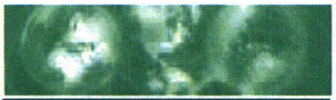

REPORT

RESPONSE TO WDEQ COMMENTS ON CAMECO RESOURCES' 2007-2008 ANNUAL REPORT

Selenium Issues Related to Comments 19, 20 and 22

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EXECUTIVE SUMMARY

Cameco Resources (Cameco) operates an In-Situ Recovery (ISR) uranium mine at their Smith Ranch-Highlands (SRH) operations. Part of the water balance is managed by irrigating fields with water bled from the ISR process. The Wyoming Department of Environmental Quality (WDEQ) review of Cameco's 2007-2008 Annual Report contained a series of comments concerning an increased level of Selenium (Se) in the soils and vegetation associated with the irrigated fields and the shallow groundwater associated with the purge storage reservoir where water for irrigation is stored.

Cameco retained Golder Associates Inc. (Golder) to research Se issues related to these comments and prepare responses. Golder determined two of these comments, numbers 21 and 23 in the 2007-2008 Annual Report Review, would require some further site characterization to develop responses that would fully respond to the concerns expressed by WDEQ. These are presented as separate reports (Golder 2010a, 2010b). The responses to the remaining comments – Numbers 19, 20 and 22 – are provided in this report. The responses to the WDEQ were developed in consideration of the scientific literature pertaining to Se in soils and vegetation and an analysis of the data set developed through Cameco's annual monitoring

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1.0 INTRODUCTION

For its mining operations at its Smith Ranch-Highlands (SRH) facility, Cameco Resources' (Cameco) manages part of its water balance by irrigating fields with water bled from the in situ recovery (ISR) process. Over time, the two fields receiving irrigation, Satellite 1 (SAT1) and Satellite 2 (SAT2), have seen an increase in selenium (Se) concentrations in both vegetation and soil above background concentrations (e.g. background measured at locations not receiving irrigation) (Figures 1 and 2). The increases have been pronounced, and are characteristic of irrigated systems with elevated Se concentrations in the water (Seiler et al 1999, Engberg et al. 1998). The Wyoming Department of Environmental Quality (WDEQ), in its review of Cameco's SRH 2007-2008 Annual Report, expressed concerns about these increases in Se concentrations, especially as it pertains to wildlife and livestock Se exposure during the active mining and post-mining periods. . Some of these comments (Numbers 13, 16, 17 and 18) were responded to directly with minor changes to the Annual Report's text, but the remaining comments, Numbers 19 through 23, were to be responded to under a separate cover. A response to these comments was required by the agency before Cameco could resume irrigation in 2010. Cameco Resources has retained Golder Associates Inc. (Golder) to direct a scientific effort to respond to these comments.

In this document Golder addresses Comments 19, 20 and 22. Comments 21 and 23 are addressed in separate reports under (Golder 2010a, 2010b). Section 2 addresses each comment individually. WDEQ comment 22 is a request to respond to Ramirez (2000). As some of the responses to comments 19 and 20 rely on the information presented within the review of Ramirez (2000), the response to comment 22 is presented first.

2.0 RESPONSES

2.1 Responses to Ramirez, 2000

Comment 22 from WDEQ's review of the 2007-2008 Annual Report states:

> *PRI was given the paper and reference to Pedro Ramirez's paper entitled "Selenium in a Wyoming Grassland Community Receiving Wastewater from an In situ Uranium Mine" (2000). PRI was asked to include a discussion of Mr. Ramirez's finding in the Annual Report concerning the impact on wildlife by bioaccumulation of selenium in the food chain.*

Within Ramirez (2000), data showed that Se was being mobilized and bioaccumulated within the food chain. While these results merit attention, it is worth noting that from Ramirez that Se "enters the food chain almost entirely through vegetation." This means that if the amount of Se in the vegetation can be reduced, or if the availability of vegetation with elevated Se levels can be reduced or eliminated as a food source, the entry of elevated Se into the food chain can be controlled.

Cameco has proposed harvesting the vegetation grown under irrigation. Removal of aboveground plant material has been suggested within the scientific literature as a strategy for Se depletion on a "biological time scale" (Mackowiak and Amacher 2008) to protect grazing animals while other processes that reduce Se exposure, such as chemical reduction and resulting sorption or volatilization, are allowed to proceed. This will also break the cycle of continued recycling of Se into the root zone from decomposing plant tissue with elevated Se levels (Mackowiak and Amacher 2008). The specific processes by which Cameco may handle this harvested vegetation are discussed below in the responses to Comment 20, but in response to the findings within Ramirez (2000), controlling the availability of vegetation with elevated tissue Se concentration effectively will block the pathway of entry of Se into the food chain in the short term. For longer-term control of Se transfers into the vegetation, and therefore into the food chain, an analysis of the data, discussed below, suggests the system is moving toward a less plant-available, and therefore less toxic, state for Se. This is consistent with trends that have been shown within the scientific literature regarding Se's behavior in soils and vegetation (Barceloux 1999, Munier-Lamy 2007). The other possible source for entry into the food chain is through aquatic vegetation to what Ramirez refers to as "food organisms," which can bioaccumulate Se (Ramirez, 2000). According to Ramirez, however, use of the purge storage reservoir (PSR) at SAT1 was noted as low enough to limit widespread exposure to Se through aquatic pathways. This limited use of the PSRs reported by Ramirez is assumed to have continued to the present.

Once the source of Se is removed, by harvesting or long-term decreases in the Se accumulation in soil or vegetation, the symptoms of selenosis in mammals are not persistent as the body can excrete excess Se to maintain homeostatic balance (Ralston et al. 2010).

2.2 Responses to #19

Comment 19 within WDEQ's review of the 2007-2008 Annual Report states:

> *Even though the irrigation areas are fenced during mining, the concern with the livestock is in post-mining conditions. In addition, for birds and small mammals, the concern is both during mining and post mining habitat. How will PRI ensure that the soils and vegetation are suitable for nesting birds and mammals during mining and to grazing and wild life use during the postmine?*

As stated above, an effective way to limit exposure during mining operations is to eliminate the source of Se. Harvesting the vegetation and disposing of it off site has been shown to be an effective way to remove Se from the system in the short-term (Mackowiak and Amacher 2008). While harvesting will limit exposure, Cameco has also decreased the amount of Se entering the system. In response to the elevated Se levels shown in the monitoring data, Cameco has added a Se treatment plant to treat this bleed stream of water before it is used for irrigation. The treatment plant began operation on September 23, 2009 and Se concentrations from the water exiting the plant has been consistently well below 0.1 mg/L.

For the prospects of post-mining time frames, an analysis of the data suggests the system is capable of moving toward a less plant-available, and therefore less toxic, state for Se. This change is independent of the Se treatment plant or any other active remediation strategies. Irrigation at SAT1 ceased in September 2001 (Bev Johnson, Cameco Resources personal communication). Since that time, the soils at SAT1 have not changed significantly (a non-significant ($p = 0.55$) trend of increasing selenium concentration). Since 2006, the soil concentrations have decreased, though, statistically, this decrease is not significant. Despite no significant changes in Se concentrations within the first 12 inches of the soil profile since the cessation of irrigation, the concentration of Se (mg/kg dry weight) in the vegetation has shown a highly significant ($p=0.0004$) decreasing trend (Figure 3). The change in concentration for the last seven years has been 2.8 mg/kg per year, which would lead to concentrations of Se at or below the generally accepted standard of 5 mg/kg (as cited by Sharmasarkar and Vance 2002) after the year 2011 if current trends continue.

2.3 Responses to #20

Comment 20 is a multi-part comment. The following responses are given in order:

2.3.1 Concerns about some livestock obtaining a large portion of their diet in vegetation with elevated Se

Annual harvesting will ensure that no livestock or wildlife will be able to obtain a large proportion of their diet from the irrigated fields during mining operations. Cameco could choose to incinerate or dispose of this harvested vegetation at an off-site facility. Alternately, as livestock feed is often supplemented for Se (multiple authors in Frankenberger and Enberg 1998), Cameco could mix its harvested vegetation with a

Se-poor feed if practicable and economically feasible. Active and passive methods of reducing Se in the soil and vegetation (see below) starting in the present and continuing until cessation of operations will ensure that the risk of exposure is limited to the generally accepted safe levels (as cited by Sharmasarkar and Vance, 2002).

Soil amendments of sulfur or organic matter can be added as an economical method to decrease the Se exposure of wildlife or livestock. Sulfate (SO_4) is a structural analogue to selenate, the most mobile oxidation state in which Se is found within soils and the most likely form by which it is being taken up by the plants (Barceloux 1999). Adding SO_4 to the soil as either elemental sulfur or as gypsum has been shown to suppress plant Se uptake up to 70% in some situations (Mackowiak and Amacher 2008, Ralston 2010). Studies have shown that additions of organic matter to a system (Neal and Sposito 1991, Zhang and Frankenberger 1999, Shrestha et al. 2006) can reduce levels of soluble Se within a system. Organic matter amendments can stimulate soil microbial activity, which in turn can stimulate the volatilization of Se in the soil column, shown to be an effective process for removing Se from soils with elevated concentrations (Frankenberger and Karlson 1994). In these studies (Neal and Sposito 1991, Zhang and Frankenberger 1999, Shrestha et al. 2006) the addition of organic matter was coupled with dry-wet cycling for the most effective volatilization. These processes could be carried out very inexpensively at the SRH operation by spreading an organic matter and using some intermittent irrigation with the irrigators already in place at the sites. The Se treatment plant allows for a readily-available source of water without the elevated Se concentrations.

2.3.2 Concerns about the predicted concentrations of Se within the soil and vegetation under irrigation

A few of WDEQ's comments ask for a basis that the levels of Se within the vegetation and soil will decrease once irrigation with water containing increased levels of Se ceases. As stated above, the situation at SAT1 gives an empirical basis (Figure 3) that the system should see decreased levels of Se in the vegetation which leads to decreases in the ability to enter the food chain (Ramirez 2000) once irrigation ceases. Although the levels of Se are not appreciably decreasing within the soil profile, the most recent data from the soils at SAT1 and SAT2 show that average soil Se concentrations around what many authors see as a critical level of 0.5 mg Se/kg soil (Figures 2a and 2b). With some more active management as discussed above such as harvesting, soil amendment, intermittent irrigation in post-mine reclamation activities and the introduction of the Se treatment plant, these soil Se concentration levels should begin to decrease. Continued monitoring should verify the efficacy of these management practices.

As WDEQ notes in this section of comments, the high clay textures of the soils make these soils difficult to leach and if they were leached, there is an unknown risk to the groundwater. The above-mentioned management practices present a pragmatic and scientifically-supported plan to decrease Se without relying on a technically-challenging leaching process and the unknown risks to groundwater it might entail.

3.0 CLOSING

Data collected from the SRH monitoring regime and the scientific literature give encouraging signs that the Se within the system can be managed so as to minimize the risk to wildlife, livestock and the local groundwater with a minimum of costly or technically challenging solutions. Allowing the system to naturally reduce and or volatilize the Se present has the added benefit of not introducing any disturbance to the system. Disturbing the soil column could lead to oxidizing conditions that would actually have the counter-productive effect of increasing the mobility of Se in the system (Vance et al 1995). A commitment to harvesting and off-site disposal of the vegetation will result in reducing the risk of Se exposure to the local food chain in the near term while changes in the management practices, most notably the Se-treatment plant, will allow for the system to lower Se concentrations. Further monitoring will verify these trends. Once the exposure levels have been reduced, local wildlife once found with elevated Se levels (Ramirez 2000) should be able to excrete excess Se and return to “normal” homeostatic levels (Ralston 2010).

With these comments, and the other reports submitted under this cover, Golder believes it has responded to the still unresolved Se-related concerns WDEQ expressed in its review of Cameco’s SRH 2007-2008 Annual Report. Golder welcomes any questions on this and all related reports, which can be addressed to Sanjay Advani at sanjay_advani@golder.com or by phone at (303) 980-0540.

GOLDER ASSOCIATES INC.

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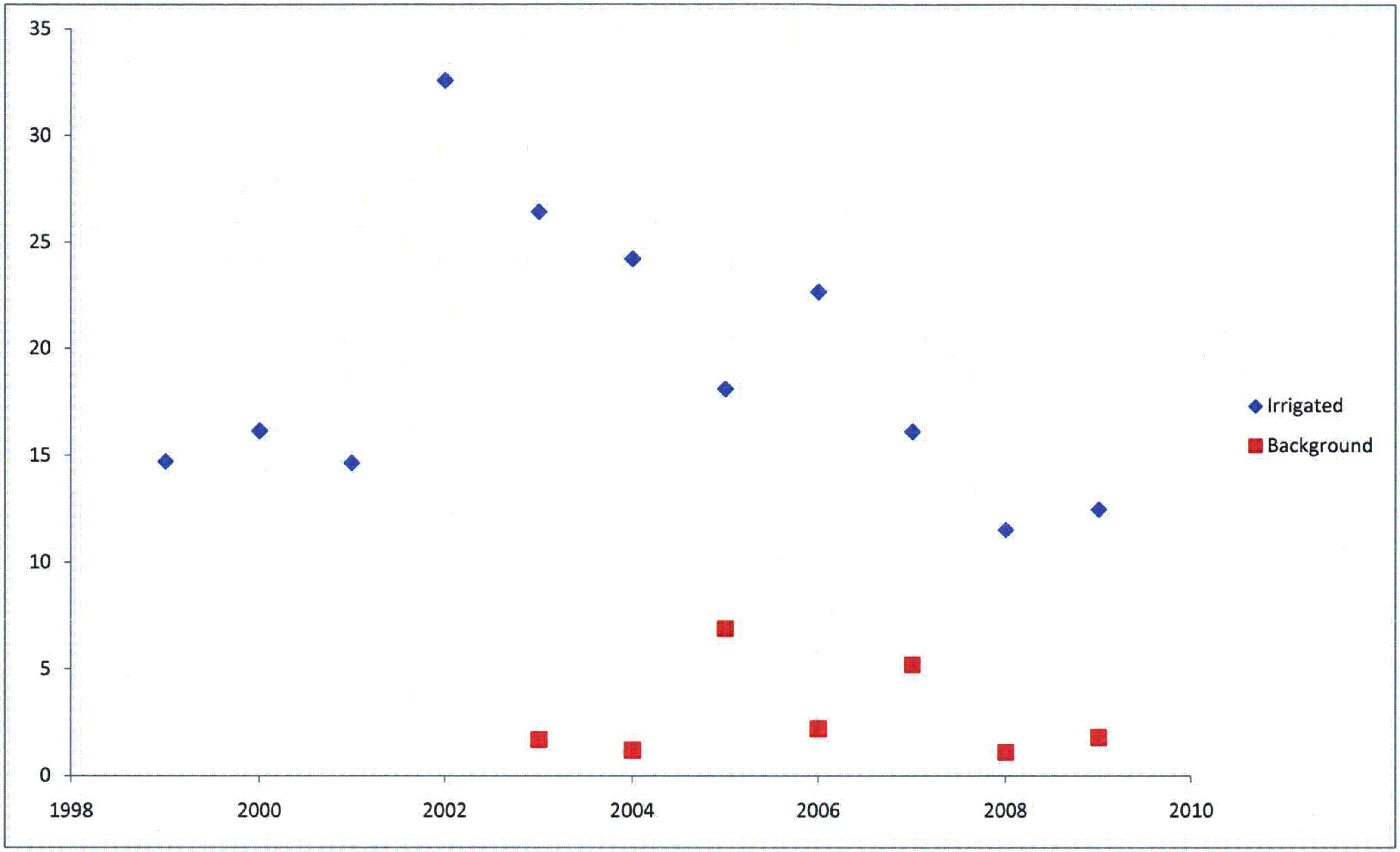
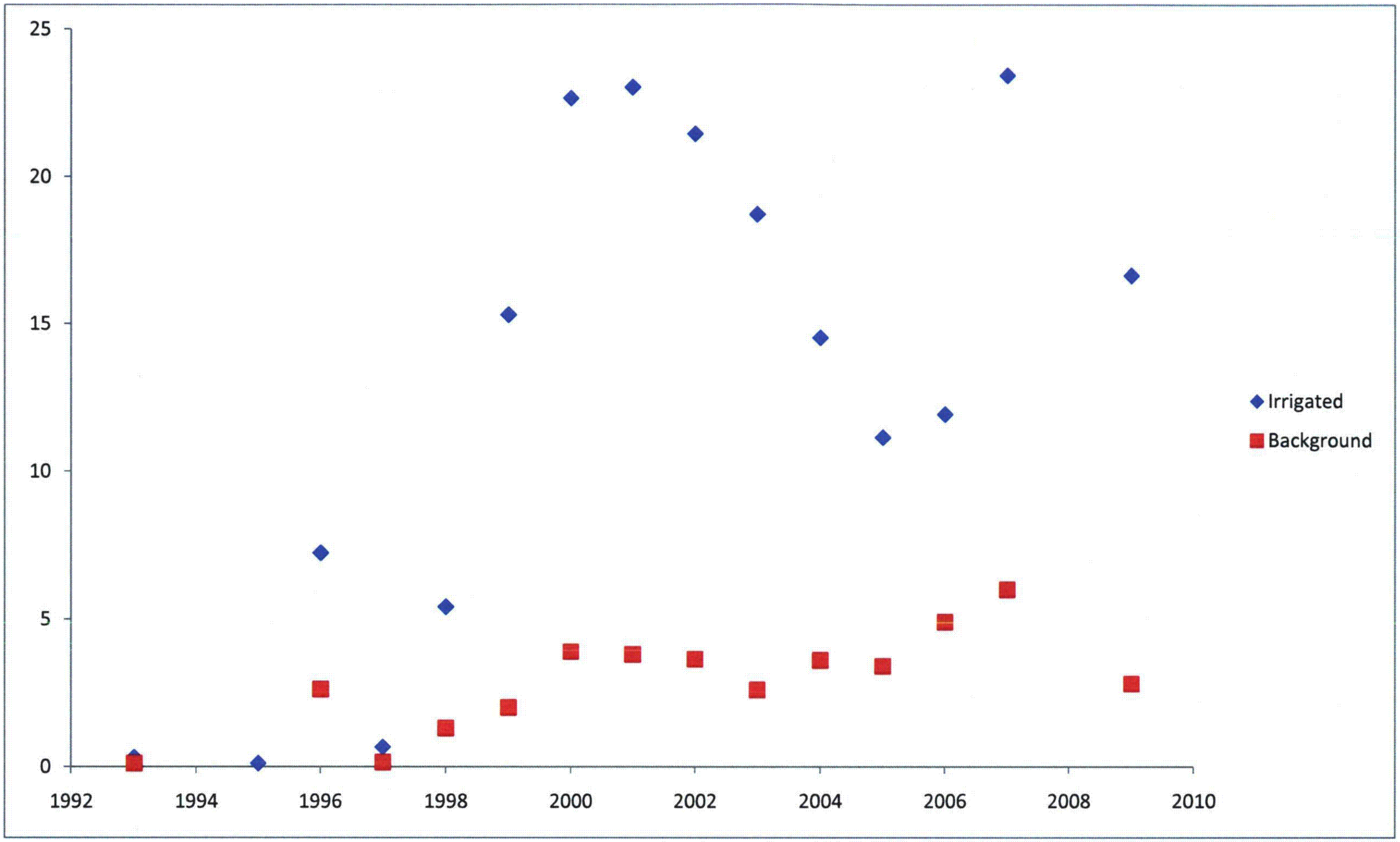
FIGURES



Golder Associates DENVER, COLORADO USA	**Selenium concentration in irrigated and background vegetation at SAT1**
CLIENT/PROJECT Cameco Resources	Date: **Apr-10** Job No.: **103-81513**
	File name: *1513 FnlRpt WDEQ_Comment_Resp_Figs_09APR10* **Figure 1a**



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Selenium concentration in irrigated and background vegetation at SAT2

CLIENT/PROJECT Cameco Resources	Date **Apr-10**	Job No. **103-81513**
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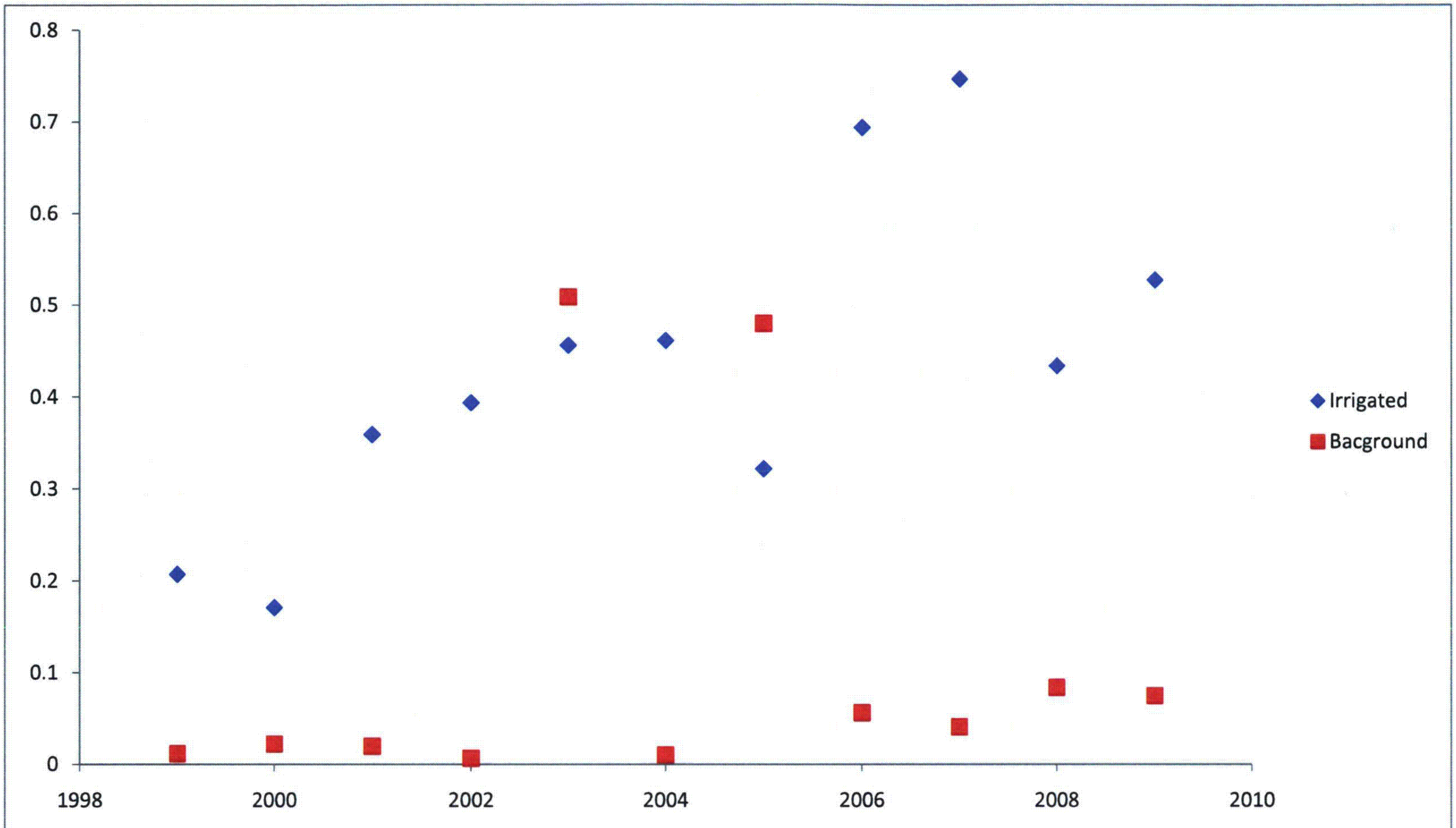

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Golder Associates DENVER, COLORADO USA	Selenium concentration in irrigated and background soil at SAT1	
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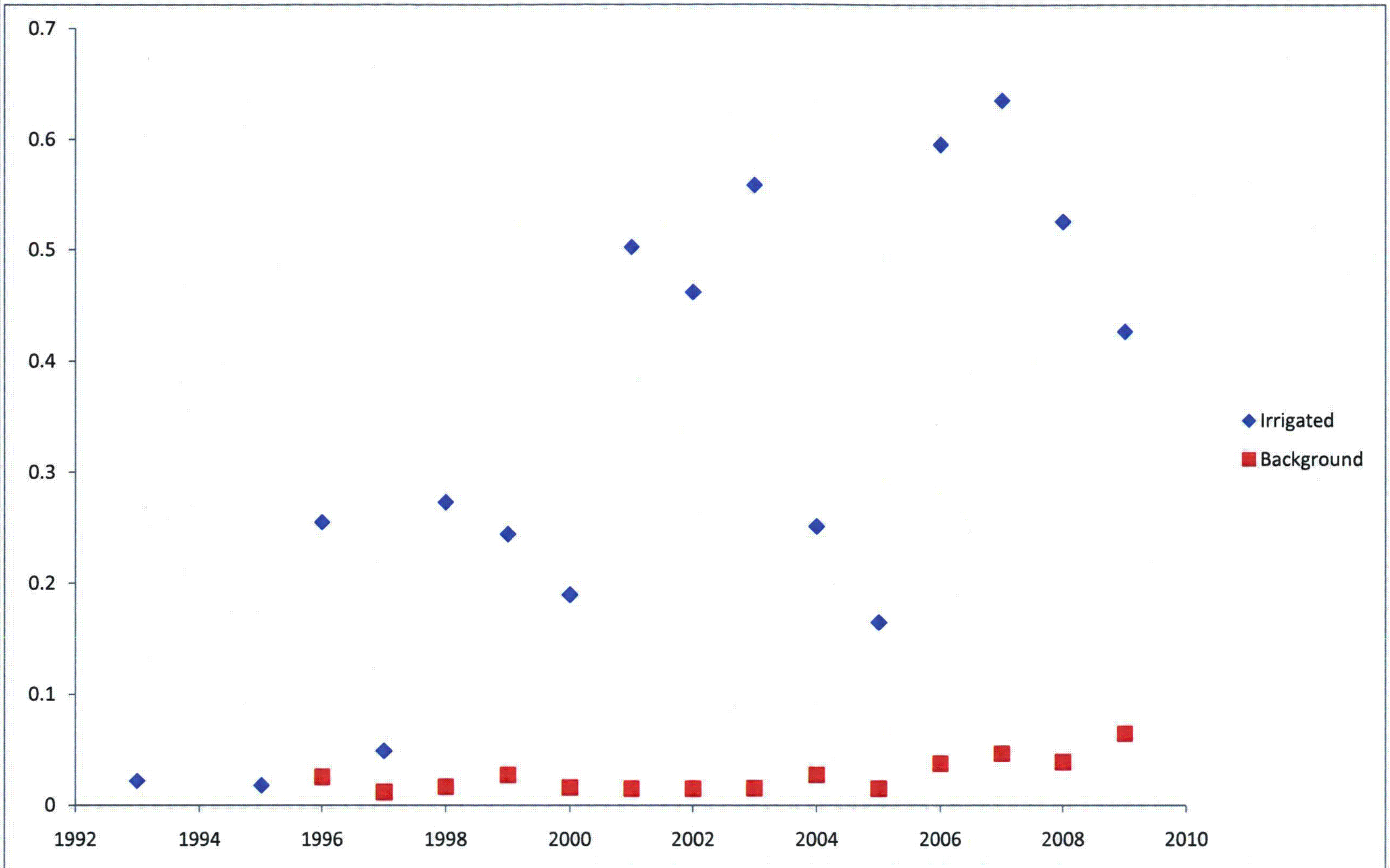

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Selenium concentration in irrigated and background soil at SAT2

CLIENT/PROJECT

Cameco Resources

Date	Job No.
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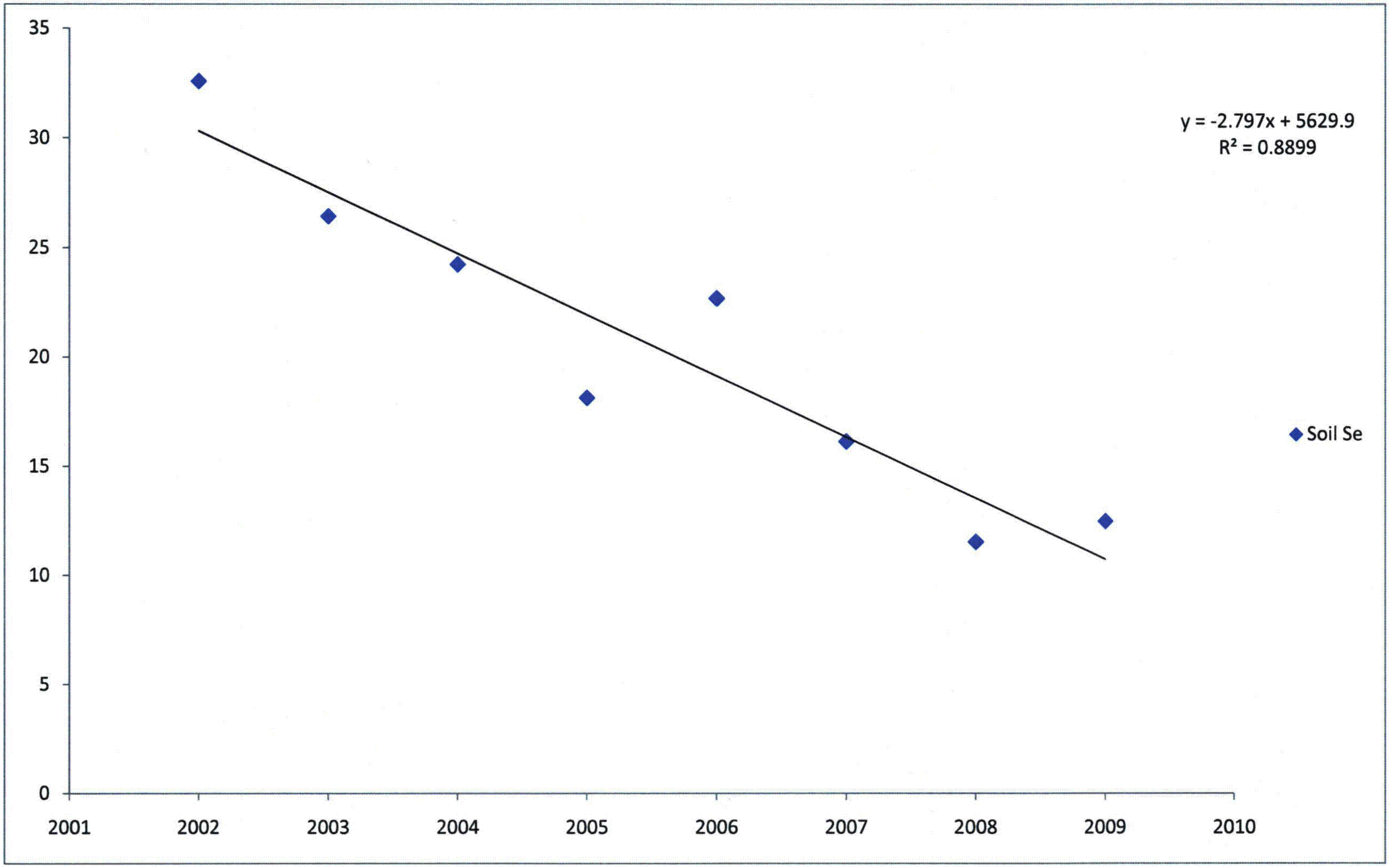
File name: *1513 FnlRpt WDEQ_Comment_Resp_Figs_09APR10*	Figure 2b



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Vegetation Se concentrations at SAT1 since irrigation ended

CLIENT/PROJECT

Cameco Resources

Date	Job No.
Apr-10	103-81513
File name: *1513 FnlRpt WDEQ_Comment_Resp_Figs_09APR10*	Figure 3