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Discussion of Climate Change-Related Water Impacts in Federal Environmental Impact Statements (EISs), January-September 2012

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Center for Climate Change Law
Columbia Law School

Discussion of Climate Change-Related Water Impacts in Federal Environmental Impact Statements (EISs), January-September 2012

March 2013

Cathy Li

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INTRODUCTION

Climate change and its predicted effect on precipitation, temperature, storm frequency and intensity, global sea levels, and numerous other factors will pose significant challenges for the maintenance and operations of built infrastructure. Climate change is predicted to exacerbate water-related issues, such as water supply shortages brought on by increasingly severe droughts and more frequent or intense flooding caused by extreme precipitation events. Executive Order 13514 and subsequent instructions from the Council on Environmental Quality (CEQ) have directed federal agencies to prepare for and adapt to the changing environment in which they will have to operate.

The National Environmental Policy Act (NEPA) of 1970 requires federal agencies, before undertaking, funding or permitting major actions that may have a significant effect on the environment, to prepare an environmental impact statement (EIS) addressing the expected impacts on the environment and identifying potential alternatives and mitigation measures. EISs are intended to improve the decision-making process by requiring decision makers to research, understand, and consider the potential consequences of the proposed action, its alternatives, and suggested efforts to mitigate these impacts. EISs could further improve the decision-making process by extending the analysis to incorporate not only the effect of the project on the environment but also the effect of the environment on the project: a "Reverse Environmental Impact Analysis."[1]

Currently, there exists little research or analysis on how various federal agencies deal with the topic of climate change in conjunction with water in their EISs, in part because such research would require the collection of hundreds of EISs scattered across many different agencies. The U.S. Environmental Protection Agency (EPA) maintains a comprehensive listing of all federal EISs published since 2004, which is searchable by date, preparing agency and state, but this database does not contain or link to any actual EIS documents. Individual federal agencies are highly inconsistent in the way that they provide online access to EISs. While a few agencies provide searchable listings of the EISs prepared by that agency, most do not. Typically, a special webpage is created for each EIS, which may be linked to anywhere on the agency website and is often difficult to find. Some agency websites have a NEPA page that links to EISs for projects currently under review or open for public comment, but these pages usually do not provide links to older EISs, and even when they do the links are often broken. In many cases involving larger projects, a separate website may be created expressly to host EIS documents and other information related to one project, using a web address that is not under the agency domain name. As a result, the only way to locate these websites is often by searching for the project name using Google or another search engine. Typically, after an agency decision is reached, these sites are no longer maintained, and the domain names routinely expire. Gathering the required EISs and reviewing the several-hundred-page documents is therefore a task that few researchers have taken on.

[1] As proposed by Center Director Michael Gerrard. M. Gerrard, Environmental Impact Analysis: Effect of Climate Change on Projects. New York Law Journal 247(45), 8 March 2012, http://www.arnoldporter.com/resources/documents/Arnold&PorterLLP_NewYorkLawJournal_Gerrard_3.8.12.pdf.

A previous report published in July 2012 by Columbia's Center for Climate Change Law (CCCL), "Consideration of Climate Change in Federal EISs, 2009-2011,"[2] examined the varying degrees to which federal agencies addressed climate change and greenhouse gas emissions in their EISs. Using a similar approach, CCCL has prepared a database examining the treatment of water-related issues in all Final EISs reported to EPA from January 1 to September 30, 2012. The database, comprised of 149 FEISs, details the extent to which federal agencies address topics related to water and climate change. This report presents a summary of the trends and patterns represented in that database.

EXISTING EIS GUIDELINES

Federal agencies receive little centralized guidance regarding the extent and manner in which they should consider water and climate change in EISs. Those documents that do address the issue often appear in the form of nonbinding guidelines rather than formal regulations. Section 102 of NEPA mandates the items that are to be generally included in EISs, including a general comment that "Environmental impact statements shall be analytic rather than encyclopedic." However, the Act itself does not address any specifics regarding impacts to or from water. NEPA further mandates that EISs must be prepared so that issues are addressed according to their significance in a project, allowing room for projects less concerned with water to include less detail. Thus, under the terms of the current legislation, EISs can differ widely in the depth and breadth with which they address water issues.

The EPA and the CEQ have periodically released more specific memoranda on what is to be included in EISs in relation to impact to water, but these have focused primarily on water pollution and water quality rather than the water abundance issues (either too much or too little) that are most likely to result from climate change:[3,4]

- In August 1980, CEQ released the report "Interagency Consultation to Avoid or Mitigate Adverse Effects on Rivers in the Nationwide Inventory,"[5] which mandates that EISs must determine if the action would alter or destroy an inventory river segment, contribute to the deterioration of water quality, involve transfer or sale of property adjacent to the river without adequate protection, or pollute the water in a way which would lower the grading of the river (i.e. from wild to recreational).

- In June 1992, EPA released a report titled "Background for NEPA Reviewers: Crude Oil and Natural Gas Exploration, Development, And Production"[6] which assists EPA

[2] Center for Climate Change Law, 2012. *Consideration of Climate Change in Federal EISs, 2009-2011.*
[3] EPA. *Environmental Impact Statement Filing System Guidance.* http://www.epa.gov/compliance/resources/policies/nepa/#eis-filing-system
[4] CEQ. CEQ Regulations and Guidance. http://ceq.hss.doe.gov/ceq_regulations/guidance.html
[5] CEQ. *Interagency Consultation to Avoid or Mitigate Adverse Effects on Rivers in the Nationwide Inventory.* http://ceq.hss.doe.gov/nepa/regs/guidances/Memo_Interagency_Consultation_on_Rivers_081008.pdf
[6] EPA. *Background for NEPA Reviewers: Crude Oil and Natural Gas Exploration, Development, And Production.* http://www.epa.gov/compliance/resources/policies/nepa/oil-and-gas-background-pg.pdf

reviewers of EISs in understanding what information should be addressed in EISs of oil and natural gas projects, including demanding specifics on the natural rate of ground water prior and post disturbance, the expected constituents and concentrations of water produced at the facility, how wastewater will be treated and managed, if the area of influence surrounding affected aquifers will be monitored for chemical change and with what frequency, the overall water balance for the site, etc. A similar set of questions is found in the December 1994 EPA report titled "Background for NEPA Reviewers: Non-Coal Mining Operations."[7]

- A September 2005 report by EPA, "Reviewing Environmental Impact Statements for Fishery Management Plans,"[8] instructs EPA reviewers of Fishery Management Plans to check for information relating to the biodiversity and population of aquatic life in the affected area, as well as "the extent that adverse water quality effects (both from fishing and from cumulative effects from other sources) can adversely affect fish (e.g., turbidity, oil sheen from vessels, fish advisories)."

Draft guidance issued by CEQ in 2010, "Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions," encouraged agencies to consider "The relationship of climate change effects to a proposed action or alternatives, including the relationship to proposal design, environmental impacts, mitigation and adaptation measures."[9] CEQ noted that "Agencies can use the NEPA process to reduce vulnerability to climate change impacts, adapt to changes in our environment, and mitigate the impacts of Federal agency actions that are exacerbated by climate change." However, three years later, these guidelines have yet to be finalized and remain non-binding on federal agencies.

In the absence of centralized guidance on how to address vulnerability to climate change in the EIS process, some federal agencies themselves have established guidelines. For example, the U.S. Forest Service (USFS) issued its 2009 guideline, "Climate Change Considerations in Project Level NEPA Analysis," which states that EISs ought to address both "The effect of a proposed project on climate change (GHG emissions and carbon cycling)…*and the effect of climate change on a proposed project*" (emphasis added). Although the guidelines do not address water-related climate change issues specifically, the Forest Service does promote the idea of bi-directional analysis of climate change impacts in EISs. The Federal Highway Administration released a report entitled *Integrating Climate Change into the Transportation Planning Process, Federal Highway Administration* in July 2008, which covers the inclusion of climate change in transportation plans, quantification of GHG impacts in transportation plans, GHG mitigation strategies in transportation planning, and climate change adaptation in transportation planning. It,

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[7] EPA. *Background for NEPA Reviewers: Non-Coal Mining Operations.*
http://www.epa.gov/compliance/resources/policies/nepa/non-coal-mining-background-pg.pdf
[8] EPA. *Reviewing Environmental Impact Statements for Fishery Management Plans.*
http://www.epa.gov/compliance/resources/policies/nepa/reviewing-EISs-fishery-management-plans-pg.pdf
[9]CEQ. *Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions.*
http://ceq.hss.doe.gov/nepa/regs/Consideration_of_Effects_of_GHG_Draft_NEPA_Guidance_FINAL_02182010.pdf

too, fails to address water related issues specifically, but it does promote the incorporation of climate change in transportation planning.[10]

In the absence of standardized guidelines from CEQ or EPA, federal agencies have taken a broad range of approaches to the consideration of water in their EISs. Often, agencies fail to consider important aspects of climate change and its consequences for the availability of water for future operations. The extent to which agencies do consider water in their EISs is correlated strongly to the type of project being considered. Consideration of water effects is inconsistent among federal agencies and even within an agency among EISs.

METHODOLOGY OF STUDY

The CCCL database of water-related EISs examines all FEISs reported to EPA from January to September of 2012 that were recorded on the website of the EPA and accessible online.[11] Some Supplementary FEISs were removed from consideration because they only included very minor changes from previous FEISs and did not necessitate the inclusion of further discussion on water. The database records the date, state, lead agency, and type of project for each FEIS and then analyzes each based on its discussion of four major water-related climate change categories: sea level and water table rise, water shortage and drought, flooding, and project water use. This study expands on the work of “Consideration of Climate Change in Federal EISs, 2009-2011,” which had tangentially addressed issues of sea-level rise and flooding for previous years.

The categories of water impacts considered in the FEISs are:

- **Water usage** – Expected amounts, type, and sources of water to be used in the construction, maintenance, and operations and the effect and probability of water shortage on the project.
- **Water shortage and drought** – Potential for the project to increase drought and water shortages in the project area. Discussion of the possibility of water drawdown in local areas and preventative measures to mitigate such effects.
- **Sea level rise and water tables** – Risk posed to the project by future sea-level rise or rising water tables and subsequent steps to be taken by the project to mitigate or counteract these effects; includes calculations of heights of projected sea-level rise over time, both local and regional, and suggested mitigation efforts.
- **Flooding** – Impact on riverbeds, levees, and other protective structures; impact of potential flooding on the project and preventative measures taken. Potential to increase chances of flooding or effects on flood peak flows or flow rates.

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[10] FHWA. *Integrating Climate Change into the Transportation Planning Process.* https://www.fhwa.dot.gov/environment/climate_change/adaptation/resources_and_publications/integrating_climate_change/climatechange.pdf

[11] The database includes only those EISs which were freely accessible online during the period of research. The database notes FEISs that were listed by EPA but unavailable online.

This report assesses EISs that addressed one or more of these topics for the scope of their analyses. While qualitative descriptions of impacts were noted, EISs were graded subject to the following questions:

- **Quantitative analysis** – Were water impacts quantitatively and specifically calculated?
- **Life-cycle analysis** – Did "operational impacts" include a thorough and complete life-cycle analysis?
- **Cumulative effects** – Did the water effects analysis include only selective discussion of localized impacts or a full consideration of cumulative impacts including impacts from unrelated projects in the surrounding area?

The dates covered by the database, ranging from January to September of 2012, were chosen in response to EPA's newly implemented policy requiring submissions made on or after October 1, 2012, to be submitted electronically through e-NEPA.

SUMMARY OF FINDINGS

Due to a lack of binding regulation for the discussion of climate change and water-related issues in EISs, there exists a wide variation among the scope and specificity of consideration, differing in part by agency, state, and project type. While some EISs include full appendices and extensive calculations of water-related climate change issues, others fail to address these topics at all. A minority of EISs feature appendices addressing specific quantities and sources of water and implementation plans for developing such water sources. These are usually far more detailed than the discussion within the main EIS document itself, but they are far less common. Discussions of water use and supply most often appear as sub-sections and generally vary in placement between EISs. Certain environmental effects are well delineated under independent headings in an EIS, such as effects to Floodplains, Wetlands, and Aquatic Environments. However, discussion of water supply is far more likely to be buried within the text of another section. Water usage may be addressed under the Alternatives section but just as often it is found under the Affected Environment or the Environmental Consequences subsections. Thus, finding information on water usage is especially difficult because there is no continuity in the methodology between agencies.

Rather intuitively, project types most related to water usage, such as non-fossil energy generating projects (hydroelectric power, nuclear energy plants) and water and wastewater management and development projects, include the most effective discussion of water-related climate change issues, often including extensive quantitative reporting across all four categories.

FINDINGS BY WATER IMPACT CATEGORY

The collected federal EISs were evaluated according to the presence and quality of their discussion of four major water-related categories: sea level and water table rise, water shortage and drought, flooding, and project water use. Water usage, water shortage, and drought are considered together here because they are significantly interrelated and were often discussed together in EISs.

Water Usage, Shortage & Drought

Consideration of water usage varies largely based on project type and leading agencies. The U.S. Army Corps of Engineers (USACE) and Bureau of Land Management (BLM) were the two agencies that were most comprehensive in their discussion on water usage. Even their analysis of water use varied according to the type of project being considered. While EISs for large-scale construction projects most often include quantitative discussion of amounts of water uses, as well as full life cycles of operational impacts, smaller actions, such as land management plans and restoration projects, often neglect to address water consumption needs or solely offer a brief qualitative mention.

The potential for the project to create water shortages and drought are mainly considered in conjunction with the project's water usage calculations. With a few notable exceptions, the great majority of projects that do address the possibility of increasing water stress and drought in a region dismiss such their own water usage as insignificant in affecting the local balance. In this respect, their behavior is similar to their consideration of greenhouse gases: even when agencies do consider their emissions, they determine that their emissions are so small relative to the nation's emissions as a whole that they do not merit further discussion.[12]

Flooding

Flooding is discussed more often than other water effects, but the discussion typically does not focus on project vulnerability. Flooding is often presented in combination with floodplains, a section traditionally included in a majority of EISs. Effects on the project as a result of flooding are discussed far less often than effects of the project on flood flows. Common examples include the potential of a project to cross culverts or channels, erosion and sedimentation of flood channels, construction of projects within floodplains, and possibility of projects to affect peak flows or probabilities of flooding. Although EISs often address the issue of flooding, they rarely provide any mitigation efforts to curtail the detrimental effects identified. Moreover, the effects of a flood on the project are rarely addressed. Though EISs commonly discuss 50- and 100-year floods and flood levels, based on the Federal Emergency Management Agency (FEMA) flood maps, there exists little dialogue on the specific ramifications of flooding on the project or how agencies plan to cope if such flooding occurs.

Sea Level Rise

Sea-level rise is ignored by a great majority of EISs, though extensive analysis can be seen on some occasions. While general consideration of climate change as a broader field is increasingly present throughout all agencies, much of the discussion is quite general. EISs often mention the presence of climate change and GHG emissions without connecting these issues to the specific project. At times, when sea-level rise is discussed, it is only to acknowledge the existence of a global phenomenon with no attempts to localize impacts. In other cases, impacts due to sea-level rise and climate change are stated to be incalculable. For the purposes of this study, discussions of sea-level rise that are neither quantified nor pertaining to the project itself are not considered to have addressed the issue. Steps to mitigate effects of sea-level rise are rarely seen. Within land-locked states, rising water tables resulting from climate change are, with

[12] Center for Climate Change Law, 2012. *Consideration of Climate Change in Federal EISs, 2009-2011.*

almost no exception, never mentioned. USACE is an exception to the rule, as it often quantitatively addresses and calculates the impacts of predicted sea-level rise.[13]

FINDINGS BY PROJECT TYPE AND LOCATION

The thoroughness of the discussion of water-related climate change issues in a given EIS corresponds heavily to the type of project proposed in the EIS. A wide array of projects are required to prepare EISs under the mandate of NEPA, from construction-heavy projects such as the building of electric-generating plants to operating changes such as a programmatic extension in the ski season of a park resort. EISs are widely divergent based on the project type for which they are prepared. This is especially true in their consideration of water, as many project types have only a tangential relationship with water usage and the marine environment.

In the database that accompanies this summary report, EIS projects were sorted into the following categories:

- Mining (Coal and Non-coal)
- Forestry
- Transportation
- Electric generating (Nuclear and Renewables)
- Military Facilities
- Waste and Wastewater
- Parks and Wildlife
- Oil and Gas Development
- Public Infrastructure
- Buildings and Real Estate

Mainly programmatic actions, such as those that largely fall under ***Forestry*** or ***Park and Wildlife*** (and thus usually covered by the U.S. Forest Service or National Park Service) have tangential usage of water such as dust abatement for roads or increasing potable water and water supplies for toilets to service increased traffic, and their EISs thus commonly contain a much more superficial treatment of water supply discussion, often foregoing it altogether. No construction activities are planned for a majority of such projects, so impacts to the surrounding environments are often considered negligible, and thus discussions on water shortage, flooding, and sea level rise are also less frequent. Similarly, although some require construction, ***Transportation*** related projects, including highways and trains, also seldom discuss water-related issues.

In projects that do require construction and further on-going operations, the discussion of water-related issues still varies by project type. ***Electric generating projects***, including nuclear, wind, hydroelectric, and solar energy harnessing plants, are among the most thorough in addressing water usage both for the purpose of construction and for operational uses. Locations and expected quantities of water wells are noted with great detail, including depths of wells, capacity of storage systems, locations of pipelines, and pumping capacities. Multiple water systems are typically discussed; for example, an EIS for a nuclear plant spoke of a "service-water

[13] See Appendix for "Freeport Harbor Channel Improvement Project."

cooling, potable-water supply, raw water to the demineralizer, fire protection, and media filter backwash" for the operations of the plant alone.[14] However, sea-level rises for such projects are seldom addressed. Examination of possibilities for increasing water stress in the area, due to the large water needs of the projects leading to drawdown of aquifers, is more, though still not very, common. Suggestions to mitigate water stress include efforts to recycle water or increase water storage.

Mining projects (usually under the Bureau of Land Management) are also typically extensive in discussing water usage needs. Water needs for drilling operations, uses for dust abatement, potable water needs are mentioned, as well as groundwater pumping quantities, life-cycle analyses, and cumulative effects. In contrast, the three remaining water categories are largely ignored.

Projects involving ***Water and Wastewater***, as expected, generally include involved discussion on water-related climate change issues. Primarily, the treatment of sea-level rise is especially notable, in part due to a correspondence with locations in coastal areas. Sea-level rise is generally quantitatively predicted for the local project area using different scenarios, and sometimes includes mitigation efforts, such as proposals for higher levees.

Location as factor in determining discussion

Climate change will have different effects in different regions of the United States, including drought in some regions, flooding others, and sea level rise along the coasts. The extent to which federal agencies consider water effects in their EISs would therefore be expected to be related to the location of the project and the nature of the threat being faced. However, the correlation is not as strong as expected, which suggests that some agencies are not considering the regional impact of climate change on their projects.

The National Climate Assessment and Development Advisory Committee (NCADAC) released its latest Draft Climate Assessment Report in January 2013 on the state of America and climate change. Commenting on the American Southwest, NCADAC writes, "Climate changes pose challenges for an already parched region that is expected to get hotter and, in its southern half, significantly drier. […] Severe and sustained drought will stress water sources already over-utilized in many areas, forcing increasing competition among farmers, urban dwellers, and the region's varied plant and animal life for the region's most precious resource."[15]

Intuitively, EISs for projects located within the American Southwest (including Arizona, Texas, Nevada, New Mexico) and California, areas predicted to be most severely impacted by climate-change related drought and water stress, would be more concerned with shortage. However, there exists no conspicuous correlation between location in a drought-prone state and discussion of drought. While some EISs, like "Upper Las Vegas Wash Conservation Transfer Area (CTA)"[16] provided discussion on how each alternative would contribute to a cumulative water shortage in the area, and provided a "Drought Plan" in case of overwhelming water

[14] Cite
[15] NCADAC. *Draft Climate Assessment Report.* http://ncadac.globalchange.gov
[16] See Appendix.

demand, most EISs for projects located in the drier states followed the general trend in the United States and largely ignored the effects to and from water stress.

For sea-level rise, the pattern remains the same. NCADAC states that "Coastal lifelines, such as water supply and energy infrastructure and evacuation are increasingly vulnerable to higher sea levels and storm surges, inland flooding, and other climate-related changes," but location did not dictate the discussion, as coastal projects did not overwhelmingly address sea-level rise to a greater extent. In Los Angeles County, for example, a U.S. Army Corps of Engineers project involving harbor redevelopment did not include any discussion of sea-level rise.[17] There was one exception to this general pattern: all four EISs prepared for projects in the state of Florida addressed sea-level rise quantitatively and in detail. Nevertheless, when looking at water stress and sea-level rise, preparing agency and project type were far better predictors for the quality of water discussion than location and expected exposure to climate change effects.

FINDINGS BY AGENCY

As mentioned previously, federal agencies vary substantially in the quality of their consideration of water in their EISs. In this section, agencies that submitted five or more EISs between January and September 2012 are discussed in greater detail.

U.S. Army Corps of Engineers (USACE)

Across the board, EISs prepared by USACE are generally the most comprehensive and all-encompassing in their discussion of water-related climate change issues. Of the ten EISs published by USACE between January and September 2012, all discussed at least one category of water effect quantitatively and most considered all four categories, save for water shortage and drought. USACE often provided full life-cycle analysis as well as substantial figures calculated from cited models. This quantitative analysis was present, even though USACE EISs covered a range of project types from water and wastewater management to parks and wildlife.

USACE's treatment of sea-level rise was among the most extensive of all agencies. Targeted to local areas as well as larger regions, sea-level rise estimations were calculated over project life span, sometimes to within an hundredth of a foot, and often citing figures from different modeling samples in comparison. USACE is one of the only agencies to include specifics on how sea-level rise would directly impact different segments of the proposed action. In certain cases, USACE provided multiple models for predicting future sea-level rises. For example, a harbor improvement project expected "An estimated 1.05ft sea level rise over the 50 year project life from combined effects of local subsidence and global SLR is expected to affect the salinity and tidal activity in project area."[18]

Three of the ten USACE EISs addressed drought and drought plans, a much greater percentage than on average. Considerations of drought were much more likely to be quantified

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[17] MARAD. *Middle Harbor Redevelopment Project, Funding, Port of Long Beach, Los Angeles County.* 2009, USACE, http://www.polb.com/environment/docs.asp

[18] See Appendix for "Freeport Harbor"

by USACE than other agencies, and the USACE discussion included a development of detailed water shortage plans, such as implementation of new supply regulations for shortage years or the collection of emergency water supplies.

Bureau of Land Management (BLM)

BLM EISs cover a wide array of project types, from mining to water and wastewater management to park and wildlife. Although these project types are diverse, and therefore may be expected to have varying levels of water consideration, there are still trends to be seen in the extent to which BLM addresses water-related issues as a general manner. Unsurprisingly, one of these trends is that BLM is more thorough in some project types than others. EISs for mining, electric generating, and pipeline projects are generally very thorough in their treatment of water-related issues, while management plans, such as park management, are much less thorough.

Water supply is covered extensively by almost all of BLM EISs. For example, the EIS for "Phoenix Copper Leach Project, Construction and Operation of a New Copper Beneficiation Facility, Lander County"[19] includes a lifecycle analysis, pumping rate, details and locations of well construction, and models for groundwater levels and usage throughout the decades of project life. EISs prepared by BLM do well in quantitatively accounting for water supply long-term through the project, often including daily operational water usage and breakdown of on-going operational demands in addition to water used in the initial construction. BLM's EIS for "Ocotillo Express Wind Energy Project, Proposing to Develop a 465-Megawatt Wind Energy Facility, Implementation, Imperial County" included a detailed breakdown of projected daily per capita water usage for sanitary needs, drinking, and fire suppression.

In contrast, BLM's EISs were especially poor in their assessment of sea-level rise. Only one of twenty EISs submitted during 2012 mentioned rising sea levels. This included six projects located in coastal regions. Roughly half the BLM EISs addressed flooding, and a little less than half addressed water shortage and the potential for projects to contribute to drought. The main discussion on flooding focused on the potential impact of floods on new dams that were being constructed.

Federal Highway Administration (FHWA)

FHWA prepares EISs for projects in transportation, most of which fall under the category of bridge and road construction and highway improvement. In 2008, FHWA released a report titled "Integrating Climate Change into the Transportation Planning Process," which promoted opportunities to link climate change with projects and recognized that "looming threats to the system from the impacts of climate change are important long term trends. Issues to be considered include VMT growth, congestion, changing development and land use patterns, sea

[19] Excerpt available in the Appendix. Bureau of Land Management. *Phoenix Copper Leach Project, Construction and Operation of a New Copper Benfication Facility, Lander County*. http://www.blm.gov/pgdata/etc/medialib/blm/nv/field_offices/battle_mountain_field/blm_information/nepa/phoenix_copper_leach.Par.20849.File.dat/10_Section_3.2_Water.pdf. 3.3.221.

level rise."[20] However, of the FHWA EISs prepared in 2012, only four addressed sea-level rise. These discussions vary widely in level of detail. On one end of the spectrum, some EISs mention that the effects of rising sea levels cannot be analyzed or claim that such analysis is beyond the capability of the organization that is waiting for a report from the state. On the other end, some FHWA EISs contain quantitative discussions on local and regional sea-level rise.

Flooding is the most addressed category in FHWA EISs. A majority of the FHWA EISs mentions the effects of the project on flood risks, but most EISs deem the effects to be insignificant and are therefore not quantified or discussed in detail.

Water shortage and drought are the least explored category in FHWA EISs, and, when discussed, amounts of water usage are also dismissed as insignificant. Water supply is usually considered, but sources and amounts are not described in detail. There are often mentions of small amounts of water needs for construction measures, dewatering, or water sources within the project area, but specification of water usage is rarely seen, with 2 two of the 13 EISs prepared for FHWA offering any quantitative data for water usage.

U.S. Forest Service (USFS)

In 2009, USFS published a guidance report titled "Climate Change Considerations in Project Level NEPA Analysis" that stated that EISs ought to address the effects both to and from climate change on a project. Despite this guidance, climate change is treated in a cursory fashion across the board in USFS EISs. Of the 45 FEISs prepared by USFS from January to September of 2012, none discussed the posed risk of sea-level rise or rising water tables as pertains to the specific project, and eight did not address water-related issues at all. Climate change is commonly mentioned in a brief cursory manner, yet sea-level rise is ignored as a part of this discussion. According to USFS guidelines, "It is not currently feasible to quantify the indirect effects of individual or multiple projects on global climate change and therefore determining significant effects of those projects or project alternatives on global climate change cannot be made at any scale."[21] This appears to be at odds with the general direction to consider the effects of climate change. While many USFS actions are taken in landlocked states, a large percentage of projects are also located in coastal areas, with California and Oregon represented heavily. Their lack of discussion of sea level rise is therefore concerning.

However, the type of actions and projects covered by USFS EISs are often those that require little infrastructure and low water use. Most USFS EISs cover programmatic actions such as timber harvesting guidelines and animal population control, so the lack of depth in the treatment of water usage and water shortage is not unexpected. Water usage and supply sources are usually mentioned very briefly, if at all. Most mentions of water use are in conjunction with discussion of dust abatement efforts for roads, irrigation, or deduced from references to water trucks as needed aspects of the project. Mentions of water drafting or well drilling from within

[20]FHWA. *Integrating Climate Change into the Transportation Planning Process.* https://www.fhwa.dot.gov/environment/climate_change/adaptation/resources_and_publications/integrating_climate_change/climatechange.pdf

[21] USFS. *Climate Change Considerations in Project Level NEPA Analysis.* http://www.fs.fed.us/emc/nepa/climate_change/includes/cc_nepa_guidance.pdf

project sites are not uncommon, though many do not address the direct source of water usage even when water need is determined. Very rarely are quantitative analyses included, and when such analysis is present, almost none are detailed nor consider needs for the full life-cycle.

A majority of EISs prepared by USFS addressed flooding as pertaining to the project, yet even within this category, most impacts are described qualitatively. Some typical USFS EISs describe an increase in erosion or sedimentation as a result of road construction or increased vehicle transportation, potential increases in chances of flooding, or increases in peak water flow. Flooding is most often addressed in terms of impacts to floodplains, with impacts to protective structures sometimes mentioned.

National Park Service (NPS)

NPS resembles USFS in that the agency primarily deals with issues regarding land management, including animal control, recreation area development, and historic site maintenance. The EISs prepared by this agency deal with Proposed Actions which usually involved no construction, thus water-related issues are some of the most scarcely discussed of all agencies.

In the infrequent case that water usage is considered, water supply sources are vaguely detailed, such as calling for a need for water trucks used for dust abatement measures or potable water for construction sites, with amounts or types of water never mentioned. In discussing climate change, certain EISs state that effects from global climate change are deemed unknowable on the park scale. Of the eight EISs prepared in the time range of this study, only one addressed sea-level rise, mentioning it as insignificant in that the specific project area was shielded from its effects.

U.S. Navy (USN)

USN prepared six EISs during the time frame of the study, but two are inaccessible online so the analysis here is based on the four remaining available to the public. Project types under the jurisdiction of USN include military facilities such as naval shipyards and bases to contain Marine units. Due to the particularly high-profile nature of these large-scale projects, water-related issues are addressed to a greater extent than on average.

Supply systems for water demand are specifically laid out in certain EISs, as well as quantitative expectations of daily water-use. The EIS for "Hunters Point (Former) Naval Shipyard Disposal and Reuse," for example, discusses the three-part implementation of a low-pressure water system, a recycled water system, as well as an auxiliary supply system. Cumulative effects of water usage were generally neglected.

USN is generally concerned with sea-level rise, especially in its coastal projects, and offers one of the rare instances in which an EIS provides steps to mitigate rising sea-levels: the EIS called for the establishment of a perimeter system, took sea-level rise into consideration when developing elevations of buildings, recommended the implementation of a storm drainage system, and recommended the creation of an "Adaptation Strategy that would include preparing an Adaptive Management Plan outlining an institutional framework, monitoring triggers, a decision-making process, and creating an entity with taxing authority to pay for infrastructure improvements necessary to adapt to higher than anticipated sea levels."[22] Flooding is less of a concern for USN, though it is addressed in three of the four available EISs, all of which quantified effects.

CONCLUSION

Due to the lack of binding centralized guidelines from EPA or CEQ pertaining to climate change, water effects, and EISs, there exists a wide divergence in the methods different agencies undertake to address these issues. While some leeway is to be expected based on project type and location, so as to be cost-effective for decision makers, a baseline for discussion should be mandated so that all water-related climate change issues of concern are discussed. For example, while it is intuitive that USFS and NPS, largely concerned with programmatic actions, focus less on water usage than construction-based projects, it is undesirable that a majority of EISs do not mention quantities or sources of water needed at all, even if such water needs are mentioned.

On the whole, EISs suffer from a lack of consideration of the bidirectional effects of climate change. Impacts from the project on the surrounding environment are addressed, but impacts from the environment on the project remain lacking.

As well, location must increasingly play a factor in determining the level of discussion in EISs. Dry states, such as the American Southwest, need to take into consideration the possibility of water shortage and stress in the upcoming years, and coastal states especially must concern themselves more with the threats of sea-level rise. While some EISs do mention these phenomena, few prepare an actual plan of action to mitigate these effects.

[22] See Appendix for "Hunters Point" EIS.

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APPENDIX I. EXAMPLE EIS SELECTIONS

This appendix provides direct text from EISs to serve as examples of the treatment of water-based climate change issues by different agencies on varying project types. The excerpts are organized by water impact categories. The samples below were selected to include discussions typical of their related agencies and project type as well as exemplary EISs. The Hunter's Point Naval Shipyard Disposal and Reuse and the Freeport Harbor Channel Improvement Project are especially notable among EISs that addressed sea-level rise, while the Pettijohn Project is very typical to Forestry and USFS EISs. While only selections are included below, links to the full reports can be found in the comprehensive database. Any text not in italics is taken directly from the text of the EIS.

WATER USAGE IN EISS

Phoenix Copper Leach Project[23] (BLM, NV)

This EIS, prepared by the Bureau of Land Management, details the amount of water used as well as providing estimations for the life-cycle of the project, here, 24 years. This EIS examines the effects to groundwater levels from pumping based on computer-coded modeling.

A new groundwater production well would be constructed in the northwest corner of Section 8 to supply water for the copper heap leach process included in the Proposed Action. The new production well would be developed in the alluvial aquifer with a planned maximum flow rate of 1,000 gpm and a nominal flow of 600 gpm. Assuming an approximate 24-year active mine life of the proposed project, the total estimated groundwater that would be used for the proposed project would be approximately 23,000 acrefeet. Historically, groundwater pumping has occurred in the

[23]Bureau of Land Management. *Phoenix Copper Leach Project, Construction and Operation of a New Copper Benfication Facility, Lander County*. http://www.blm.gov/pgdata/etc/medialib/blm/nv/field_offices/battle_mountain_field/blm_information/nepa/phoenix_copper_leach.Par.20849.File.dat/10_Section_3.2_Water.pdf. 3.3.221.

alluvial aquifer in existing permitted wells that are used for water supply and as part of a chloride-plume mitigation system. Between January 2005 and December 2009, the average monthly pumping rate from the existing production wells in the alluvial system has ranged from 24 to 4,389 gpm. These existing permitted groundwater production wells are anticipated to continue to be pumped in the future until the end of the mine life.

Potential impacts to groundwater levels and surface water resources resulting from the proposed groundwater pumping were evaluated using a calibrated groundwater flow model developed for the site. The model was designed to simulate groundwater flow in the alluvial aquifer system. The groundwater modeling was conducted by Itasca using a three-dimensional finite-element computer code (MINEDW). Details regarding the model setup and implementation including steady-state and transient calibration are provided in the model documentation report (Itasca 2010).

The calibrated groundwater model was used to simulate two different pumping scenarios:
Scenario 1 – Historical and future pumping of existing permitted wells with the additional pumping from the proposed new production well; and
Scenario 2 – Historical and assumed future pumping of existing permitted wells (without the proposed new production well).

The predicted drawdown at the end of mining resulting from the two pumping scenarios is presented in Figure 3.2-6. The difference between the two model scenarios represents the incremental increase in drawdown attributable to the proposed production well. The results indicate that groundwater withdrawal from the proposed well is expected to result in a slight increase in drawdown compared with the currently permitted groundwater pumping activities. The simulated drawdown area does not encompass any known perennial surface water resources or surface water rights.

The closest perennial stream reach to the groundwater development site is along Willow Creek located approximately 2 miles upstream (and north) of the site. The groundwater flow model was used to simulate flows in Willow Creek. The model results suggest that the pumping included in Scenarios 1 and 2 would have a negligible effect (less than 0.01 cubic feet per second) on stream flows in Willow Creek compared to the assumed baseline conditions (Itasca 2010). Therefore, pumping of the proposed production well is not expected to affect perennial flows in Willow Creek.

Process Facilities

Proposed facilities included in the Proposed Action would be designed, constructed, operated, and monitored in accordance with NDEP and BLM permit requirements and associated plans and procedures. Examples of NDEP requirements include process component design factors, such as the synthetic linings under the heap leach pads, the synthetic linings and storage capacities of process pond systems, and other aspects of process fluid containment. Temporary and permanent diversion channels designed to convey the 100-year, 24-hour storm event would be constructed around the proposed Reona and Phoenix copper HLFs to capture and divert sheet flow generated from upgradient source areas around the facilities. (Additional discussion of these diversion structures is provided under the Other Flooding, Erosion Sedimentation, and Runoff Related Impacts.) The proposed process facilities would be constructed and operated as zero-discharge facilities, as defined through the WPCP review and approval process by the NDEP.

The water resources monitoring plan describes the ongoing program for ascertaining water quality within the currently authorized POO boundary (Battle Mountain Gold Company [BMG] 2000). In the plan, monitoring locations Phx-9 and Phx-10 track surface water conditions in the Reona vicinity, and monitoring locations Phx-11, Phx-12, and Phx-13 monitor conditions in the vicinity of the proposed Phoenix Copper HLF. It is likely that selected surface water monitoring locations may be added or modified as a result of the Proposed Action. Additional monitoring associated with the proposed POO amendment would be specified in revisions to WPCP NEV87061. Quarterly monitoring reports would continue to be submitted to appropriate agencies.

The following discussion evaluates the potential impacts to water resources associated with construction, operation, and closure of the proposed copper HLFs; proposed facilities that could be constructed in the Section 5 OUA; other impacts associated with flooding, erosion, and sedimentation; and runoff from the proposed facilities.

Levy Nuclear Plant (NRC, Florida)[24]

Typical of many electric-generating projects, this EIS, prepared by the Nuclear Regulatory Commission, provides a detailed description of the locations and amounts of expected water supply. Specifically, NRC uses a local-scale model to determine maximum daily uses for water on this project.

5.2.2 Water-Use Impacts

A description of water-use impacts on surface water and groundwater is presented in the following sections. The water resource usage by proposed LNP Units 1 and 2 operations is limited to diverting water from the CFBC for makeup-water needs during normal operations and pumping groundwater for general plant operations, including service-water tower drift and evaporation, potable water supply, raw water to the demineralizer, fire protection system, and media filter backwash.

5.2.2.1 Surface Water

Waters obtained from the Gulf of Mexico and spring flow into the CFBC would be used as the source of makeup water used during normal plant operations. As stated in Section 3.4.2.1, LNP Units 1 and 2 would withdraw a maximum of 84,780 gpm (190 cfs) from the CFBC and discharge 57,923 gpm (129 cfs) of blowdown from the cooling system to the CREC discharge canal. Because the Gulf is virtually an unlimited source of water supply compared to the LNP Units 1 and 2 makeup-water requirements, the review team determined that the use of water from the Gulf would have essentially no impact on it. Therefore, the impact on surface-water

[24] Nuclear Regulatory Commission. *Levy Nuclear Plant Units 1 and 2, Application for Combined Licenses (COLs) for Construction Permits and Operating Licenses, (NUREG-1941), Levy County.* 2012. http://pbadupws.nrc.gov/docs/ML1210/ML12100A063.pdf

resources due to LNP use during operations is expected to be SMALL and further mitigation measures would not be warranted.

5.2.2.2 Groundwater

Groundwater from onsite water supply wells completed in the Upper Floridan aquifer will be used to supply general plant operations, including service-water cooling, potable-water supply, raw water to the demineralizer, fire protection system, and media filter backwash (PEF 2009a). PEF has estimated that plant operations would require an average total withdrawal of 1.58 Mgd of groundwater from the Floridan aquifer and a potential maximum daily withdrawal of 5.8 Mgd (PEF 2009b). PEF developed a local-scale groundwater flow model as a requirement of the LNP Site Certification Application to the State of Florida. This model, which was a local refinement of the Southwest Florida Water Management District's (SWFWMD) District-Wide Regulation Model, Version 2 (DWRM2) regional groundwater flow model, was used to simulate both LNP and cumulative groundwater-usage impacts (see Figure 2-12). SWFWMD staff provided technical guidance and peer review on development of the local-scale model and, once all identified technical deficiencies were resolved, issued a completeness determination that recommended authorizing the average and maximum daily usage values described (i.e., 1.58 and 5.8 Mgd, respectively), provided that State of Florida Conditions of Certification are met (FDEP 2011a).

As discussed in Section 2.3.1.2, this model was subsequently recalibrated to improve model fit in the vicinity of the LNP site. Operational Impacts at the Proposed Site NUREG-1941 5-8 April 2012 PEF tested a number of wellfield locations and configurations using the model to evaluate potential drawdown impacts throughout the model domain. Based on this analysis, PEF determined that siting the wellfield in the southern portion of the proposed LNP property, where regional- and/or local-scale transmissivity is greatest, would reduce drawdown levels in both the Upper Floridan and surficial aquifers compared to siting wells in other feasible locations. Using this wellfield configuration, PEF performed predictive simulations of aquifer drawdown response to an annual average wellfield production rate of 1.58 Mgd and a 1-week maximum withdrawal of 5.8 Mgd (PEF 2009b).

Results from the predictive simulations (PEF 2010a) indicate that annual average LNP groundwater usage from the Upper Floridan aquifer is minor relative to the overall model water balance (Figure 5-2). As indicated, average LNP operational usage (1.58 Mgd) represents only a small percentage (0.8 percent) of the total water flux (208 Mgd) through the model domain (Figure 2-12). At this withdrawal rate, the LNP wellfield is predicted to decrease the surficial and Upper Floridan aquifer discharge to surface-water bodies within the model domain by approximately 0.4 Mgd, or about 2 percent of the total simulated groundwater discharge to rivers and lakes. These simulated impacts on Lake Rousseau and the lower Withlacoochee River, which is designated as an Outstanding Florida Water, are minor relative to the 37-year recorded average daily discharge of 687 Mgd through the bypass channel to the lower Withlacoochee River. In addition, the groundwater model predicts that discharges to the two largest springs in the vicinity of the proposed LNP site, Big King and Little King Springs, would decrease by approximately 0.05 Mgd (35 gpm) or about 1 percent of their total simulated flux (PEF 2010a).

PEF predictive simulations indicate that operation of the LNP wellfield is not expected to adversely affect adjacent permitted users of the Upper Floridan aquifer. The model predicts less than 1 ft of additional drawdown response at the closest Upper Floridan aquifer user under annual average total LNP usage conditions of 1.58 Mgd. Under maximum daily usage conditions (5.8 Mgd) for a duration of 1 week, the model predicts that increased drawdown will not extend to the closest Upper Floridan aquifer well (i.e., permitted user).

Because LNP operational groundwater usage is minor relative to the overall model water balance, the staff concludes that operational groundwater-use impacts would be SMALL, and mitigation beyond the FDEP Conditions of Certification would not be warranted.

Pettijohn Late-successional Reserve Habitat Improvement and Fuels Reduction Project (USFS, CA)[25]

This EIS, prepared by USFS, is typical of the level of discussion found in Forestry EISs. The following excerpts are the only substantial quotes on water supply, which is addressed without specificity or quantification. Dust abatement is the primary activity involving water needs in most USFS EISs.

Water drafting for dust abatement on roads will occur at designated sites for that purpose. Erosion control measures will be employed on the access and/or main road to prevent water leakage from causing stream sedimentation. Hazardous material spill prevention and containment equipment will be present on water trucks. Water trucks and pumping equipment will be in a well-maintained condition, free of fluid leaks, and have hoses in good operation condition. 31

[…]

Sites for water drafting for dust abatement are designated by the Forest Service and agreed to by the purchaser. Water drafting will meet the NOAA 2001 design standards when drafting from anadromous fish bearing stream reaches. If pumps are used they will adopt spill prevention criteria specified in TSC for servicing and refueling of equipment. F-3

SEA LEVEL RISE IN EISS

Hunter's Point Naval Shipyard Disposal and Reuse (USN, CA)[26]

This U.S. Navy prepared EIS on a former shipyard is an exceptional example of consideration of sea-level rise. Atypical of most EISs, USN has detailed multi-part mitigation plans in the face of

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[25] USFS. *Pettijohn Late-successional Reserve Habitat Improvement and Fuels Reduction Project. http://a123.g.akamai.net/7/123/11558/abc123/forestservic.download.akamai.com/11558/www/nepa/21305_FSPLT2_126822.pdf. 31, F-3*

[26] USN. *Hunters Point (Former) Naval Shipyard Disposal and Reuse, Supplement Information on the 2000 FEIS, Implementation, City of San Francisco, San Francisco County*. http://www.bracpmo.navy.mil/basepage.aspx?baseid=45&state=California&name=hps

projected sea-level rise, including construction of a shoreline protection system, a storm drainage system, consideration of sea-level rise in the determination of building elevations, and an adaptation strategy which considers monitoring measures, payment processes, and decision-making processes related to sea-level rise.

SEA LEVEL RISE

As shown in Figure 2.3-18, portions of HPS are vulnerable to inundation based on interim sea level rise estimates for 2050, as put forth by BCDC and the State Coastal Conservancy (California State Coastal Conservancy 2009). Therefore, Alternative 1 has accounted for rising sea levels in the project planning process to prevent future flooding or loss of infrastructure due to shoreline erosion. Planning for sea level rise includes four components that are summarized below and described in detail in the Infrastructure Plan (Appendix N):

1. Construction of a shoreline protection system that would initially be built to accommodate a midterm rise in sea level of 16 in (41centimeters [cm]), with an adaptable design to meet higher than anticipated levels in the mid-term and long-term;
2. Construction of a storm drainage system that initially would be built to accommodate a mid-term rise in sea level of 16 in (41 cm), with an adaptable design to meet higher than anticipated sea level rise levels;
3. Construction of buildings and vital transportation infrastructure at elevations that would not be exceeded by flood waters, even if the shoreline protection does not function, for existing conditions and over a longer-term as compared to the two components above; and
4. Formation of an Adaptation Strategy that would include preparing an Adaptive Management Plan outlining an institutional framework, monitoring triggers, a decision-making process, and creating an entity with taxing authority to pay for infrastructure improvements necessary to adapt to higher than anticipated sea levels.

Project design for sea level rise meets both near-term (2050) and long-range (2080) objectives; and in addition, incorporates an adaptive management strategy (a systematic process for continually improving management policies and practices by learning from the outcomes of previously employed policies and practices) to address sea level rise for the most conservative estimates for 2100 and beyond. Since building structures are generally “immovable,” whereas a perimeter and/or storm drain system can be adapted to keep up with changing sea levels, each was designed to a specific planning horizon as described below.

Shoreline Protection (Perimeter System) and Storm System Design

For the perimeter system, it is not practical to build a high wall around the project for a design condition that may not happen for several decades. At the same time, it is not prudent to build to present sea level conditions and keep raising it as sea levels rise. Therefore, an interim sea level rise estimate for 2050, as put forth by BCDC and the State Coastal Conservancy, was selected as the criterion for design and construction (California State Coastal Conservancy 2009). Sea level rise projected at 16 in (40.6 cm) higher than present would make it unlikely that adaptive management construction activities would be needed before at least 2050. In addition, shoreline and public access improvements have been designed with a development setback to allow any future increases in elevation to accommodate higher sea level rise values, should they occur.

However, the design would be adaptable to higher levels of sea level rise by leaving a development setback such that future improvements could be made (see the Finished Grade Elevations Above Base Flood Elevation control measure in Section 2.3.2.1.9 and discussion of the Adaptation Strategy, below.)

For the storm drain system, the same approach as the perimeter system described above was adopted. The design would be adaptable to higher levels of sea level rise with minimal intervention by implementation of a Shoreline Improvements to Reduce Flood Risk control measure as detailed in Section 2.3.2.1.9. This would avoid installing pumps and other appurtenances at the present time, when they are not needed, while still ensuring that an adaptation strategy and a funding mechanism exists for future management actions.

Figure 2.3-18 shows the existing flood zone and the flood zone with a 36-in (91-cm) sea level rise scenario. With the proposed action improvements at the time of construction, the flood zone would be reduced to that shown in Figure 2.3-19. Figures 2.3-20 through 2.3-23 show typical HPS shoreline sections and improvements along the edge of the proposed development to reduce flooding from sea level rise.

Development Design

Buildings and entrances to subterranean parking and streets would be set at an elevation that is 36 in (91 cm) higher than the existing base flood elevation. This 36-in (91-cm) sea level rise allowance, plus a freeboard of 6 in (15 cm), would be used for finished floor elevations of all buildings. This would provide that, even if no shoreline protection improvements are undertaken, or in the event of a slope failure along the shoreline, neither buildings nor transportation infrastructure would be flooded if water levels rise 42 in (107 cm) higher than the current base flood elevation. Additionally, this allowance provides subterranean parking a minimum of approximately 36 in (91 cm) between the parking finish floor and present groundwater levels. Per the most conservative rate of sea level rise (Rahmstorf, et al. 2007, which includes ice-cap melt estimate), a sea level rise of 36 in (91 cm) would not occur until about 2080, which would be approximately 50 years beyond the last phase of construction for Alternative 1 (Lennar Urban 2009b).

Ongoing measurements of sea level rise from the scientific community would be incorporated into Monitoring and Adaptive Management Plans, administered by a Geologic Hazard Abatement District or other entity with similar funding responsibility (Moffatt & Nichol 2009b). This entity would guide the decision-making process for implementation of future improvements, such as raising the perimeter. The proposed Monitoring and Adaptive Management Plan for the project would include appropriate language specifying management actions that would need to occur should sea level rise exceed 36 in (91 cm).

Should the sea level rise exceed 36 in (91 cm), the proposed action-specific funding mechanism (Geologic Hazard Abatement District or similar) would pay for improvements.

Adaptation Strategy

A project-specific sea level rise Adaptation Strategy would be implemented to provide guidance, identify relevant stakeholders, define appropriate management actions and triggers, and

establish a projectspecific funding mechanism. It would be administered by an entity created for Alternative 1 that would have taxing authority and funding responsibility.
The strategy envisions incorporating ongoing measurements of sea level rise from the scientific community into a Monitoring Program that would guide the decision-making process for future improvements. The Monitoring Program would include protocols to compare observed changes in sea level with the as-built perimeter elevations, using updates of changes in sea level provided by the National Oceanic and Atmospheric Administration, National Geodetic Survey, or other appropriate agencies. The Monitoring Program would be administered by a public entity with similar funding responsibilities as a Community Facilities District. This entity would guide the decision-making process for implementation of future improvements, such as raising the perimeter.

The Adaptive Management Plan would define specific triggers for action, based on observed changes in sea level arising from ongoing measurements obtained during the Monitoring Program. The Adaptive Management Plan would require 5- or 10-year updates based on observed changes in sea levels, as well as any other effects of climate change (i.e., more or less extreme storm wave conditions). The initial strategy, as well as any updates, would be coordinated with relevant stakeholders, including the city, State Parks, the Federal Emergency Management Agency, and BCDC.

Future improvements that may be needed to respond to sea level rise are as follows:

- When mean sea level rises 16 in (40.6 cm) above existing levels, the crest elevation of the shoreline protection system would be raised 20 in (50.8 cm) and storm drain system pumps would be installed.
- When mean sea level rises 36 in (91 cm) above existing levels, the shoreline protection system would be improved to act as a flood barrier. The proposed development setback distances would enable a variety of future perimeter modifications to accommodate at least 55 in (140 cm) of sea level rise, with the ability to accommodate even higher levels. The adaptive management strategy described above is based on elevation and structural characteristics of the shoreline along the project boundaries. The varied nature of this shoreline, ranging from protected and unprotected slopes, beaches, seawalls, and wharves, results in a multitude of potential adaptive management measures. Perimeter adaptations would likely include a combination of the following components in response to varying land uses and wave run-up characteristics at different locations around the project site:
- Raising the shoreline embankment in place to function as a storm surge or flood barrier;
- Constructing a series of embankments of increasing heights away from the water (and between sets of embankments that could hold periodic wave overtopping that “drain out” between high tides);
- Constructing sea walls, particularly along Parcel B, where they would also function as a public amenity; and
- Where feasible, “lay back” the shoreline to create cobblestone beaches or tidal marshes that limit wave run-up and overtopping, rather than increasing embankment heights.

Freeport Harbor Channel Improvement Project (USACE, TX)[27]

This USACE-prepared harbor improvement project provides an in-depth examination of sea level rise factoring in both local subsidence and eustatic sea level rise to estimate a 1.05 ft rise in sea-level over the next 50 years. This EIS is one of the most rigorous in calculations for sea-level rise.

3.1.5 Relative Sea Level Change

There are two primary components to relative sea level change in the study area—subsidence and worldwide or eustatic sea level rise associated with large-scale temperature changes. These are described below, followed by a discussion of expected combined effects on the study area.

3.1.5.1 Local Subsidence
Land subsidence has been occurring in the Clear Creek study area over the last century, primarily from the effects of groundwater pumping. In the first part of the twentieth century, subsidence was greatest along the Houston Ship Channel and the Texas City area. At the end of the twentieth century, control efforts had been successful in the channel area, and the area of greatest subsidence had migrated to the west (Figure 3.1-1).

In response to the subsidence situation, the entire metropolitan area is moving to a surface-water supply and away from groundwater. With that change, it is reasonable to expect that the rate of subsidence will be substantially reduced during the project life (2020–2070). Assuming the more recent period is representative of the distribution of subsidence and probably higher than expected for future conditions, it is representative of the existing or baseline condition.

From the recent contours, as shown on Figure 3.1-1, the upstream end of Clear Creek in Fort Bend County experienced roughly 2 feet of subsidence in the 22 years from 1978 to 2000, or 0.091 foot per year. In the same interval, the downstream end of the study area experienced 0.5-foot subsidence, or 0.023 foot per year. These are taken to be the existing or baseline rates of subsidence for the study area. Note that a higher rate of subsidence in the upstream portion of the study area has and will continue to have the effect of reducing the slope of Clear Creek. This reduced slope reduces the rate at which floodwater drains and thus increases the peak flood elevation that results from a given amount of rain.3-10

Figure 3.1-1. Historical Subsidence in Study Area

3.1.5.2 Eustatic Sea Level Rise
The eustatic, or global, rate of sea level change is difficult to quantify for a variety of reasons. The National Oceanic and Atmospheric Administration (NOAA, 2001) analyzed the long-term trends in relative sea level for water level recording stations in the U.S. and found a substantial

[27]USACE. Freeport Harbor Channel Improvement Project, Proposes to Deepen and Widen the Freeport Harbor Channel and Associated Turning Basins, Brazoria County.
http://www.swg.usace.army.mil/Portals/26/docs/Planning/Clear%20Creek%20Final%20Environmental%20Impact%20Statement-Main%20Report-October%202012.pdf

amount of variation in the rates at different locations in the U.S. Figure 3.1-2 shows the longterm mean sea level (msl) trends at stations in the Gulf, Caribbean, and Pacific. The Louisiana and Texas stations have the highest rates, but that may reflect some of the subsidence effect in addition to sea level change. The rates of East Coast stations are on the order of 2 to 3 millimeters (mm)/year and appear reasonably consistent. From this, a baseline rate of eustatic sea level change of 2 mm/year (0.08 inch, or 0.0066 foot per year) is selected. This is much less than the rates of local subsidence in the study area. Over the 50-year project life, this baseline rate would result in 0.33 foot of increase in sea level.3-11

Figure 3.1-2. Trends in Relative Sea Level Rise at Stations along the U.S. Coast
Because of observed and possibly accelerating climate changes, the rate of sea level change in recent history may not be the best predictor of the rate that will occur in the future. To account for possible accelerated rates of eustatic sea level rise, the USACE has chosen to follow EC 1165-2-211 (2009), which updates the recommendations of the National Research Council (NRC, 1987). Both publications present three possible future scenarios for sea level change: low, intermediate, and high estimates.

The calculated elevations in feet for the three scenarios for the project periods are shown in Table 3.1-1. The change over 50 years with the low scenario (1.05 feet) is based on the rate observed at the Pier 21 water level gauge of 6.39 millimeters per year (mm/yr). This is larger than that predicted from typical U.S. rates (0.33 foot).

3.1.5.3 Combined Effects
From the above, it is clear that a baseline representation of relative sea level change will involve both local subsidence and global sea level increase and is likely to have effects on the study area. One effect will be reducing the slope of the watershed by raising the water elevation at the downstream end and greater subsidence at the upstream end of Clear Creek. 3-12

Table 3.1-1
Calculated Future Rates of Sea Level Change for the Study Area Based on EC 1165-2-211 (2009)
(table omitted)

The change in relative sea level can be expected to increase the tidal exchange in Clear Lake, both from greater surface area and tidal prism in Clear Lake and greater tidal activity in Galveston Bay. This can be expected to increase average salinity in both Galveston Bay and Clear Lake and allow salinity to intrude farther inland during dry or low-flow conditions.

4.1.2 Relative Sea Level Change

As presented in subsection 3.1.5, the baseline condition for relative sea level change is an expected increase in the relative sea level from the combined effects of subsidence and eustatic, or global, sea level rise. Historically, the subsidence effect has been much larger, but in the future it is possible that eustatic increase in sea level may take on greater significance. These changes could potentially affect flooding and flood protection plans in two ways. One is that higher relative sea level will allow greater coastal storm surge propagation into Clear Lake. The storm surge elevations in the Clear Lake area are now substantially higher than the water elevations, which result from stream flooding, and higher sea level will increase that difference.

For example, the 1 percent probability stream flood elevation in Clear Lake is approximately +4 feet msl, much lower than coastal surge elevations, which are typically two to three times higher. This study addresses stream flooding and flood risk management measures proposed for the inland reaches of Clear Creek and its tributaries upstream of Dixie Farm Road. The effect of higher coastal storm surge is limited in that it only has a small increase in the length of the lower stream reaches where proposed measures dealing with the stream flooding effects do not occur.

The other major mechanism for relative sea level change to affect flooding is by reducing the slope of Clear Creek by both raising the water level at the downstream end and higher inland subsidence lowering the land level at the upstream end. This aspect is addressed below.

CA-11 and Otay Mesa East Port of Entry Project (FHWA, CA)[28]

This EIS, prepared by FHWA for a highway project, addresses sea-level rise as affecting the project but states that it is waiting on a more detailed state report to be released concerning sea-level rise, and "without statewide planning scenarios for relative sea level rise and other climate change impacts, Caltrans has not been able to determine what change, if any, may be made to its design standards for its transportation facilities." Similar statements can be seen in other agencies and project types.

"Adaptation strategies" refer to how Caltrans and others can plan for the effects of climate change on the state's transportation infrastructure and strengthen or protect the facilities from damage. Climate change is expected to produce increased variability in precipitation, rising temperatures, rising sea levels, storm surges and intensity, and the frequency and intensity of wildfires. These changes may affect the transportation infrastructure in various ways, such as damaging roadbeds by longer periods of intense heat; increasing storm damage from flooding and erosion; and inundation from rising sea levels. These effects will vary by location and may, in the most extreme cases, require that a facility be relocated or redesigned. There may also be economic and strategic ramifications as a result of these types of impacts to the transportation infrastructure.

At the Federal level, the Climate Change Adaptation Task Force, co-chaired by the CEQ, the Office of Science and Technology Policy, and the National Oceanic and Atmospheric Administration, released its interagency report October 14, 2010, outlining recommendations to President Obama for how Federal Agency policies and programs can better prepare the U.S. to respond to the impacts of climate change.

The Progress Report of the Interagency Climate Change Adaptation Task Force recommends that the Federal Government implement actions to expand and strengthen the Nation's capacity to better understand, prepare for, and respond to climate change. Climate change adaption must

[28] FHWA. *Phase II - CA-11and Otay Mesa East Port of Entry Project, Construction of a New Toll Highway (CA-11) and Port of Entry in the East Otay Mesa Area and Commercial Vehicle Facility, County of San Diego.* http://www.dot.ca.gov/dist11/Env_docs/SR11/Final_tech.html

also involve the natural environment as well. Efforts are underway on a statewide level to develop strategies to cope with impacts to habitat and biodiversity through planning and conservation. The results of these efforts will help California agencies plan and implement mitigation strategies for programs and projects.

On November 14, 2008, Governor Schwarzenegger signed EO S-13-08, which directed a number of state agencies to address California's vulnerability to sea level rise caused by climate change. This EO set in motion several agencies and actions to address the concern of sea level rise.

The California Natural Resources Agency (Resources Agency) was directed to coordinate with local, regional, state and federal public and private entities to develop The California Climate Adaptation Strategy (Resources Agency 2009), which summarizes the best known science on climate change impacts to California, assesses California's vulnerability to the identified impacts, and then outlines solutions that can be implemented within and across state agencies to promote resiliency.

The strategy outline is in direct response to EO S-13-08 that specifically asked the Resources Agency to identify how state agencies can respond to rising temperatures, changing precipitation patterns, sea level rise, and extreme natural events. Numerous other state agencies were involved in the creation of the Adaptation Strategy document, including Environmental Protection; Business, Transportation and Housing; Health and Human Services; and the Department of Agriculture. The document is broken down into strategies for different sectors that include: Public Health; Biodiversity and Habitat; Ocean and Coastal Resources; Water Management; Agriculture; Forestry; and Transportation and Energy Infrastructure. As data continues to be developed and collected, the state's adaptation strategy will be updated to reflect current findings.

Resources Agency was also directed to request the National Academy of Science to prepare a Sea Level Rise Assessment Report by December 2010 to advise how California should plan for future sea level rise. The report is to include:

- Relative sea level rise projections for California, Oregon and Washington taking into account coastal erosion rates, tidal impacts, El Niño and La Niña events, storm surge and land subsidence rates;
- The range of uncertainty in selected sea level rise projections;
- A synthesis of existing information on projected sea level rise impacts to state infrastructure (such as roads, public facilities and beaches), natural areas, and coastal and marine ecosystems;
- A discussion of future research needs regarding sea level rise.

Prior to the release of the final Sea Level Rise Assessment Report, all state agencies that are planning to construct projects in areas vulnerable to future sea level rise were directed to consider a range of sea level rise scenarios for the years 2050 and 2100 in order to assess project vulnerability and, to the extent feasible, reduce expected risks and increase resiliency to sea level rise. Sea level rise estimates should also be used in conjunction with information regarding local uplift and subsidence, coastal erosion rates, predicted higher high water levels, storm surge and storm wave data.

Until the final report from the National Academy of Sciences is released, interim guidance has been released by the Coastal Ocean Climate Action Team, as well as Caltrans, as a method to initiate action and discussion of potential risks to the state's infrastructure due to projected sea level rise.

All projects that have filed a Notice of Preparation (NOP), and/or are programmed for construction funding from 2008 through 2013, or are routine maintenance projects as of the date of EO S-13-08 may, but are not required to, consider these planning guidelines. The NOP for the proposed project was filed in December 2008 and the project is scheduled to begin construction in 2013, so a sea level rise analysis would not be required.

Furthermore, EO S-13-08 directed the Business, Transportation, and Housing Agency to prepare a report to assess vulnerability of transportation systems to sea level affecting safety, maintenance and operational improvements of the system and economy of the state. Caltrans continues to work on assessing the transportation system vulnerability to climate change, including the effect of sea level rise.

Currently, Caltrans is working to assess which transportation facilities are at greatest risk from climate change effects. Without statewide planning scenarios for relative sea level rise and other climate change impacts, Caltrans has not been able to determine what change, if any, may be made to its design standards for its transportation facilities. Once statewide planning scenarios become available, Caltrans will be able review its current design standards to determine what changes, if any, may be warranted in order to protect the transportation system from sea level rise.

Climate change adaptation for transportation infrastructure involves long-term planning and risk management to address vulnerabilities in the transportation system from increased precipitation and flooding; the increased frequency and intensity of storms and wildfires; rising temperatures; and rising sea levels. Caltrans is an active participant in the efforts being conducted in response to EO S-13-08 and is mobilizing to be able to respond to the National Academy of Science report on Sea Level Rise Assessment which is due to be released in 2012.

WATER STRESS IN EISS

F-35A Training Base (USAF, Multi-state)[29]

This EIS, prepared by the U.S. Air Force, addresses the potential of water shortage in the southwest, and determines quantitatively the percentage increase in water demand due to change in personnel and its linkage to water stress in the area. Vague conservation measures are mentioned as done on the city level. This EIS is on the above average side in the thoroughness with which it discusses drought and water stress.

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[29] USAF. *F-35A Training Basing, To Base a Pilot Training Center with the Beddown of F-35A Training Aircraft at four Alternative Bases, Boise AGS, Holloman AFD, Luke AFB, and Tucson.* http://www.f-35atrainingeis.com/resources/F-35A Training Basing FEIS Vol I June 2012.pdf

Potable Water System.
Under the F-35A aircraft scenarios, the largest net change in personnel associated with the change in mission would be an increase of approximately 5,588 personnel (including dependents); this would occur under Scenario H3W. The most recent data regarding municipal water consumption for the Alamogordo area indicate that municipal water use in 2005 was about 4.43 MGD (Alamogordo 2007b) and base use was 1.2 MGD. With an average per capita household water use estimation of about 70 gallons per day (AWWA 2010), it is anticipated that additional personnel associated with Scenario H3W would result in an increase of approximately 391,160 gallons per day. This represents a potential increase of about 6.95 percent of the latest demand statistics.

Adverse impacts associated with increases in potable water usage may occur under scenarios in which water usage may increase between 6 and 10 percent. Water shortages have been well documented in the southwest, and given the population of the Alamogordo area, an increase of about 6.95 percent in demand is considerable when tied to water usage. Currently, the city is developing new conservation measures and trying to secure additional water supplies to meet current and projected demands (Alamogordo 2007b). The potential impacts associated with increased water usage in the area may be mitigated by implementing water conservation measures for on-base housing or for personnel residing off base (e.g., water conservation directives for off-base personnel, utility compensation incentives).

Upper Las Vegas Wash Conservation Transfer Area (BLM, NV)[30]

In this BLM prepared EIS, there is discussion of how each Alternative would contribute to a cumulative water shortage because of increased water demand and uncertain water supply. This EIS also references a "Drought Plan," separate from the EIS, in case of overwhelming water demand.

4.14.2 Water Resources
In consideration of past, present, and reasonably foreseeable projects, the actions common to all of the alternatives would not have cumulatively significant impacts to surface water, groundwater, or water supply and demand. Surface and stream bank erosion and the 100-year floodplain are expected to remain similar to baseline conditions of the CTA.

Existing regulations pertaining to hazardous materials and water quality would minimize any individually or cumulatively significant adverse impacts resulting from the presence of an REC and the construction of new road alignments and utilities. Because no wells are proposed under any of the alternatives and there is little potential to encounter groundwater during construction activities within the disposed parcels, impacts to groundwater levels would not be cumulatively significant.

[30] BLM. *Upper Las Vegas Wash Conservation Transfer Area (CTA), Propose to Establish a Final Boundary, Implementation, Clark County*. https://www.blm.gov/epl-front-office/projects/nepa/29453/35503/37303/Volume_1_Final_CTA_SEIS_093011.pdf

Alternative A
In consideration of past, present, and reasonably foreseeable projects, Alternative A would not have cumulatively significant impacts to surface water or groundwater. The amount of sediment loss resulting from surface and stream bank erosion is expected to mirror current conditions within the CTA study limits, and the 100-year floodplain and existing drainage would not be altered with the implementation of this alternative. As a result, no new flood control facilities or erosion control measures would be required under this alternative.

Existing regulations pertaining to hazardous materials and water quality would minimize any individually or cumulatively significant adverse impacts resulting from development within the disposed parcels.

Because no wells are proposed under Alternative A and there is little potential to encounter groundwater during construction activities within the disposed parcels, impacts to groundwater levels would not be cumulatively significant.

Implementation of Alternative A would result in an incremental increase in water demand to accommodate development within the disposed parcels. Because the demand for water in the LVV continues to grow and supplies are uncertain, this increase, despite being minimal, could represent a cumulatively significant impact if SNWA cannot meet future projected water demands. SNWA, in cooperation with local municipalities, will continue its effort to achieve more rigorous conservation goals, will implement its Drought Plan (SNWA 2007), and will explore additional supply opportunities to help meet long-term demand within this region.

Alternative B
Cumulative impacts related to groundwater would not be significant for the same reasons as described under Alternative A. Implementation of the Preferred Alternative would result in an incremental increase in water demand to accommodate development of the disposed parcels. If the forecasted water shortfall cannot be met by the SNWA water portfolio (refer to Figure 3.3-2), the additional water requirementsunder the Preferred Alternative could contribute to a cumulative impact to water supply and demand.
SNWA, in cooperation with local municipalities, will continue its effort to achieve more rigorous conservation goals, will implement its Drought Plan (SNWA 2007), and will explore additional supply opportunities to help meet long-term demands within this region.

Under the Preferred Alternative, stream bank erosion processes would increase incrementally within the CTA study area and in downstream reaches of the ULVW. The additional impervious surfaces and increased runoff from development would lead to a slightly larger floodplain, assuming no enlargement to Chapter 4 Upper Las Vegas Wash Conservation Transfer Area240 Final SEISthe existing flood control facilities or construction of new facilities. Mitigation measures would be required to reduce the cumulative erosion and hydrologic impacts.

Alternative C
Implementation of Alternative C would not have cumulatively significant impacts to groundwater for the same reasons as those described under Alternative A. In addition, the construction of a new detention basin within the CTA to address flood control needs would

promote groundwater recharge. However, a new detention basin would alter existing flows and sediment transport within the wash, disrupting the natural flows and erosion processes. Existing regulations pertaining to hazardous materials and water quality would minimize any individually or cumulatively significant adverse impacts resulting from development within the disposed parcels.

Alternative C would result in an incremental increase in water demand to accommodate development within the disposed parcels. The increase represents a small percentage of future projected demands over the presumed 20-year build-out period. Because future water sources are undetermined, any increase in water requirements in the LVV could represent a cumulatively significant impact if SNWA cannot meet its projected demands. SNWA will continue its effort to achieve more rigorous conservation goals, will implement its Drought Plan (SNWA 2007), and will explore additional supply opportunities to help meet long-term demands within this region.

Alternative D

Because no wells are proposed under Alternative D and there is little potential to encounter groundwater during construction activities within the disposed parcels, cumulative impacts to groundwater levels would not be significant under Alternative D. In addition, the construction of a detention basin within the CTA to address flood control needs would promote groundwater recharge.

Existing regulations pertaining to hazardous materials and water quality would minimize any individually or cumulatively significant adverse impacts resulting from development within the disposal parcels.

Under Alternative D, there would be an incremental increase in water demand to accommodate development of the disposed parcels. If the forecasted shortfall cannot be met by the SNWA water portfolio, the additional water demand required under Alternative D could represent a cumulatively significant impact to water supply and demand. SNWA, in cooperation with local municipalities, will continue its effort to achieve more rigorous conservation goals, will implement its Drought Plan (SNWA 2007), and will explore additional supply opportunities to help meet long-term demands within this region.

Implementation of Alternative D would contribute to cumulative erosion and sedimentation processes within the CTA study area and in downstream reaches of the ULVW. Mitigation measures would be required to reduce the magnitude of cumulative erosion and sedimentation impacts.

Alternative E

Implementation of Alternative E would not have cumulatively significant impacts to groundwater for the same reasons as those described under Alternative A. In addition, the construction of a detention basin within the CTA to address flood control needs would promote groundwater recharge. Existing regulations pertaining to hazardous materials and water quality would minimize any individually or cumulatively significant adverse impacts resulting from development within the disposal parcels.

Implementation of Alternative E would contribute to cumulative erosion and sedimentation processes within the CTA study area and in downstream reaches of the ULVW. Mitigation measures would be required in order to reduce the magnitude of cumulative erosion and sedimentation impacts.

Alternative E would result in an increase in water demand to accommodate development within the disposed parcels. The incremental increase represents a small percentage of future projected demands over the presumed 20-year build-out period. Because future water sources are undetermined, however, any increase in water requirements in the LVV could represent a cumulatively significant impact if SNWA cannot meet projected demands. SNWA, in cooperation with local municipalities, will continue its effort to achieve more rigorous conservation goals, will implement its Drought Plan (SNWA 2007), and will explore additional supply opportunities to help meet long-term demands within this region.

FLOODING IN EISS

Mid-Columbia Coho Restoration (BPA, WA)[31]

This EIS, prepared by the Bonneville Power Administration, discusses a fishery management project and includes information on projected impacts to floodplains, flood storage volume, and channels. The discussion on flooding is typical for EISs, which do not aggressively quantify effects.

3.10.3 Impacts of the Proposed Action

Implementation of the Proposed Action would probably have little or no effect on flood elevations. Where there is an effect, it is likely to be beneficial, as the new or expanded acclimation ponds would provide some small amount of additional floodplain storage (difference between the existing land surface elevation and the working water surface elevation). The spoil materials created by construction activities such as excavation of ponds and ditches, grading of roads to improve winter access, or installation of buried water supply pipes would be disposed of outside the 100-year floodplain in accordance with the local grading and floodplain management ordinances. Consequently, there are not likely to be changes in grades that could direct or divert flood flows affecting properties either upstream or downstream of the individual project sites. Site-specific impacts are discussed only for the primary and backup sites with substantial construction activities. Sites that require only minor improvements to existing ponds, access roads, or conveyance facilities are not expected to alter the potential for flooding at those sites and are therefore not discussed further. New wells, although providing additional flow through the acclimation sites, would withdraw water from shallow aquifers that are typically hydraulically connected to the adjacent creek or river. Therefore, there is no real gain or loss of water (see Section 3.6). Additionally, the well discharge would be very minor compared to flood

[31] BPA. *Mid-Columbia Coho Restoration Program, Proposal to Fund the Construction, Operation, and Maintenance of the Program to help Mitigate for Anadromous Fish, Okanogan County.* http://efw.bpa.gov/environmental_services/Document_Library/Mid-Columbia_Coho_Restoration_Project/Mid-C Coho FEIS pkg 2-21-12.pdf

flows (Section 3.6). Consequently, sites that require only flow augmentation from wells are not discussed further.

3.10.3.1 Wenatchee Acclimation and Hatchery Sites

Table 3-37 lists the entire Wenatchee basin hatchery and acclimation sites, the floodplain development activities associated with each project, and the likely need for a floodplain development permit. Where the floodplain development permit process is required, a professional civil engineer would need to perform substantially more detailed analyses of floodplain impacts. These detailed floodplain analyses are not part of this impact evaluation and are beyond the scope of the EIS.

Surface water intakes proposed at the Tall Timber, Chikamin, and Dryden sites would be below grade and would match the existing contours of the river banks. They would be designed so they do not decrease flood storage volume and would not impede flow. Pipelines delivering water from these intakes would be buried and would have no impact on flood elevations. Site-specific discussions of sites requiring construction follow the table.

Primary Acclimation Sites

Tall Timber
The Tall Timber site is located on the unmapped section of the Napeequa River near its confluence with the White River. Although FEMA has designated a special flood hazard area along the White River (Zone A), the project site is located outside the special flood hazard area. The Tall Timber acclimation site would require a river intake and pipeline delivering water to an existing disconnected side channel. An 800-foot-long water supply pipeline from the intake to the side channel would be buried. An existing culvert would convey water from the side channel back to the river. Because the pipeline would be buried, it is expected that there would be no effect on flooding. Floodwater elevations in the stream reach between the intake and the outlet of the acclimation diversion may be slightly reduced due to the withdrawal of water from the main channel.

Chikamin
Construction of an acclimation pond at the Chikamin site would require excavation of approximately 1,370 cubic yards of material. An intake would be constructed on the bank of Chikamin Creek and a 200-foot-long water supply pipeline from the intake to the pond would be buried. A rock-lined open channel, 100 feet long and 5 feet wide, would be constructed to convey water from the pond back to the creek. The Chikamin site is not located in a FEMA mapped flood hazard area, but is likely in the 100-year floodplain of Chikamin Creek. The construction of a pond would likely lower flood elevations a small amount due the removal of excavated soils from the floodplain. Overall, the project would have little effect on flooding.

Minnow
Construction of an acclimation pond at the Minnow site would require excavation of approximately 1,370 cubic yards of material from the bed and banks of Minnow Creek,

essentially widening and deepening the channel. The Minnow site is not located in a FEMA mapped flood hazard area but is in the 100-year floodplain and floodway of Minnow Creek.

During a flood, the flows would be essentially the same because there is not a substantial amount of active storage in the pond. Consequently, there could be very small reduction in flooding but no change to the floodway.

Tappan Zee Hudson River Crossing Project (FHWA, NY)[32]

This FHWA EIS on the construction of a bridge in New York, unlike typical EISs, which mostly comment on effects to floodplains, considers flooding as impacting the project, though not with great detail.

FLOODING EVENTS
Based on the above data, it is reasonable to assume that sea level and floodplains would rise by up to 2.0 feet by the end of the century, with a smaller chance of increases up to 4.5 feet. The elevation of the current 1-in-100 probability flooding event is 6.6 feet (NAVD88), and therefore, the 1-in-100 probability coastal flooding level by the end of the century is likely to be in the range of 8.6 to 11.1 feet. The lowest point along the bridge access is approximately 30 feet above this level (this occurs along the Rockland approach), and the bridge and its approaches would not be expected to flood in future coastal flooding events within a 1-in-100 probability per year (this is similar to the No Build Alternative).

Note that the 1-in-500 probability floodplain on the Rockland side in the area of the bridge approach (Figure 15-5) extends further upland on the steep slopes west of the Thruway (not parallel to the Hudson); flooding in that area is associated with sheet flow caused by heavy downpours, not coastal flooding. Although it is likely that the frequency of heavy downpours events (very short events where precipitation would exceed 4 inches per day, currently once every three years on average) may be increased by climate change, there is currently no information to indicate if climate change would impact the most extreme events, occurring with a probability of less than 1-in-100.

Such infrequent flooding events would have a similar flooding effect in the Rockland bridge approach area as in the current condition, and are currently expected to occur with a probability ranging from 1-in-100 to 1-in-500 in any given year.

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[32] FHWA. *Tappan Zee Hudson River Crossing Project, To Provide an Improved Hudson River Crossing between Rockland and Westchester Counties Funding.*
http://www.newnybridge.com/documents/feis/index.html