not been fully applied because economic pressures conflict with technical legal rules.[93] CAMINAR asserted that the Law No. 19,300 was not fully applied for four reasons: (1) economic criteria are often weighed more heavily than technical or environmental concerns; (2) stakeholder and public participation in the process is hindered by insufficient administrative support and assistance and the environmental impact assessment time frame "is not long enough for people to understand the depth of the implications for each project"; (3) control of the projects is technically under jurisdiction of local administrative services, but these services generally do not have

88. Orlando Acosta & Pablo Rengifo, *Saline Groundwater: An Alternative for Sustainable Exploration of Andean Highland Groundwater Reserves, in* WIM 2010:PROCEEDINGS OF THE 2ND INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY, 157–165 (Jacques Wiertz ed., 2010).

89. *Id.*

90. *See* Arrueste, *Water Scarcity, supra* note 12, at 4.

91. *See* Law No. 19300, Marzo 9, 1994, DIARO OFICIAL [D.O.] (Chile).

92. *See* AMEZAGA ET AL., *supra* note 9.

93. *Id.*

sufficient resources to adequately process proposed projects; and (4) Law No. 19,300 allows projects to start before approval.[94] These four factors result in economic interests slipping past environmental regulators.

Article 11 of Law No. 19,300 states that an EIS is required for projects that have "significant adverse effects on the quantity or quality of renewable natural resources, including land, water and air."[95] The EIS must describe the project or activity, mitigation measures for potential adverse effects, and repair actions pursuant to Article 12.[96] An EIS is accepted or refused under Article 16, pursuant to Article 11. Article 16 states that "an EIS shall be approved if it complies with the environmental legislation and in the event it fulfills the effects, characteristics or circumstances set forth in Article 11, it proposes adequate mitigation, restitution or compensation measures. On the contrary, it shall be refused."[97] CONAMA (or "COREMA") must issue an opinion on the study within 120 days after its submission.[98] An appeal may be made to the CONAMA Board of Directors within thirty days of notification of a study's rejection.[99]

The practical reality is that the EIS process touches the bedrock of the Chilean economy: mining projects. When the framework law for the EIS process was first implemented, success lagged due to the delay in promulgation of regulations—as a result, mining and other activities caused significant environmental impacts.[100] Despite mining's continued prominence in the Chilean economy, there are signs that CONAMA has not only smoothed over these initial issues, but has shifted its underlying policies for project approval. Chile cannot rely on mining alone to sustain economic growth in the long term and must protect natural resources, especially water, for future use by the agriculture industry and growing urban populations.

IV. MINING

Mineral exports finance Chile's economic success and national laws facilitate business transactions with, and often cater to, the mining

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94. *Id.*

95. Law No. 19300, Marzo 9, 1994, 6–7, DIARO OFICIAL [D.O.] (Chile).

96. *Id.* at 7–8.

97. *Id.* at 9.

98. Paul J. Schlauch & Lawrence J. Jensen, *Chilean Environmental Framework Law,* 7 COLO. J. INT'L ENVTL. L. & POL'Y 319, 322 (1996).

99. *Id.* at 323.

100. *Id.* at 328.

industry's needs. For example, the Foreign Investment Statute ("Decree Law 600") specifically extends contract time limits to twelve years only for mining investments.[101] Indefinite exploitation concessions under the Mining Code provide stable property rights, which allow mining companies to effectively price resources. COCHILO, in its report on copper and gold mining investment from 2010–2015, affirmed, "it is in Chile's interest to ensure that valuable projects not suffer unnecessary delays . . . [and it is] in line with the Ministry of Mines policy to encourage mining investment."[102] While these two organizations are close to the heart of the mining industry, they nonetheless are allowed to shape Chilean mining policy. Despite the free market policies and laws that specifically favor the mining industry, water supply has become a limiting factor, along with energy, for the development of new mining projects and the expansion of old ones.[103]

A. Current Mining Operations and Water Use

Water requirements for mining operations vary by method; the two primary ore extraction methods are concentration and hydrometallurgy.[104] Copper concentration plants are the most water intensive facilities, followed by hydrometallurgical plants.[105] Fresh water consumption rates for concentration range between 0.3 and 2.1m^3/tonne; for hydrometallurgy, water consumption rates range between 0.08 and 0.25m^3/tonne.[106] Although mines have increased efficient use of water, mining companies recognize that the pressures on water resources are becoming unsustainable.[107]

The projected growth in concentrate output suggests that more water will be required on a per ton basis over the next decade.[108] COCHILCO projected that copper mine output

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101. *See* Law No. 600, art. 3, Diciembre 16, 1993, DIARIO OFICIAL [D.O.] (Chile).

102. ESTIMATIONS FOR 2010–2015, *supra* note 6, at 1.

103. WIM 2008: WATER IN MINING, I INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY IX (Jacques Wiertz. ed., 2008).

104. *See generally* ESTIMATIONS FOR 2010–2015, *supra* note 6; WIM: International Congress on Water Management in the Mining Industry, July 9–11, 2008.

105. Arrueste, *Water Scarcity, supra* note 12, at 3.

106. Isaac Aranguiz, *Chairman's Address*, *in* WIM 2008: WATER IN MINING, I INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY VIII (Jacques Wiertz. ed., 2008), *available at* www.gecamin.com/pdf_literatura/tablas_contenido/wim_2008.pdf.

107. Arrueste, *Water Scarcity, supra* note 12, at 1.

108. *See* ESTIMATIONS FOR 2010–2015, *supra* note 6, at 10.

> [W]ill stand at 7.29 million tons refined copper by the year 2020, a 35.2 percent increase for the period under review . . . most expected growth is taking place in concentrate output, which will go from 3.28 million tons in 2009 to 5.73 million tons in 2020, a 74.9 percent increase for the period under review.[109]

Mines have already refined their water use. Two general methods of water conservation are available: water reclamation and better control of water losses, such as evaporation in the arid climate.[110] Mines use "thickened" tailing dams[111] as well as water saving and recycling measures.[112] Filtrate tailing dams are also being assessed as a potential alternative water-saving measure.[113] One of the most important measures for increasing water efficiency is to reuse the water accumulated behind a tailing impoundment by using a Water Recovery System ("WRS").[114]

Some argue that additional water should be extracted from groundwater reserves to meet the growing water needs. Deep, untapped groundwater reserves are a potential target.[115] Water developers argue that those who misunderstand the issue interpret extraction as "an uncontrollable exploitation of the aquifer." These developers contend that groundwater extraction is not simply exploitation and should be analyzed as an option for potential net benefits to northern Chilean communities.[116] Chilean law treats surface water and groundwater as independent entities from a legal standpoint, which makes integrated water resources management difficult with this option. Yet the proponents of further groundwater extraction seem undeterred by the fact

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109. *Id.*

110. WIM 2008: WATER IN MINING, I INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY IX (Jacques Wiertz. ed., 2008).

111. "Thickened" tailings are significantly dewatered mining tailings.

112. Arrueste, *Water Scarcity, supra* note 12, at 4; Jorge Arrueste, 8th International Conference: Clean Water Technologies for the World Mining Industry, April 13–16, 2008, Water Availability for Mining Usage Crisis and Solution.

113. Arrueste, *Water Scarcity, supra* note 12, at 4.

114. Jorge Serey & Arnaldo Santander, Analysis and Technico-Economic Optimisation of a Long Distance Water Recovery System, in WIM 2010: PROCEEDINGS OF THE 2ND INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY 167 (Jacques Wiertz ed., 2010).

115. Pablo Rengifo, Edgardo Dzogolyk, and Orlando J. Acosta, Use of Deep Groundwater Reserves, *in* WIM 2010: PROCEEDINGS OF THE 2ND INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY, 127 (Jacques Wiertz ed., 2010).

116. Orlando Acosta, A Socially Sustainable Approach for the Intensive Use of Aquifers in Northern Chile, *in* WIM 2010: PROCEEDINGS OF THE 2ND INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY 147 (Jacques Wiertz ed., 2010).

that these aquifers do affect the water table and generate public concern. They go so far as to state that:

> [I]t is obvious that the water table has dropped . . . The continuous descent of groundwater levels usually creates a lot of concern in public opinion, and the use of terms such as collapse, crisis, shortage, depletion, and others, is not infrequent. However . . . the only real effect . . . is that some shallow wells have to be deepened a few more meters . . . .[117]

However, there is strong evidence that groundwater usage has reached its capacity limits, especially in arid regions.[118] In northern Chile's Coposa catchments, the impacts of groundwater extraction were underestimated at the Collahuasi Mine— "after five years of groundwater extraction from Coposa, the hydraulic impacts were equivalent to those predicted after 20 years of extraction."[119]

Such groundwater drawdown not only impacts potential human use, but may negatively impact local ecology, depending on local groundwater flow. A significant number of terminal saline basins, called *salares*, are found in the north of Chile.[120] In particular, the Soncor lacustrine ecosystem is an important protected area within Flamingos National Park—a major feeding, mating, and nesting site for migrating birds.[121] The lagoons within the Soncor ecosystem are hydrologically connected to surrounding aquifers.[122] Overexploitation of groundwater due to human activity could threaten desert oases for wildlife and associated Altiplano tourism.

A third option is a technological solution, such as seawater desalination or direct pumping of seawater for metallurgical processes through pipelines to mines in the interior.[123] It should be noted that

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117. *Id.* at 148.

118. Raymond Phillipe, Richard E. Dixon & Silvana Dal Pozzo, Sal or Desal: Sea Water Supply Options for the Mining Industry, *in* WIM 2010: PROCEEDINGS OF THE 2ND INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY 14 (Jacques Wiertz ed., 2010).

119. Claire M. Cote, Chris J. Moran & Orlando J. Acosta, Progressing towards Sustainability*: From Water Efficiency to Water Effectiveness at the Collahuasi Mine*, *in* WIM 2010: PROCEEDINGS OF THE 2ND INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY 37 (Jacques Wiertz ed., 2010).

120. Ramon Aravena et al., Evaluation of Sources of Water to Lagoons, Salar de Atacama Basin: An Isotope and Geochemical Approach, in WIM 2010: PROCEEDINGS OF THE 2ND INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY 48 (Jacques Wiertz ed., 2010).

121. *Id.*

122. *See id.*

123. Arrueste, *Water Scarcity, supra* note 12, at 4.

groundwater extraction is far cheaper than seawater desalination, which is expensive not because of the plant construction costs but because of the high cost of pumping water through pipelines to the remote, high altitude, mine location.[124] Seawater desalination costs approach about US$2/meter,[3] including pumping to the plant site and the high cost of energy.[125] While the distance from the coast to inland mining sites is relatively small, the increase in elevation from sea level to the high Altiplano requires significant energy expenditures. Despite the high cost of seawater desalination, the uncertain availability of groundwater and high cost of water rights suggest that because seawater is a more secure resource it could become cost-effective.

B. Water as a Limiting Factor

Water rights are already limited and increasingly costly, and projections indicate that mining will boom in the next decade as new projects come online. More water will be needed if Chile wishes to avoid conflict between sectors and continue to reap the economic benefits of mineral exploitation. Between 2010 and 2012, COCHILCO projects a period of strong sustained growth with a 9.7% global production increase in copper between 2009 and 2012.[126] Medium term projections from 2013 to 2015 show an even larger copper production output, with an expected increase of 14.3% between 2012 and 2015.[127] Long-term predictions are that copper production will peak in 2017 with a maximum copper production of 7.58 million tons, which will then gradually begin to decline.[128] By 2020, the expected mining water requirements will have grown 45% compared to 2009 levels.[129]

Because water rights are increasingly costly and subject to a prior appropriation system, the availability of a certain amount of water is no longer a guarantee.[130] In addition, Chile's water requirements will increase as water resources are limited by social pressures and competition with agricultural and urban areas. Thus, current water use is

124. Telephone Interview with Roberto A. Lastrico, Business Development Latin America, Israeli Desalination Engineering (Oct. 11, 2010).

125. Arrueste, *Water Scarcity, supra* note 12, at 4.

126. ESTIMATIONS FOR 2010–2015, *supra* note 6, at 10–11.

127. *Id.* at 11.

128. *Id.*

129. Phillipe et al., *supra* note 118, at 14.

130. Jorge Arrueste, 8th International Conference: Clean Water Technologies for the World Mining Industry, April 13–16, 2008, Water Availability for Mining Usage Crisis and Solution.

unsustainable given limited resources. Mines will need a reliable alternative to local surface and ground water. In light of these pressures and the finite nature of groundwater, mining projects must use an alternative water source.

CONAMA has also increased the rigor of its analysis before approving new projects. CONAMA's "mission is to promote the environmental sustainability."[131] In order for a mining project's environmental impact assessment to be approved by CONAMA, mining companies need to show that they will not diminish surface or groundwater resources in Chile despite their water rights.[132]

For CONAMA to approve projects, a Water Management Plan ("WMP") needs to be established for water resources in the project areas, which also outlines how a project will minimize potential aquifer depletion.[133] "Currently, the use of non-conventional water resources, such as desalinated or fresh sea water, would be an important added value in the process of project approval" by CONAMA.[134] A mine's water right is of no value by itself, because it can only be used after permits are granted pursuant to a completed CONAMA EIS. Thus, CONAMA has essentially presented mining companies one option for future freshwater supplies on new projects: desalination.

V. DESALINATION

Desalination is the removal of dissolved solids, such as minerals and salts, from a saline water source, usually seawater.[135] A variety of methods are used to desalinate saline water. The two primary methods in use are (1) thermal distillation, where the saline water is heated to the boiling point and separated from the salts and minerals, and (2) Reverse Osmosis ("RO"),[136] where the saline water passes through a semi-permeable membrane that separates salts from water. Desalination of seawater to supply mines is an expensive process, largely due to the costs of pumping the newly created fresh water a long distance uphill.[137]

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131. Arrueste, *Water Scarcity, supra* note 12, at 4.

132. *Id.*

133. *Id.*

134. *Id.*

135. *Id.* at 5.

136. RO technology is what is already being used in Chile. Arrueste, *Water Scarcity, supra* note 12, at 5.

137. Thomas M. Missimer & Robert G. Maliva, Alternative Intake Designs to Reduce Costs of Sea Water Desalination Systems for Mine Water Supply, *in* WIM 2010: PROCEEDINGS OF THE 2ND INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE

There are three distinct components of desalination facilities: (1) the intake and outfall; (2) the treatment process (pre-treatment and membrane process); and, (3) the pipeline, including pumping stations.[138] Pre-treatment processes remove marine organisms, sediments, bacteria, and large organic molecules that are present in seawater before the water passes through membranes (or another process).[139] Desalination costs for water treatment depend primarily on the size of the facility and electricity costs, but the intensity of the overall treatment process also affects costs.[140] Alternative intakes, which pull water through wells, beach galleries, or seabed filters, can significantly reduce capital operating costs because they pull water through natural filters.[141] Alternative intakes can also reduce harm to marine life, an added benefit.[142] These intakes are site-specific, however, and thus not available for every plant.

Desalination has a number of advantages and disadvantages for Chilean mining.[143] Desalination provides the following advantages: (1) consistent water quality; (2) a reliable water resource; (3) a buffer against droughts and decreased groundwater and surface water recharge due to decreased snow pack in the Andes (and climate change's influence); (4) full control by the mine company over its mine's local water supply (if desalination plants are privately owned and operated); and, (5) the potential for future use by the local municipality after ore bodies have been fully mined, or by the mining company for profit.[144] Because CONAMA is apparently reticent to dole out limited water resources, mining companies and corporations must create their own water because the nation's water is increasingly protected for other types of domestic use.

Desalination has some costs as well. First, desalination depends heavily on an energy supply to be cost-effective.[145] But, technological advancements that conserve energy can offset some of these costs. For example, RO membrane-based systems "have only become an economically viable option within the last decade, largely due to

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MINING INDUSTRY, 197–202 (Jacques Wiertz ed., 2010).

138. *Id.* at 197.

139. *Id.*

140. *Id.*

141. *Id.* at 198-99.

142. *See infra* p. 26 and note 151.

143. *See* COOLEY, ET AL., DESALINATION, WITH A GRAIN OF SALT: A CALIFORNIA PERSPECTIVE 39–81 (2006).

144. *Id.*

145. *Id.*; Arrueste, *Water Scarcity, supra* note 12, at 1.

advancements in membrane technology as well as the refinement of energy-capturing devices that reduce the overall energy consumption of the process."[146] RO improvements include: greater membrane life; development of corrosion-resistant heat-transfer surfaces; using off peak energy to produce base-load plants; co-generation of thermal energy and electricity; as well as, co-locating desalination and energy plants.[147] Additional engineering advances could make systems even more affordable.

Second, desalination can be prohibitively expensive depending on the price of metals.[148] Desalination is feasible when the price of metals is high. Given COCHILO's copper and gold investment projections, however, it appears that the production of metals will increase, and copper prices will continue to rise, especially as China's economy recovers from the global recession and continues to grow.[149] Because copper prices continue to rise, desalination will become increasingly feasible.

A third concern with desalination is that chemicals and unregulated contaminants introduced by the plant into end product water may affect human health.[150] Chemicals within the plants may enter the water source. This is a nonissue for Chilean mines, however, because the water would be used for production, not human consumption. The only potential threat to public health would be in the disposal of any contaminated water. Additional contaminants should not be cause for alarm, as wastewater should be properly processed before disposal. Conservative wastewater disposal procedures can decrease the risk of groundwater contamination.

Fourth, desalination can cause damage to the environment in a number of ways. Four major drawbacks include: (1) the production of toxic salt concentrate; (2) harm to marine life; (3) changes in local ecology; and (4) energy use that contributes to climate change.

Local environmental effects are directly related to water intake and output. Concentrated salts discharged from the desalination process are

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146. Arrueste, *Water Scarcity, supra* note 12, at 5–6.

147. COOLEY, ET AL., *supra* note 143, at 44.

148. *Id*. at 41–45; Arrueste, *Water Scarcity, supra* note 12, at 4.

149. Matt Whittaker, Copper Hits Record on China Appetite, Chile Strike, WALL ST. J., Nov. 11, 2010, http://online.wsj.com/article/SB10001424052748703848204575608682052917368.html?mod=rss_whats_news_us&utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+wsj%2Fxml%2Frss%2F3_7011+%28WSJ.com%3A+What%27s+News+US%29 (last visited Nov. 16, 2011).

150. COOLEY, ET AL., *supra* note 143, at 53–55.

toxic to the environment, especially to marine life.[151] Even worse for public relations is the fact that large marine organisms, such as adult fish, invertebrates, birds, and even mammals are killed on water intake screens (impingement); organisms small enough to pass through an intake screen are killed during the processing of the salt water (entrainment).[152] But there are ways to mitigate the impact of salt concentrate.

Two types of intakes can minimize these deaths. Alternative intakes, which pull water through wells, beach galleries, or seabed filters, reduce impingement and entrainment because they pull water through natural filters like sediments.[153] Open or direct intakes provide another intake alternative; they suck in water at a very slow rate, which minimizes the disturbance to the aquatic ecosystem by reducing the force of the intake's cone of depression[154] in the water column.[155]

Desalination can also upset the local water budget and ecology if water is not properly managed, but the effects of any project will have to be analyzed on a case-by-case basis. Individualized solutions based on geology, marine ecology, project budget, and technology provide a suite of options. In addition, the EIS process adds an additional buffer that would require projects to meet national environmental policy standards. It is unlikely CONAMA would want to be associated with marine mammal impingement.

Finally, energy use by desalination plants is expensive and can contribute to climate change. Because desalination is energy intensive, relying on it creates or increases the water producer's exposure to energy price variability.[156] Yet Chile is working to address its insufficient energy resources problem through the development of hydroelectric projects and renewable resources. Chile is currently looking to develop geothermal energy resources with its northern neighbor, Bolivia.[157] A more

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151. KERRY J. HOWE, UNIV. OF N.M., TECHNICAL CHALLENGES TO CONCENTRATE DISPOSAL FROM INLAND DESALINATION (2004).

152. COOLEY, ET AL., *supra* note 143, at 59.

153. *Id.*

154. A cone of depression is the area of water influenced by an intake. The term comes from the field of hydrogeology where a depression in the potentiometric surface of groundwater has the shape of an inverted cone around a well from which water is being withdrawn.

155. Telephone Interview with Roberto A. Lastrico, Business Development Latin America, Israeli Desalination Engineering (Oct. 11, 2011).

156. COOLEY, ET AL., *supra* note 143, at 55.

157. Todd White, Chile May Develop Geothermal Energy with Bolvia, BLOOMBERG BUSINESSWEEK

(on file with author).

conventional option is to place desalination plants by existing power stations to reduce the cost of energy transfers, which has an added environmental benefit of keeping industrial operations in already industrialized areas. New desalination technologies may also reduce the impact of a potential plant. For example, novel Sea Water Desalination Vessels ("SDVs") integrate a power plant and water treatment facility in a seagoing tanker.[158] An environmental assessment indicated that the discharge system's environmental footprint is more favorable than a land-based facility; with an SDV, the concentrate can dilute in the full water column as opposed to a land-based operation.[159] Additional concerns include rising sea levels due to climate change, which could threaten coastal desalination plant locations, and difficulty in getting accurate cost estimates.[160]

But desalination is already in use in Chile, and desalination plants are currently sustained by the strong minerals market:

> [M]embrane seawater desalination by Reverse Osmosis is the preferred technology, coupled with pumping and pipelines to the plant facilities, implying a total desalination water supply cost of about US$1.8-2.0/m^3. These high water costs are not representing a limitation to mining projects development and operation, being sustained in the high metal prices [sic].[161]

Given that the next decade will be one of tremendous growth in the mining industry, desalination is a cost-effective solution to mining operations' need for a steady water supply. Cheaper alternative intakes can be used, assuming appropriate site locations, to (1) lower some costs of operation, and (2) provide natural filters that minimize direct impacts to marine life. The capital saved by using a natural filter could then be applied to technology to offset the effects of toxic salt discharges. Suitable site selection seems key to minimizing environmental impacts and the EIS process can act as a check on plant construction.

VI. CONCLUSION

By forcing mining companies to use methods like desalination for future mining projects' water supply, Chile will remain true to the

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158. Lisa Henthorne & Jose Pesce, Flexible and Sustainable Water Supply: Sea Water Desalination Vessel Options and Analysis, *in* WIM: INTERNATIONAL CONGRESS ON WATER MANAGEMENT IN THE MINING INDUSTRY 212–216 (Jacques Wiertz ed., 2010).

159. *Id.* at 214–215.

160. COOLEY, ET AL., *supra* note 143, at 43–45.

161. Arrueste, *Water Scarcity*, *supra* note 12, at 1.

country's free market history while simultaneously revolutionizing environmental protections. Water scarcity has increased the cost of water rights, "impelling and justifying the implementation of approved tailing dewatering systems, and the use of either desalinated or fresh sea water."[162] Although desalination has high economic and environmental costs, the benefits of desalination outweigh the negatives. In addition, Chile is embracing free market environmentalism by making mining companies bear the full cost of mineral exploration and development by paying the full cost of water production and energy for transport.

Foreign companies must bear the risk of a mining investment, not Chile. Desalination forces these mining companies to internalize negative externalities and take responsibility for any environmental damage. Domestic water resources are then unofficially reserved for domestic purposes, such as agriculture and urban use, and can be used to benefit Chileans in a direct manner. Because mining is necessarily extractive and mineral deposits are finite, Chile is protecting its long-term economic welfare by securing domestic surface and groundwater resources without undermining its water market system. By protecting terrestrial freshwater resources, CONAMA protects another economic driver, agriculture, which will continue to sustain Chile once mineral resources have been extracted. Water can also be saved for droughts and used to offset the effects of climate change.

Desalination also benefits mining companies. Mining companies get full control over water production and projects in their entirety. A water production plant, which has a virtually unlimited amount of seawater as a supply source, will protect mining operations from drought period limitations and increased aridity due to climate change or the effects of El Nino.[163] Even if mining companies choose not to develop mineral resources because it is too expensive, companies would still have water production capacity and could potentially sell water on the market in a desperately dry area.

Because this beneficial policy remains unwritten and coincidental, Chile should adopt an official written policy banning appropriation of water for consumptive mining uses. By making extractive operations bear the full cost of their legal property right, Chile will further incentivize water use efficiency, protect its domestic economy, and minimize the negative environmental effects of consumptive water use by large industry. Further, subsidization by implication is simply not in line with free market economics; mining companies need to internalize

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162. *Id.* at 4.

163. *See* NAT'L ENVTL. COMM'N., CLIMATIC VARIATION IN THE CHILEAN TERRITORY IN THE XXI CENTURY (2007).

the full cost of their operations. When fresh water is in short supply, it should not be free for consumptive use. Chile's free market history has already blended with its water policies to create a custom that complements both economic and environmental goals. Why not make it official?