Dear Phil,

It was great to meet with everyone last week. You have a fine staff, and the questions and discussion were first rate.

I'm sorry that I'm not qualified to draft an emergency response plan… and I feel badly enough about that to pass along some potentially helpful observations. You will certainly want to have a suitable set of response plans developed as you move forward.

Emergency Response

The keys to emergency response are planning, preparation, and practice (the three P's). Omission of any one of these is a bad idea.

Emergency response with regard to Delta flood risk has two main flavors: (1) protection of life safety, and (2) protection of water transmission and property (economic issues). Environmental issues are also important, but they will be less urgent in any disaster scenario. The key for the environment, and for the eco-systems, will be to ensure that suitable response capability is available for life safety and water supply reliability, so that those issues do not suddenly rise up during a severe emergency to "trump" (and threaten) eco-system damages that might be irreparable.

There are three basic types of risk or "threat": (1) "regular" non-seismic levee failures (e.g. overtopping, through-seepage and erosion, underseepage, slope instability, burrowing rodents, etc.), (2) potential terrorism, and (3) seismic levee damage. I'll briefly address each of these in turn.

1. "Regular" Non-Seismic Levee Failures:

As we discussed, levees are very challenging due to the adverse terrain and geology upon which they must be sited, their lengths traversed, inadequate budgets for engineering field exploration and also for analysis, lack of public and political attention for long time spans, lack of budgets and/or attention for long-term maintenance, ongoing degradation over time (settlements, cracking, progressive erosion, etc.), and other issues.

Levees can be better or worse, depending upon the levels of effort and funding applied. It will never be cost-feasible to render the roughly 1,100 miles of levees in the Delta fully immune to potential failure, so we can expect that non-seismic failures will continue to occur over time.

These failures usually occur during or shortly after high-water events, and they most often occur singly (though there have been times when several occurred more or less simultaneously in a single high water event.) There have been more than 160 such failures in the Delta since 1900, and we are well-used to fixing them. So we know a good deal about it.

High water events are predictable (they can be accurately forecast), and so they are usually monitored. "Flood fighting" is the combined activity of: (1) locally inspecting and closely monitoring levees (usually by driving along the levee crests and walking the levee faces and toes) during high water events, and then (2) intervening (with

construction crews, equipment, and materials) to attempt to forestall any incipient failures before they can develop fully. Flood fighting is the presumptive basis for most U.S. levee design standards; engineers (often unknowingly) intrinsically assume that flood fighting will occur when establishing design criteria, margins of safety, etc. Flood fighting is a major activity of the DWR during high water events, but usually only in situations where significant numbers of people are potentially at risk. Many Delta islands are sparsely inhabited, and many Delta levee districts (islands) in the Delta cannot afford much or any flood fighting, and so many Delta levees are often poorly monitored during periods of high water risk.

And, occasionally, levees fail not during high water events; so they "surprise" us.

(a) Life Safety

As we discussed, one of the keys to life safety is to understand that Delta floodwaters will be cold; typically on the order or 45° to 60°F, and that people cannot long persist (nor swim) in such temperatures. That is a stark contrast to the floodwaters from the Gulf that inundated New Orleans which, at about 82°, were akin to warm bathtub water. People were able to survive, in and out of those waters, for multiple days.

Saving lives in the Delta means getting people quickly out of the water. Fortunately, for non-seismic levee breaches, that is a fairly straightforward task.

When non-seismic levee failures occur, they are finite "breaches". These initiate at a given location, and then as the floodwaters begin to rush through into the island these widen and deepen due to erosion (or "scour") from the inrushing floodwaters. They often grow to widths of several hundred feet in the first hours, and then widen (and deepen) more slowly after that as the inrushing waters are slowed by the waters already ponding within the island or tract. Because these are openings of finite width, the islands fill relatively slowly. It can take up to a couple of days to fully fill a large island. So the waters rise relatively slowly.

The result is a low level of risk with regard to life safety, as people have time to migrate to higher ground (e.g. the top of the nearest levee). Sometimes people are sleeping, or distracted, and so they become trapped on top of buildings and have to be rescued. But even then, there is time available for doing that.

Most Delta islands are sparsely inhabited, so the number of people at risk is small. The exceptions are few, and they include the legacy towns, which have populations on the order of several hundreds to a few thousand, and portions of Stockton and other "cities" that encroach the edges of the Delta. For the largest of the legacy towns, it might be assumed that many would "self-rescue" (move to the nearest levee crest), and would wait there to be removed further. Less than a thousand might have to be rescued from buildings, and several hours would be available (at least) during which that could be accomplished. So a limited number of helicopters and/or boats could do the job.

Response would thus entail learning about the breach, and then mobilizing and delivering the necessary helicopters and boats. DWR are usually among the first to be notified when breaches occur, and both DWR and 911 notifications need to be routed to

those who can best provide the necessary rescue resources. Preparation would consist of "education" of inhabitants as to the risk, and telling them to make their way to the nearest levee crest road if they possibly can. Otherwise, stay put and wave down rescuers as they arrive.

Helicopters and boats would have to be available, and operators of those would have to understand the situation and the timeline (as the waters rise.) Also the dangers of submerged obstacles that might sink boats. Again, planning and practice.

Recent exercises have consisted of putting small numbers of people (usually a dozen or less) into relatively warm puddles in the Delta, and then lifting them to safety with helicopters and winches; and announcing that we are well prepared. That is falsely reassuring and not very useful. Better practice scenarios would entail plucking people from rooftops or windows of buildings, with overhead power lines and antennas as possible complicating obstructions, and likely in the wind and rain (as these usually accompany high water events.) Both boats and helicopters would likely be needed.

Once people are out of the water, transport of displaced persons from the levee crest to a more permanent rescue site would then be needed, but with less urgency.

(b) Levee Repair, Water Transmission Reliability, and Property and Assets

The second issue is the repair of the breach, and (1) property retrieval, and (2) the restoration of safe water transmissibility.

Levee breaches are repaired by first "armoring" the two ends of the opening to prevent further erosion as tides carry water into and out through the breach twice each day. Large rock is used for this armoring. There are only a finite number of quarries that can produce such rock in the region, and only one that can do so quickly and in bulk. That is the Dutra quarry on the shore of San Pablo Bay, and it is constantly under legal siege from nearby homeowners who wish to shut it down to eliminate the noise (explosives blasting) from the quarry. [It is a noisy process, but the quarry was there first…] The need for rock in the Delta is certainly a strategic security issue for the State of California, and likely also for the Nation, and it has long been my recommendation that either the State or the Fed's declare the Dutra quarry a vital strategic resource and so protect the availability of rock for the coming century (or so). That won't be politically popular, but you guys are empanelled to lead. The other potential sources of rock are quarries in the foothills to the east, but they cannot produce it quickly in similarly large quantities, and it must be transported by trucks (rather than by barge). If rock from these other quarries was to be stockpiled in sufficiently large quantities, then the strategic need for the Dutra quarry could be reduced.

After the two ends are "capped" (armored), a pair of arched rock berms are usually next built across the opening, creating an oval (or nearly circular) "blister" between the two berms into which ordinary soils can then be deposited. This fills the breach. These blisters usually extend some considerable distance onto the island, and are readily visible from helicopters and aircraft when you fly over the Delta. This type of repair can usually be accomplished in several weeks.

Wind-blown waves can also attack the inner slopes of levees in a flooded island. These inland faces have so erosion protection, as they are not usually in contact with

water, and they can erode very quickly if they are not protected. It is often necessary to provide emergency levee slope face protection against erosion on the inside a flooded island, away from the actual breach, and stockpiles of materials and supplies (and plans) for this have advanced over recent years. More can be done here, and at small expense.

The final step is to "unwater" the island (the correct technical term for pumping out the ponded floodwaters.) This can take weeks to months, depending on the size and depth of the island, and the number of pumps mobilized.

An important policy consideration for the Council is that, prior to about 2004, the U.S. Army Corps of Engineers (USACE) used to respond jointly with DWR to address and repair Delta levee breaches. Then it was realized that the Corps was actually not supposed to be doing that; it was beyond their mission, especially as most Delta levees are "non-project" levees in which the Corps officially has no stake. So now DWR are on their own.

DWR can handle single breaches, but as we will next be discussing first multiple breaches, and then even worse seismic damage scenarios, it will become important to consider how Federal (and even potentially military) assets might be mobilized. As a policy issue; the security and reliability of the Delta and its water transmission role are key State and National security issues, and it should be possible to get the USACE formally tasked to respond to levee failures that are larger than a single, isolated breach (e.g. by Act of Congress, or similar.)

Retrieval (unwatering) of property and assets (buildings, rail lines, gas facilities, etc.) has historically been done by pumping out the islands, but there has been no systematic effort to then help with restoration of functionality. And that has worked fine so far. Most people (and corporations, etc.) understand that there is some risk, and they have historically made their own efforts to restore their assets. Or to insure them. Some thought might be given to this by the Council. Trains can be re-routed around a damaged island, and supplemented with trucks, until disrupted rail service is restored. The PG&E gas storage facilities in the central Delta are interesting, as the Bay Area relies heavily on those during December and January (as gas transmission capacity is too limited to bring enough gas to the Bay Area during these two cold months); but we are hardly the North Pole, and this may be an acceptable risk. The current precedent is to let people (and corporations and utilities, etc.) fend for themselves in this regard. Changing that could open a can of worms. But changing the levels of protection provided Delta-wide as part of the evolution of the Delta under the Council's benevolent new management may eventually require consideration of policy changes here, as well as other potential steps such as grouping (or "bundling") of key assets into protected islands or corridors, etc.

(c) Multiple Levee Failures

In the unusual situation wherein several levee failures occur during a single event, the issue would only be one of scale. Sufficient resources would need to be available to address several rescues, and several levee repairs. DWR would be somewhat challenged to handle this on their own, and it is here that pre-arrangement for sharing of resources and responsibilities with Federal agencies (e.g. the USACE, the Coast Guard, etc.) might begin to be especially valuable.

2. Terrorism

The Delta is, fortunately, not a very good target for terrorism. Clever terrorists could theoretically mobilize a number of mobile truck bombs, or similar, and could detonate them simultaneously causing multiple breaches. There would be little threat to life safety, however, and they could not reasonably expect to produce enough damage that the breaches could not be repaired and the islands pumped out in less than a single water year. If we are reasonably responsible with south-of-Delta water storage for emergencies, this would not be a very damaging scenario. There are certainly far better targets for terrorists.

Responsible south-of-Delta water storage is important here. We have worked very hard over the past couple of decades to enhance emergency water storage "downstream" of the Delta, and good progress had been made. Most noteworthy was the construction of the Eastside Reservoir by the Metropolitan Water District. Unfortunately, over the past several years, reductions in water deliveries under the environmentally driven constraints imposed by Judge Wanger have eaten deeply into "emergency" water reserves, and we were at the start of last year as potentially vulnerable as we have ever been. It was a pretty good water year, however, and Judge Wanger has now revised his own rulings after realizing the need to balance water needs for humans and for ecosystems. ("Co-equal"…bless him!) His revision of those rulings may have involved briefings on the strategic importance (at a National level) of being prepared for potential seismic disruption of the Delta; as will be discussed next. What is missing here, on a policy level, is a requirement that water agencies maintain some required minimum reserve for emergencies…. no matter what. Also, a requirement that water agencies do a better job of cross-connecting their lines so that in a serious water emergency the State can literally commandeer water and move it to where it is most needed. Those will not be popular issues with regard to the water agencies. But your principal concern must be the greater common good. And, as we discussed, one of the main lessons from New Orleans and Hurricane is the cost of not being prepared when catastrophe strikes.

3. Seismic Levee Damage

Seismic levee damage potential is not well understood, largely because we have not yet experienced it in the Delta. We have, however, seen it in many other parts of the world, and so we know all too well how it works.

One important aspect of seismic levee damage is the lack of a "weather prediction" or any other notice or warning. Earthquakes are always a surprise, and so response is always a challenge.

The main differences between non-seismic and seismic levee damage, however, are those of scope and scale. Non-seismic levee failures can produce a limited number of localized "breaches", each of which can be relatively quickly repaired. An earthquake can produce soil liquefaction (loss of strength of sandy levee foundation soils and sandy levee embankment soils) such that the soils largely become "fluid" in their characteristics. This can produce catastrophic slumping and instability of levees, and this is not a localized phenomenon; this can occur for many contiguous levee miles. A

mid-sized east bay Earthquake can produce many tens of miles of such failures, and larger events can produce more than a hundred miles of levee failures and slumping.

The result will be damages that simply cannot be rapidly repaired.

Much of the Delta will be temporarily transformed to a shallow inland bay. We will not be "filling" in finite holes (or "breaches"), instead we will be re-constructing many miles of levees largely from scratch. And much of the work will have to be done from barges. With no finite holes to fill, large rock will not be needed to armor the ends of breaches. Instead, dredging and wholesale earthmoving on a massive scale will be needed to rebuild the damaged and slumped levee sections.

It will take multiple years to accomplish this, especially if we do not make realistic and prudent preparations in advance (as is the current situation). Accordingly, restoration of water delivery will instantly become both the top State and likely also the top National priority. It is quietly expected that States of Emergency, and Executive orders, will be used to over-ride normal environmental laws, and there is a significant risk that irreparable damage may be done to ecosystems as a result of efforts to restore at least partial water transmission and delivery as expeditiously as possible. There is no precedent for a disaster of this scale in a modern society such as ours.

Current best estimates of the likelihood of occurrence of an earthquake that would cause extensive damage to the Delta are on the order of 1% to 2% per year. The public has little understanding of that, as we have not had a major Bay Area earthquake since the Great San Francisco Earthquake of 1906. But the seismic history of the Bay Area is episodic; we get about 50 years of significant activity (multiple major earthquakes), such as occurred between 1860 and 1906, and then we get roughly a century of "quiet" as the fault systems store up new energy (as they "reload"). We are now entering a period when they are fully reloaded, and the next half century is expected to be a period of significant seismic activity.

(a) Life Safety

Because of the lack of warning, seismic damage and flooding will come as a surprise. The scale of the damage, which may include flooding of a majority of the Delta islands in a worst case scenario, will be extensive. Because we will not be dealing with "breaches" of finite dimensions, some islands will fill very quickly, and the rapidly rising floodwaters will pose a significant threat to life safety.

And the Delta will not be the only location affected. Appurtenant regions (e.g. the more populous Bay Area, Sacramento's "pocket", Natomas basin, etc.) will also likely be affected, so emergency response assets will be stretched in many directions all at once. The result is usually best described as chaos.

Given that tens of thousands of people may have to be rescued very quickly from what will quickly become dangerously deep waters in the Sacramento "pocket" and/or from the Natomas basin, it may be anticipated that many in the Delta will simply have to fend for themselves in the critical first few hours. Preparation, and education, will thus be vital.

People will need to understand the potential risk, and to have thought about what they will do. Boats will be needed, on each island or tract, that can float freely to the surface as the waters rise, and that have gas for their engines so that they can serve as a local rescue capability. People who can't make their way to a nearby levee crest (or who have no nearby levee crest because it slumped away beneath the waters) will have to be shuttled to intact "high ground" (surviving levee crests) to await further rescue. Time will be of the essence, and people with boats will have to be taught to deposit their own families on the remaining intact levee crests, and then go back for others, rather than spending an hour or more to get their own families fully removed to solid ground. In the cold waters, those who are not quickly removed from those waters (e.g. 20 to 30 minutes or less) will suffer hypothermia, and then they will drown.

In legacy towns, which have higher concentrations of people, it would be advisable to provide some number of buildings of sufficient height (and with sufficient rooftop accessibility, even for the old and infirm) as to represent a temporary refuge above the waters until rescue can arrive. Ditto for "urban" communities around the edges of the Delta.

Such an earthquake will be a major national event, and it will draw a full response from FEMA and other national agencies. But they will have had no warning (as opposed to hurricanes, where they do get a significant warning and so can begin to mobilize and stockpile resources even before the storm arrives), and so emergency "rescue" will be slow to arrive, and most Delta residents will have to largely fend for themselves and for their neighbors.

(b) Levee Repair, Water Transmission Reliability, and Property and Assets

Levee repair in the wake of significant seismic damage will not be done "in the usual manner". We have no precedents, and no experience, with the expected scenario.

Current estimates are that it will take three to five years to restore the Delta sufficiently as to resume water transmission and delivery to the Bay Area and to southern California. That will create a situation without precedent, and it is difficult to predict how that will play out with regard to potential abrogation of environmental laws and other expedient measures to restore water delivery as quickly as possible.

A better solution would be to be prepared for this before it happens. We are currently fully unprepared.

Preparation would include considering serious, and potentially feasible options for dealing with a water system disaster. Potential rationing and even State or National commandeering of water supplies may occur. The San Joaquin River system, and its dams, may be re-directed towards providing water for delivery south-of-the Delta, and farming (and use of pesticides and fertilizers) in the San Joaquin watershed may be banned for several years to improve runoff quality and amounts. But that will not likely be nearly enough.

Emergency storage south-of the-delta will, of course, also be vital. We will all have to hope that these emergency storage reserves have been diligently maintained, even in the face of what usually appear to politicians and decision-makers as "more urgent" short-term demands on such water. As a policy matter, utilities could be

required to be fully diligent with regard to such emergency storage; even in the face of "regular" drought, etc.

And steps could be taken to promote reparability of the Delta, especially with an initial focus on at least partial restoration of water delivery, and in a manner that would not be devastating (over the long-term) to ecosystems or species. Both water users, and ecosystem advocates, would have an interesting common interest in this when the chips are down.

Current efforts to stockpile rock are useful for individual, finite, non-seismic failures but they will be of little value for seismic damages (except for the potential use of mobile rock barriers to re-direct streams and channels as the levees begin to be restored.) What will be needed will be massive resources, of the type that only the Federal government can reasonably bring to bear. And barges.

The Federal government should, in collaboration with the State, make realistic contingency plans for mobilizing a response akin to that type of military response with which we would expect to meet an attack on our Nation. Instead of tanks and planes, however, we'll need excavators, dredges, bulldozers, trucks, and barges.

There are only a finite number of construction barges able to do this type of work from the water available on the west coasts of North and South America. We'll need all of them, or at least as many as we can get, and plans should be made for acquiring them. Additional barges are available on the east coasts, and they can be brought through the Panama Canal.

Plans should be in place for restoration of levees and also for restoration of water system serviceability. Ecosystem considerations should be included in the criteria, and ecosystem advocates should be positively engaged here based on the understanding that in the alternative of workable solutions the resulting chaos will likely lead to less attractive approaches that will produce devastating ecosystem damages. In the all too likely case that constructive agreement proves to be unworkable, then tough decisions and contingency plans will have to be made in the absence of agreement.

It will be vital to coordinate local, State and Federal water utilities and agencies. Collaborative wielding of resources (especially storage reservoirs, and their controllable releases, and pumps, etc.) will be of vital importance, and probably over a period of several years. Response planning should include gathering together the key State and Federal decision-makers in a command center, where all necessary information can be made available and where the necessary decisions can be made; in the first hours, over the first days, and over the weeks and months that will follow. Prior agreements will have to have been reached as to who is in charge. Petty rivalries will have to be put aside. Leadership will be needed.

And "practices" will have to be held. Role playing scenarios in which the actual parties work their way through scenarios, learning their roles, tuning the overall response plans, and getting to know their counterparts (partners) from other agencies and services.

Much of this would eventually be rendered moot if the State (or the Feds) ever manage to construct a seismically robust water transmission system or facility.

Prospects for that continue to be remote at this time, however, and we are currently at least seven years away from that in the best-case scenario. Any number of parties can easily delay that for a great deal longer, and it is certainly possible that the wrangling of the past 60 years will continue until an earthquake finally occurs.

And so it is advisable to also have a Plan B. Given the stakes, Plans C and D (and so on) may also be advisable.

Plans B and C might look like: (B) planning to re-work the San Joaquin River system to provide as much water as possible for south-of-Delta water needs, severe rationing, banning water use for landscaping outright, etc., in order to stretch emergency water supplies as far as possible, and (C) placing large soil berms along selected sections of a through-Delta channel that might then be “rapidly reparable” in the wake of a major seismic event.

Wide soil berms could be placed now, in preparation for a potential seismic event, on the landward side of the levees along such a channel (on the agricultural fields) with little adverse ecosystem impacts. If sections of the adjacent levees then slumped and failed during the earthquake, the adjacent elevated berms would be available to serve as the already partially constructed bases of the new (replacement) levee sections. For sections that do not slump and fail, the adjacent berm materials (soils) would be available as borrow material for use in construction of replacement levees at sections which did suffer damage. And again without major adverse ecosystem impact, as would otherwise occur with dredging of levee fill soils from the river channels. Seasonal re-establishment of partial water delivery might be rapidly accomplished in this manner, and moveable rock berms could be used to direct (and re-direct) flows as necessary due to changing water conditions and ongoing repair progress. This would be a crude and temporary water transmission system, and far from a perfect solution. And it is rife with obvious difficulties and drawbacks under “normal conditions”. But under the extraordinary duress of a major seismic water disaster it might be far better than the current situation of non-preparation coupled with denial and wishful thinking.

Better heads, gathered together and directed appropriately to consider feasible solutions, might do even better. That exercise, based on realistic understanding of the actual likely post-earthquake situation, is long overdue.

Closure

We discussed an admirably broad range of topics yesterday, but I wanted to finish by reminding you about the attached list of potential short-term actions. Many of these would serve admirably both with regard to protection of life safety as well as education of the still largely unaware Public. They would also be fiercely resisted by select special interests, and would also run strongly counter to ever-popular denial. You would have to be courageous, or very foolish, to attempt to incorporate any of these in your plans…but perhaps God loves a brave fool?

Best regards,
Ray Seed

Short-Term Actions

1. Realistic Emergency Response Plans (vs. “Denial”)

- Realistic appraisal of the actual situation
- Logistics (contacts, coordination, resources, chain of command, etc.)
- Boats…. the “Natomas Navy”, on every island and tract; untethered on their trailers and with 30 feet of rope, so that they can float to the surface and be available as rescue craft. Map the locations of these, and provide boats for communities that don’t have enough. The cost would be low (most would volunteer), and administrative costs would be low as well.
- Evacuation (mandatory standards….)
- Plan, and practice
- Cost of preparation vs. the cost of not being prepared (e.g. new Orleans)
- The adverse role of denial in public policy and public safety
- The value of back-up Plan’s B (e.g. the Deepwater Horizon platform disaster and oil spill

2. Warning and Notification (and Education)

- Two blue lines on lamp posts and sign posts at the 100-year flood level
- Mapping and disclosure
- Teach appropriate personal/family response planning

3. Preparation

- Building codes: require neighborhoods potentially susceptible to deep inundation to have some accessible rooftops above the 100-year flood level
- In New Orleans, the new building codes require potential egress from attics so that people won’t again be trapped and drowned by rising waters
- Maps of locations of boats/boat marshals…provide additional boats where needed
- Improve levees/flood protection for larger communities (e.g legacy towns, Stockton, etc.)?