AN EVALUATION OF THE OREGON STATE CLEANUP PROGRAM

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Abstract

This paper discusses the factors that impact contaminated site cleanup duration at the state level, focusing on the Oregon Department of Environmental Quality cleanup program. The factors of interest are regional divisions, organizational administration, and prior operations on-site. The duration to achieve cleanup, defined by a "No Further Action" determination, was quantified from the publicly available Oregon Environmental Cleanup Site Information database. A "No Further Action" determination is a regulatory agency action, typically following investigative or cleanup activities, to determine that all or part of a site poses no unacceptable risks to human health or the environment. The analysis of variance (ANOVA) statistical method was used to determine whether there was any statistically significant difference between populations, grouped by regional division, organization administration, and prior operations. Follow-up analyses were conducted on the three regional division populations via a simple comparison of the mean durations and organizational administration populations via a one-way t-test to specifically compare 1) the independent cleanup program to the voluntary cleanup program, and 2) the voluntary cleanup program to the site response program.

The results indicated that regional divisions, organizational administration and prior operations have an impact on the length of time required to complete a site cleanup. Research on the staffing, budget resources, and workload allocated to each region may shed further light on the duration variation between the Eastern (average duration 3.5 years), Northwestern (4.5 years), and Western (5.5 years) regions. This analysis shows that site response program has a longer duration to cleanup than the voluntary cleanup program, whereas no statistically significant difference was noted between the independent cleanup program and the voluntary cleanup program. As a caveat, the site response program may be employed to address sites with higher risk and complexity than the voluntary cleanup program, which would potentially result in longer timeframes to achieve cleanup completion. However, the voluntary cleanup program has a reputation of taking a more cooperative approach between regulatory agency and responsible party; this may explain the shorter duration to complete site cleanup. To address the types of operations that may cause a lag in the cleanup process, state agencies may consider forming technical groups for similar sites and standardized methods for investigation, risk assessment or remediation for certain types of sites.

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Introduction

Contaminated properties are ubiquitous. Environmental contamination can be found in our own backyard, figuratively, and sometimes even literally. The United States Environmental Protection Agency (USEPA) posits that most land contamination is the result of accepted prior practices that are now understood to cause environmental damage (USEPA, 2011). Less significant, contamination may also be caused by accidental spills, negligence, naturally occurring events, or purposeful acts. The all-encompassing term "brownfield," as defined by the USEPA, is "real property where the expansion, redevelopment, or reuse may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant" (USEPA, 2012). Over 400,000 brownfields are in the United States (GAO, 2004).

Brownfields may result in health impacts to workers or residents via direct contact with soil, impacts to indoor or outdoor air, or ingestion of impacted groundwater. The impact from a brownfield does not stop at the property boundary. Migration of contamination off-site may result in off-site risk to human health and the environment. A brownfield may be a stigma to a community, as properties surrounding brownfields may be devalued (Paull, 2008). Additionally, previously undeveloped sites, i.e., greenfields, may be favored for development instead of brownfields, resulting in a net loss of green space, a need for new infrastructure, and stimulation of sprawl. Brownfields, once restored, allow for development within the existing developed areas and increase the tax base and job growth. The benefits of remediating brownfields go beyond the basic mission of environmental agencies: protection of human health and the environment.

Background

With the adoption of Comprehensive Environmental Response Compensation and Liability Act (CERCLA) in 1980 and reauthorization through the Superfund Amendment and Reauthorization

Act (SARA) in 1986, a federal regulatory process was outlined to address contaminated sites. Since 1995, the trust fund for the Superfund program has been decreasing due to the expiration of taxes on the chemical and petroleum industries. This tax had previously provided $1.5 billion annually (Lazzari, 1996). A majority of funding for the Superfund trust fund is now appropriated from the general Treasury fund, as directed by Congress (GAO, 2008). In 2009, the total program funding requested by the USEPA was $1.26 billion, with $1.09 billion to be sourced from the general Treasury revenues (Ramseur, Reisch, & McCarthy, 2008).

For entry into the Superfund program, sites must be identified on the National Priorities List (NPL). Both a preliminary assessment, which determines whether a site poses a threat to human health and the environment and requires further investigation, and a site inspection, where samples are collected to assess the level of threat and types of hazardous substances released, must be conducted in order to identify whether a site is to be listed on the NPL. A Hazard Ranking Score, a value based on the potential risk to human health and the environment, is developed. Upon a sufficiently high Hazard Ranking Score, the site is proposed for listing on the NPL. Following public comment, the site may then be confirmed on the NPL. Assessment and remediation may take many years to complete. Delisting from the NPL marks the completion of the remedial action, however, monitoring and maintenance may continue following delisting. There is a backlog of 3,000 sites with approximately 200 added annually (USEPA, 2011).

Though the Superfund program is recognized for tackling large, severely contaminated sites, states manage a significant amount of site assessment and cleanup. Sites not included on the federal NPL are the states' responsibility (Page, 2005). In response, many states have enacted laws to institute cleanup policies and funding mechanisms. As states are not required to meet minimum requirements or be approved at the federal level, there is variability across state cleanup programs. In general, state regulatory oversight of contaminated sites is provided via two methods: a state-ordered cleanup

"minisuperfund" (Page, 2005) or a voluntary or independent cleanup program administered at the state level. Some states may also have a "brownfield" program as well. In 1996, the USEPA developed an interim guidance to work with state cleanup programs (USEPA, 1996), which may have catalyzed new and improved existing state cleanup programs. Only 24 states have a formal agreement with USEPA (USEPA, 2010).

By 2000, states had completed cleanups at approximately 29,000 non-NPL sites (Environmental Law Institute, 2002). By comparison, at the end of 2000, construction had been completed at 760 sites listed on the NPL (USEPA, 2011). In addition, states take a role in NPL sites, providing a 10% cost match on remedial action costs incurred by EPA and 100% of long-term maintenance costs, reviewing documents, serving as a work party to carry out components of the investigation/cleanup, or implementing operation and maintenance once construction is complete. States are the workhorses for regulating environmental cleanup, based on the inability for the underfunded Superfund to address significant sites and the magnitude of the low- to moderate-risk sites.

Objective

In times of lean state budgets, state cleanup programs are under pressure to deliver results cost-effectively. The effectiveness of state cleanup agencies can be assessed by the duration from when a site is identified as a problem, i.e., listing as a contaminated site to the point that the site is no longer an issue, i.e., cleanup completion. Sequential steps are taken to move the site towards closure (e.g., initial site assessment, remedial investigation, feasibility study, etc.). Lapses in activity may indicate insufficient pressure from the regulatory agency or an uncooperative party responsible for the cleanup.

A multitude of factors may influence the effectiveness of a state cleanup program in moving sites through the process to achieve a No Further Action (NFA). Blackman et al (2008) studied the attraction of sites to enrolling in a cleanup program, specifically that the Oregon voluntary cleanup

program (VCP) is attracting sites with significant contamination and that sites on the Confirmed Release List or with DEQ permits are more likely to participate in the VCP. In an analysis of Superfund sites, Daley and Layton (2004) found that less complicated sites and an increase political pressure relate positively to achieving construction completion, while the presence of community groups may correlate negatively to construction completion. To some degree, cleanup authorities can attract sites to enter cleanup programs (Blackman, 2008). There is less control by the cleanup authority, however, in the context in which a cleanup is conducted (e.g., political pressure, complexity of the site). Factors that state cleanup agencies have some authority over include standardized decisions and timeframes, organizational structure, established cleanup policies, cleanup program types offered, regional implementation, funding mechanisms, and fee structures. This study focuses on the features of cleanup programs that are within state control and how they may have an impact on effectiveness as measured by movement of sites through the process.

This master's project attempts to identify factors within the control of state governments (e.g., regional and organizational program divisions, administrative overlays) that trigger shorter durations as measured from site listing to closure. Additionally, factors not within the control of state governments (e.g., prior use or operations) will be analyzed to understand the impact, if any, on duration from listing to cleanup. Of the state cleanup programs, the Oregon Department of Environmental Quality (DEQ) was selected for analysis due to its robust database of sites, maturity and modifications over time.

Overview of Oregon Cleanup Program

Cleanup in Oregon is governed primarily by the Environmental Cleanup Law, with several related laws. The Environmental Cleanup Law (Oregon Revised Statutes [ORS] §§465.200-420, §465.900) was enacted in 1987 and amended 1989, 1991, 1995, 1999, 2003, 2005, and 2011. This law established the Hazardous Substance Remedial Action Fund, an Orphan Site Account, and a priority

list. Under this law, the DEQ is authorized to clean up sites contaminated by hazardous substances. Provisions for enforcement, liability, cost recovery, cleanup standards, and public participation are included.

The Brownfields Redevelopment and Cleanup Law (ORS §285A.185-.192) first enacted in 1997 and amended in 2001, 2005, 2007 and 2009, provides authorization for the State's brownfields program. By this law, the Oregon Business Development Department was tasked with aiding entities in redeveloping brownfields and a Brownfields Redevelopment Fund was created. Related statutes include Spill Response and Cleanup of Hazardous Materials (ORS §§466.605-680) enacted in 1985; Oil Storage Tanks (ORS §§466.706-845, 466.994 and 466.995) enacted in 1987; Heating Oil Tanks (ORS §§466.858-882) enacted in 1999; and Cleanup from Contamination Resulting from Dry Cleaning Facilities (ORS §§466.500-545) enacted in 1995.

Cleanup regulations and implementation of programs are dynamic; a summary of regulations and guidance modifications in Oregon is as follows. To implement the cleanup statutes, OAR 340-122, the Hazardous Substances Remedial Action Rules (the Rules) were originally developed in 1988, which included regulations on remedial investigations, selection of remedial actions, and cleanup rules for leaking petroleum underground storage tanks (LUST) systems. In 1989, the soil matrix cleanup options and numeric soil cleanup standards for LUST were added. In 1990, the Rules were revised to include regulations on site evaluations and establishment of the Confirmed Release List (CRL) and Inventory. An Inventory Ranking was included in the Rules in 1991. 1992 added a section on Involuntary Acquisition by the Government. 1993 provided regulations for the Solid Waste Orphan Site Account. 1997 added generic remedies, and regulations on risk assessments and feasibility studies. 1998 included risk-based concentrations for the LUST program.

The Risk-Based Decision Making for the Remediation of Petroleum-Contaminated Sites guidance document was originally developed by DEQ in 1999, specifically for petroleum-contaminated sites.

The revision in 2003 expanded its application to hazardous substance cleanups, not just petroleum-contaminated sites. The spreadsheets accompanying the guidance document have been updated almost annually, in 2006, 2007, 2008, 2009, and 2011.

The DEQ Cleanup Section, within the Land Quality Division, has several programs within it to complete its goal of protecting "human health and the environment by identifying, investigating, and remediating sites contaminated with hazardous substances" (DEQ).

- Brownfields Program: Serves as an information resource to remediate brownfields.
- Dry Cleaner Program: Provides liability relief to dry cleaners and requires dry cleaners to pay fees into a cleanup fund. Established in 1995.
- Emergency Response Program (ERP): Prevents and responds to spills of oil and hazardous materials.
- Orphan Sites Program: Facilitates the investigation and remediation for Orphan sites, where the responsible party is not known, able or willing to pay for needed remedial actions at a contaminated site.
- Site Assessment Program: Discovers, assesses and ranks contaminated sites that require further action to protect health and the environment. Oversees limited removal and remedial actions. Maintains Environmental Cleanup Site Information (ECSI) database and the Confirmed Release List and Inventory
- Site Response Program: Investigates and cleans up contaminated sites under an enforceable order or decree if a responsible party chooses not to address the contamination (i.e., "minisuperfund")
- Voluntary Cleanup Program (VCP): Provides oversight for property owners investigating and cleaning up hazardous substance sites in a voluntary manner via either the Independent Cleanup Pathway or the Voluntary Cleanup Pathway. The VCP was established by policy in

1991 and legislatively ratified by a budget bill in 1993, and operates on a cost-recovery basis, where DEQ oversight is billed to the responsible party. All non-NPL and non-enforcement sites are eligible for Voluntary Cleanup Pathway. Only low and medium priority sites are eligible for Independent Cleanup Pathway.

Though not a program per se, DEQ offers Prospective Purchaser Agreements (PPAs), a legally binding agreement between DEQ and a prospective purchaser or lessee, which limits liability provided there is a "substantial public benefit." Generally, the PPA will include some combination of: "substantial funding for cleanup or a commitment to perform substantial cleanup; productive reuse of a vacant or abandoned industrial or commercial facility; or a development by a government entity or nonprofit organization to address an important public purpose" (DEQ).

External to the Cleanup Section but related to its ultimate goal, the Leaking Underground Storage Tank Program focuses on contaminated sites related to spills and releases from regulated underground storage tanks.

Methods

Data Source

The DEQ maintains a publicly available database entitled the Environmental Cleanup Site Information (ECSI) Database (DEQ). Data as of March 2011 were downloaded and used for this analysis. The DEQ caveats the limitations of the database in that it may be incomplete, is a summary, and does necessarily include all contaminated sites in Oregon. The downloaded data were unmodified for the purposes of the analysis, with the exception of minor data scrubbing, including modifying characters that prevented importing, filling in missing dates from the online ECSI database, and correcting some date errors. A total of 4,759 sites were identified in the ECSI database

as of March 2011 (see Figure 1). A relational database was reconstructed in Microsoft Access to provide a more straightforward means of examining the data therein.

Dependent Variable

This research focuses on the duration from initial discovery by DEQ to completion where the human health and environmental risk has been managed. For the purposes of the analysis, the start and endpoint must be defined to quantify duration. Though earlier actions may have occurred, the earliest date an administrative action record was recorded in the ECSI database is considered the "start." The earliest recorded administrative action is inconsistent across sites, however, several actions are common entry points into the ECSI database (e.g., "Site Screening Recommended," "Site Evaluation," "Site Added to Database").

As sites have a varied history of actions documented in the ECSI database, defining the ending point signifying "cleanup" is essential. A "No Further Action" (NFA) determination is a regulatory agency action, typically following investigative or cleanup activities, to determine that all or part of a site poses no unacceptable risks to human health or the environment. Though indicative of "completion," reopener clauses may result in additional remedial activities if conditions change or additional information is discovered. There are several different types of NFAs: a full NFA issued for a site by DEQ; a conditional NFA issued by DEQ requiring institutional or engineering controls to be maintained and recorded on the property deed; a partial NFA issued for one section or one type of media for the site; and a federal-issued NFA where no further remedial action is planned under a federal program. For the purposes of this analysis, full NFA determinations issued by DEQ will be used as a proxy for completion. Of the 4,759 sites in the ECSI database, as of March 26, 2011, 1,335 sites had been issued NFA determinations by the DEQ.[1]

[1] A total of 1356 NFAs have been issued by the DEQ, as some sites were issued NFAs more than once.

The dependent variable, "duration" is defined as the time between the initial site action noted in the ECSI database to the date of the most recent full NFA determination issued by the state.

Independent Variables

This research attempts to identify factors within the control of state governments that trigger shorter durations as measured from site listing to NFA determination. The focus is features of cleanup programs that are within state cleanup program control, with some analysis to understand the influence of variables external to the control of a cleanup program. For this analysis, the independent variables analyzed include the following:

- Regional divisions – DEQ is administratively divided into three regions: the Northwest Region, the Eastern Region, and the Western Region, as shown in Figure 1.
- Oversight – Several different programs may provide oversight of the ECSI sites in order to obtain an NFA. Per the ECSI database, 13 entities have issued one or more NFAs. Though many of these are within the umbrella of the DEQ Cleanup Section, not all are (e.g., Leaking Underground Storage Tank Program).

Though not within the control of state governments, prior use or operations on the site is analyzed to understand the influence on duration. To approximate prior use, the Divisions of the Standard Industrial Classification (SIC) Code are used (e.g., Division A: Agriculture, Forestry and Fishing).

Analytical Method

Sites with NFA determinations were grouped into populations, based upon the independent variables established. Counts of all ECSI sites, including those without NFA determinations, were reviewed for comparison. Descriptive statistics and box plots are provided for NFA sites. To understand whether there is a significant difference between population means based on the samples, a one-way analysis of variance (ANOVA) was performed, using the Microsoft Excel Data

Analysis Tool-Pak. The one-way ANOVA assesses the effect of a single factor on a single response variable. The ANOVA is appropriate if 1) all samples are simple random samples drawn from each of population; 2) observations are independent of one another; 3) the dependent variable is normally distributed in each population; and 4) the variance of the dependent variable is the same in each population (Wabed, 2010). As the data exhibit positive skewness, to improve normality, the data were transformed prior to analysis, using a square-root transformation. The null hypothesis is that the population means are equivalent. The alternative hypothesis is there is a difference between at least two of the population means. The null hypothesis is rejected if the calculated F-statistic is larger than F critical. If the ANOVA indicates rejection of the null hypothesis, multiple comparisons of pairs of means may be conducted in a post-hoc analysis.

Results

For the 1,335 sites with state-issued NFAs, the average duration from initial entry into the ECSI database to NFA is approximately 4.5 years. State-issued NFAs have been given to 28% of the total ECSI sites; however, this does not suggest that the remaining 72% of ECSI sites require an NFA determination. These sites may be administratively inactive or have a partial or conditional NFA determination. Of note, the earliest action and the NFA issuance occurred concurrently for 25 sites, resulting in a zero-day duration for cleanup. This suggests that the ECSI database may omit some preceding steps required to obtain an NFA determination.

Regional comparison

Summary statistics on the durations by regions (Eastern, Northwestern, and Western) are shown in Table 1. Of the total 4,759 ECSI sites, the distribution by region is 41%, 32%, and 28%, Eastern, Northwestern, and Western, respectively. The distribution of the 1,335 NFA sites by region is 24%, 40%, and 35%, Eastern, Northwestern, and Western, respectively. A box plot is shown on Figure 2.

An ANOVA was completed on the square-root transformed data, with results shown in Table 2. Using an alpha of 0.05, the F-value was calculated as 12.94 compared to an F-critical of 3.00. The p-value was <<0.001. Based on the ANOVA, there is some statistical difference between the regions. As the confidence intervals are relatively similar among each region's population, a simple comparison of the means was conducted. The Eastern region average duration is lower than the Northwestern region, which is lower than the Western region. The averages for each region are approximately 3.5 years, 4.5 years and 5.5 years, for Eastern, Northwestern, and Western regions, respectively.

Administrative Oversight

To understand the impact of the administrative oversight, the sub-section of DEQ issuing the NFA for each site is shown. There are 12 groups plus a group created for sites with an NFA issued by more than one group. A box plot of the minimum, inner quartiles, median and maximum is shown on Figure 3. The data was square-root transformed for the purposes of improving normality. Nine groups were excluded from the ANOVA due to small sample size, dissimilar variance, NFA-issuance by more than one entity, or outside of the DEQ Cleanup Section. The remaining four groups (i.e., Independent Cleanup Program, Site Assessment Program, Site Response and Voluntary Cleanup Program) total 94% of the NFAs (see Table 3). Using an alpha of 0.05, the F-value of 5.51 was calculated as compared to an F-critical of 2.61. The p-value was <<0.001. The ANOVA results indicate statistical difference between two or more means within the administrative oversight groups that were analyzed (see Table 4). Two t-test comparisons were conducted between Voluntary Cleanup/Independent Cleanup and Voluntary Cleanup/Site Response. Between the Voluntary Cleanup and Independent Cleanup, no statistical significance was noted (one-tail p-value = 0.338; see Table 5). Between the Voluntary Cleanup and Site Response groups, there is some statistical significance (one-tail p-value <<0.001; see Table 6).

Prior Use

The SIC codes provided in the ECSI database were classified into the SIC Divisions of the SIC manual as shown in Table 5. Forty-four percent of the NFA sites have no SIC code associated with them, limiting the extent of the analysis. As Division D Manufacturing has 14% of the NFA sites, this division was subdivided. Sites that had no SIC code, 2 or more SIC codes, or unclassified were excluded from the analysis. Additionally, two divisions were excluded from the analysis for small sample size and disparate variance (i.e., "Division B Mining," "Division H Finance, Insurance and Real Estate"). The remaining 11 groups total only 46% of the NFAs (see Table 7). Using an alpha of 0.05, the F-value of 6.92 was calculated as compared to an F-critical of 1.85. The p-value was <<0.001. The ANOVA results indicate statistical difference between two or more means within the administrative oversight groups that were analyzed (see Table 8). Box plots are shown on Figure 4. No follow-up analysis was completed on SIC Divisions.

Discussion

Based on the analysis of factors within control of DEQ, both the region and administrative oversight factors impact the NFA duration. Additionally, the type of operations may suggest the speed of NFA issuance.

Regional Comparison

The region impacts the duration of NFA issuance. The Eastern Region is the most expedited region, with an average duration to NFA nearly one year shorter than the Northwestern Region, and two years shorter than the Western region. These results call into question the difference between the regions, potentially focusing on DEQ-triggered factors: staffing, budget or administration. Possible non-DEQ related explanations should be explored as well, for example, due to the variability in

statewide distribution of facilities associated with particular industrial sectors, some regions may comprise simpler sites or a carry a lighter case load that allows faster throughput.

Administrative Oversight

Based on the proxy of the entity issuing the NFA, administrative oversight impacts the duration from entry into the database until NFA issuance. Of the groups with a sample size greater than 10, the Voluntary Cleanup and Independent Cleanup provided the quickest, on average, pathway to an NFA. The Voluntary Cleanup program disallows enforcement and NPL sites, but accepts high priority sites, while the Independent Cleanup program disallows high priority sites. The Site Response program tackles the more difficult properties in which a property owner may be recalcitrant in cleaning up the property, which may be the rationale for the longer duration to NFA. This analysis suggests that there is little advantage in terms of an expedited NFA in choosing Independent Cleanup over Voluntary Cleanup, or vice versa. The difference between Voluntary Cleanup and Site Response may be used to encourage parties to avoid the Site Response program and proceed in a voluntary manner. Though not analyzed beyond descriptive statistics, it is important to note the duration increase for the "more than one NFA" group.

Administrative oversight may be more complex than simply using the entity that issued the NFA. A site may enter DEQ's oversight within the Voluntary Cleanup pathway, but may be "elevated" to the Site Response program if, over time, satisfactory efforts towards addressing the contamination are not made. The issuance of the NFA is a good indicator of the last entity that dealt with the site.

Prior Use

Prior use has an impact on duration to some degree. The total ECSI sites to NFA sites by SIC Division are roughly proportional. Divisions impact the duration, although differing explanations may vary by SIC Division, such as more lucrative operations have more funding to spend on

cleanups, DEQ's familiarity with certain operations and standardized methods of clean up (e.g., gas stations), complex operations resulting in higher risk, or other factors.

Limitations

This research relies heavily on the accuracy of the DEQ ECSI database. The variable in question is the duration from initial entry into the database, but DEQ's knowledge of the site may pre-date the initial record in the database. This may incorrectly shorten the average duration.

To complete the ANOVA, populations that had small sample sizes or variances were removed from the analysis. Additionally, the normality of the data was improved by using a square root transformation. A more advanced statistical approach may be more inclusive for all NFA sites. Additionally, the analysis does not address any interference of SIC Divisions with administrative oversight or region.

Recommendations

The results of the regional analysis require further understanding of what triggers the difference. Though the Eastern region has achieved the most expedited NFA determinations on average, NFAs have been issued for 17% of all ECSI sites in the Eastern region. By comparison, the northwestern and western regions have issued NFAs for 35% and 36% of the ECSI sites in the region. Understanding the types of sites within the region may clarify the difference to determine whether there is variability in statewide distribution of facilities associated with particular industrial sectors. Though project managers may work across regions, staffing and budget resources within each region may impact the duration. The impact of staffing could increase or decrease duration. Lower staffing levels may work to expedite the NFA, as there is not as much ability to drill into details of each site, but they could also allow sites to languish. For instance, the Voluntary Cleanup program has a waiting list for sites unassigned to project managers.

As noted in the administrative oversight discussion above, the duration to achieve NFAs issued by the Site Response program is longer than the Voluntary Cleanup program. Quantifying the implications of avoiding the Site Response program for responsible parties and associated transaction costs may encourage them to proceed in the voluntary cleanup program. As both programs operate on a cost-recovery basis, where DEQ oversight is billed to the responsible party, the costs to DEQ would be comparative.

Though not analyzed in detail, the sites where more than one NFA was issued have a much longer duration. Changing site conditions or policy guidance may be unavoidable and cause NFA reopeners, but ensuring that an NFA is issued with complete documentation even though it may delay the process slightly, in the long-term is advantageous.

More understanding of the impact of prior use is necessary. Forming technical groups that previously addressed similar sites may more efficiently restore sites to an NFA determination. For certain operation types with extended durations to achieve NFAs, DEQ may consider developing standardized methods for investigation, risk assessment or remediation. Additionally, understanding the financial and technical capabilities of the responsible party in completing a cleanup is important. Some level of sophistication is required in understanding the legal and environmental importance in addressing contamination at a site.

This research uses NFAs as an endpoint, signifying the completion of the investigation and/or remediation process. Although NFAs are recognized milestone in cleanup, many sites may continue with administrative actions post-NFA. While the date of an NFA is equivalent to the last administrative action for many sites, some sites have post-NFA actions. The activity "post-NFA" could be classified into either post-closure activities or potential reopener activities. Mitigating reopeners would provide more certainty to the responsible parties.

Additionally, further analysis should be completed on the portion of sites that have not yet received an NFA, and have not received completion through an administrative off-ramp. Many sites may be suspected as contaminated and are, accordingly, added to the ECSI database. These sites may not be contaminated and are either delisted or not listed on the Confirmed Release List and the Inventory of Hazardous Substance Sites, subsets of the ECSI database.

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Tables

Table 1: Summary Statistics: Regions

	All Sites		NFA Sites							
	Count	%	Count	% of NFA Sites	% of All Sites	Average Duration (days)	95% Confidence Interval		Min	Max
Total	4,759	--	1,335	100%	28%	1,673	±	101	0	10,419
Region										
Eastern	1,931	41%	327	24%	17%	1,283	±	168	0	7,910
Northwestern	1,509	32%	535	40%	35%	1,632	±	161	0	10,419
Western	1,310	28%	473	35%	36%	1,991	±	183	0	9,209
No Region Identified	9	0.2%	--							

Table 2: ANOVA Results: Region

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Eastern_Transformed	327	9680.2926	29.6033413	407.898756
Northwest_Transformed	535	18065.6473	33.767565	492.183673
Western_Transformed	473	17846.3584	37.7301447	568.479479

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	12900.6698	2	6450.33489	12.9371231	2.72491E-06	3.00247993
Within Groups	664123.39	1332	498.591134			
Total	677024.06	1334				

Table 3: Summary Statistics: Administrative Oversight

Entity Issuing NFA	NFA Sites					
	Count	% of NFA Sites	Average Duration	95% Confidence	Min	Max
			(days)			
Included in ANOVA						
Independent Cleanup	241	18%	1,493	± 255	3	9,209
Site Assessment	527	39%	1,616	± 155	0	9,096
Site Response	64	5%	2,288	± 479	88	7,612
Voluntary Cleanup	423	32%	1,392	± 140	0	8,225
Excluded from ANOVA						
UST	41	3%	4,210	± 650	393	8,210
Leaking UST	11	0.8%	3,000	± 1,649	259	6,803
Emergency Response	6	0.4%	465	± 540	154	1,477
IL	4	0.3%	147	± 349	0	470
Cleanup	1	0.1%	964	--	964	
DC	1	0.1%	695	--	695	
ILA	1	0.1%	0	--	0	
Orphan	1	0.1%	2,982	--	2982	
More than one NFA	14	1.0%	5,276	± 1,657	1,504	10,419

Table 4: ANOVA Results: Administrative Oversight

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
ICP-sqrt-trans	241	7636.59925	31.6871338	490.529407
SAS-sqrt-trans	527	17121.8077	32.4891986	561.698079
SRS-sqrt-trans	64	2782.33893	43.4740458	404.039206
VC-sqrt-trans	423	13701.5516	32.3913749	343.407362

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	7706.98001	3	2568.99334	5.50731936	0.00092975	2.61201611
Within Groups	583552.624	1251	466.468924			
Total	591259.604	1254				

Table 5: Independent Cleanup and Voluntary Cleanup t-test Results

	ICP-sqrt-trans	*VC-sqrt-trans*
Mean	31.68713382	32.39137487
Variance	490.5294069	343.4073624
Observations	241	423
Hypothesized Mean Difference	0	
df	431	
t Stat	-0.417359305	
P(T<=t) one-tail	0.338311716	
t Critical one-tail	1.648396712	

Table 5: Independent Cleanup and Voluntary Cleanup t-test Results

	SRS-sqrt-trans	*VC-sqrt-trans*
Mean	43.47404579	32.39137487
Variance	404.0392055	343.4073624
Observations	64	423
Hypothesized Mean Difference	0	
df	80	
t Stat	4.15196341	
P(T<=t) one-tail	4.09098E-05	
t Critical one-tail	1.664124579	

Table 7: Summary Statistics: SIC Divisions

SIC Divisions	All Sites		NFA Sites							
	Count	%	Count	% of NFA Sites	% of All Sites	Average Duration (days)	95% Confidence		Min	Max
Total	4759	--	1335	100%	28%	1,673	±	101	0	10,419
Included in ANOVA										
Div. A: agriculture, forestry, farming	71	1%	24	2%	34%	1,218	±	602	2	4,388
Div. C: construction	30	1%	15	1%	50%	1,020	±	643	4	3,724
Div. D, major group 24: manufacturing: lumber and wood products	288	6%	62	5%	22%	2,304	±	502	6	8,218
Div. D, major group 28: manufacturing: chemicals	69	1%	19	1%	28%	4,441	±	1,242	378	9,096
Div. D, major groups 33, 34: manufacturing: metal products	143	3%	38	3%	27%	2,841	±	836	0	8,225
Div. D, other manufacturing	191	4%	64	5%	34%	3,119	±	615	2	10,419
Div. E: transport, comm. electric, gas, and sanitary	458	10%	113	8%	25%	1,790	±	309	0	7,422
Div. F: Wholesale trade	413	9%	77	6%	19%	2,010	±	378	0	7,120
Div. G: Retail trade	342	7%	90	7%	26%	2,658	±	467	0	8,210
Div. I: Services	405	9%	93	7%	23%	1,606	±	353	1	7,077
Div. J Public Administration	68	1%	13	1%	19%	1,279	±	1,039	0	5,966
Excluded from ANOVA										
Div. B: Mining	111	2%	6	0%	5%	2,220	±	1,511	460	4,016
Div. H Finance, Insurance and Real Estate	3	0%	3	0%	100%	1,378	±	1,888	622	2,142
Unclassifiable	92	2%	36	3%	39%	504	±	378	1	4,750
2 SIC Codes	290	6%	77	6%	27%	2,209	±	403	31	6,783
3 SIC Codes	76	2%	15	1%	20%	2,397	±	1,252	1	7,387
4+ SIC Codes	20	0%	2	0%	10%	2,355	±	13,812	1,268	3,442
No SIC Code	1689	35%	588	44%	35%	1,099	±	120	0	9,209

Table 8: ANOVA Results: SIC Divisions

Anova: Single Factor

SUMMARY

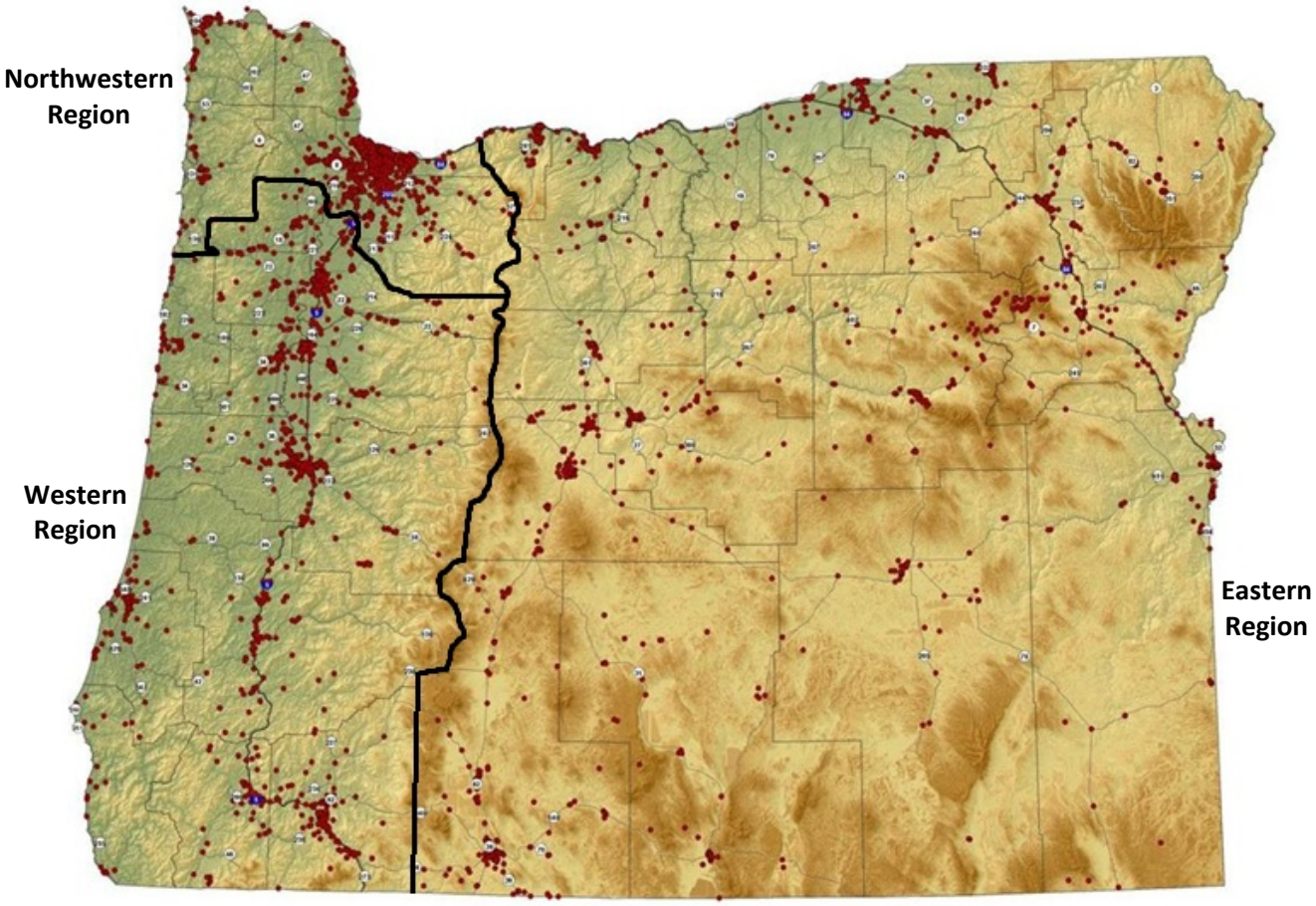
Groups	*Count*	*Sum*	*Average*	*Variance*
sqrt-SIC div. A: agriculture, forestry, farming	24	685.960297	28.5816791	418.308823
sqrt-SIC div. C: construction	15	408.170782	27.2113855	299.364821
sqrt-SIC div. D, major group 24: manufacturing: lumber and wood products	62	2698.32169	43.5213176	416.696474
sqrt-SIC div. D, major group 28: manufacturing: chemicals	19	1200.80511	63.2002691	471.599654
sqrt-SIC div. D, major groups 33, 34: metals	38	1781.23668	46.8746494	661.085272
sqrt-SIC div. D, other manufacturing	64	3189.32194	49.8331553	646.016259
sqrt-SIC div. E: transport, comm. electric, gas, and sanitary	113	4204.64515	37.2092491	409.565279
sqrt-SIC div. F: wholesale trade	77	3099.14217	40.2485996	395.12984
sqrt-SIC div. G: retail trade	90	4141.48276	46.0164751	546.466989
sqrt-SIC Div. I: Services	93	3196.07153	34.3663606	429.115798
sqrt-SIC Div. J Public Administration	13	364.371514	28.028578	534.348716

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	32825.4869	10	3282.54869	6.91718444	2.74603E-10	1.84655216
Within Groups	283306.248	597	474.549828			
Total	316131.734	607				

Figures

Figure 1: Cleanup Sites in Oregon



Source: Maul, Foster & Alongi

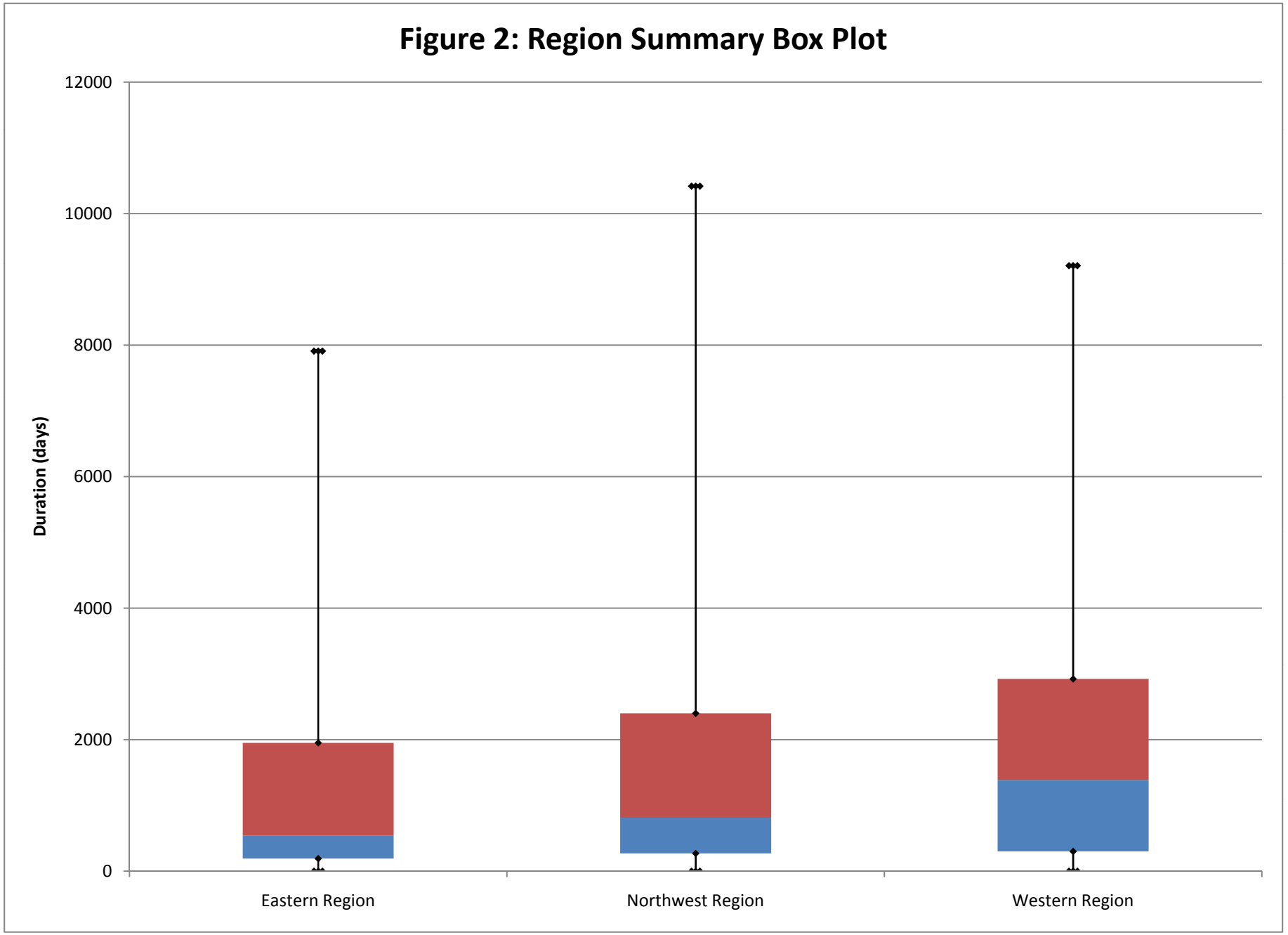
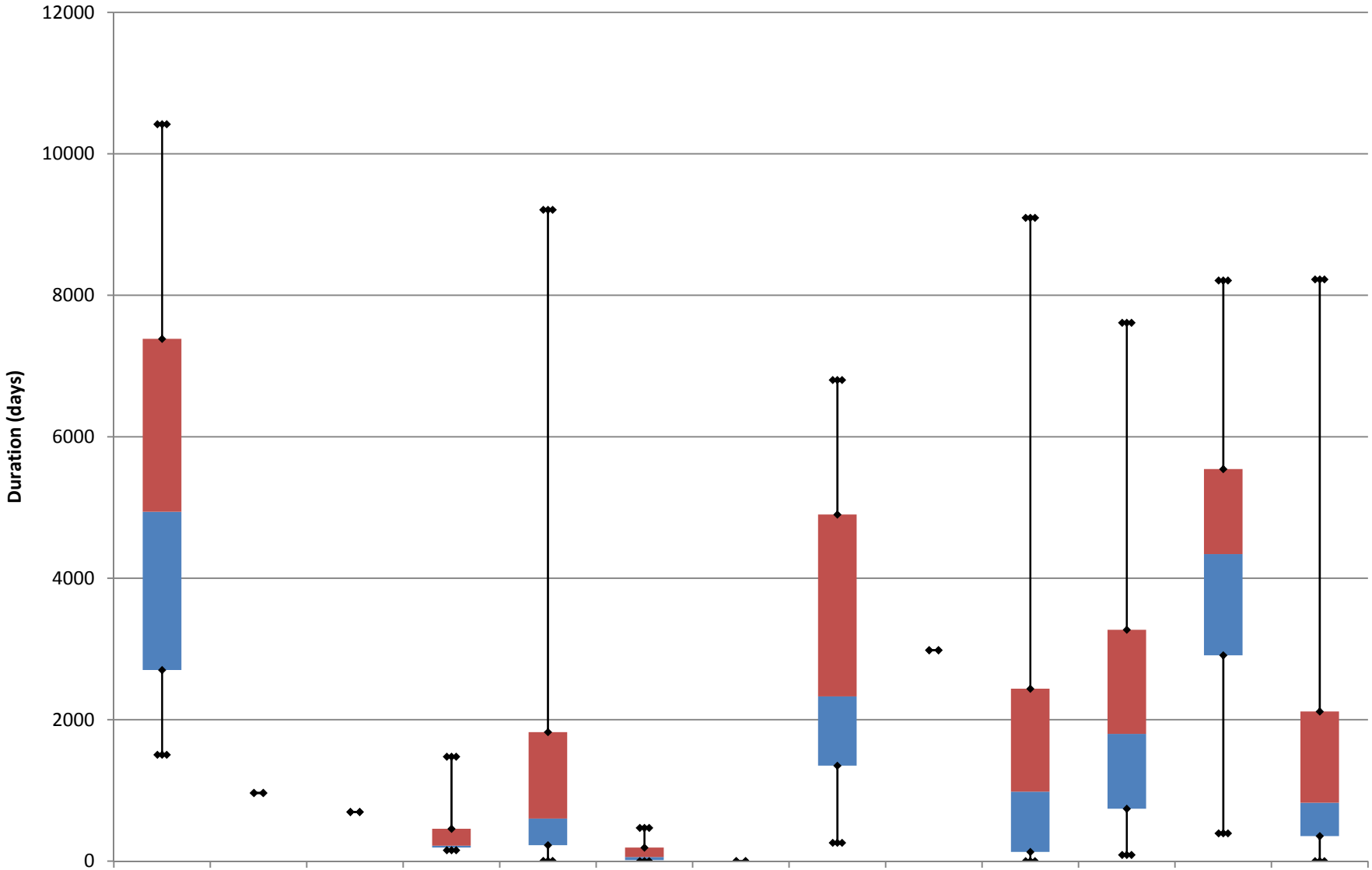


Figure 2: Region Summary Box Plot
12000
10000
8000
6000
4000
2000
0
Duration (days)
Eastern Region
Northwest Region
Western Region

Figure 3: Administration Oversight Summary Box Plot



*The singular data point for ILA has a value of zero.

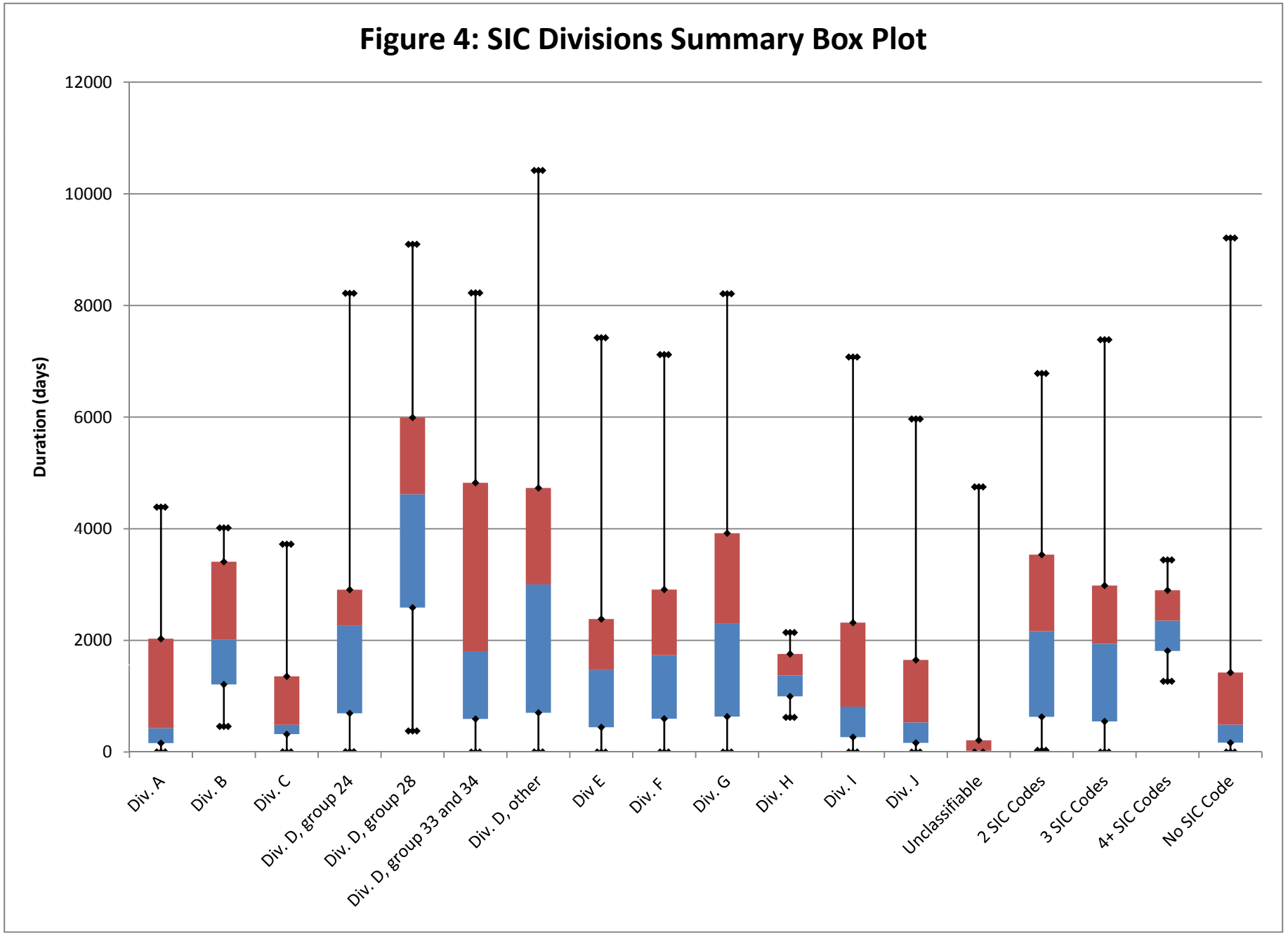


Figure 4: SIC Divisions Summary Box Plot
Duration (days)
12000
10000
8000
6000
4000
2000
0
Div. A
Div. B
Div. C
Div. D, group 24
Div. D, group 28
Div. D, group 33 and 34
Div. D, other
Div E
Div. F
Div. G
Div. H
Div. I
Div. J
Unclassifiable
2 SIC Codes
3 SIC Codes
4+ SIC Codes
No SIC Code