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GROUND WATER MINING, WATER TRANSFERS
AND THE OGALLALA AQUIFER STUDY

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I. Ground Water Mining

A. Overview

In 1975 eighty-three percent of the fresh water consumed in the United States was for crop irrigation. In the western states (Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming) the amount was ninety-one percent. Although the major source of irrigation water has been surface water, the use of ground water for irrigation has increased dramatically. Ground water constituted thirty-eight percent of the water used for irrigation in the western states in 1975, compared with twenty-one percent in 1955. The quantity of ground water used for irrigation in the western states increased from eighteen million acre feet in 1955 to fifty-six million acre feet in 1975.

This increase in ground water use for irrigation has led to the mining of ground water in several western states, notably California, Arizona, Kansas, and Texas. Ground water mining occurs when withdrawals from an aquifer are made at rates in excess of net recharge. Mining becomes serious when it continues on a sustained basis. As ground water tables decline, the cost of withdrawing ground water increases. When the economic returns from irrigation no longer pay the costs of withdrawal, economic depletion of the aquifer has occurred.

Ground water mining is not inherently wrong. Economic problems will occur, however, when ground water is mined without considering its future value. If a ground water reservoir were not hydrologically interconnected with surface supplies, and if it were owned or controlled by a single entity, the decision to mine or not to mine could be left to the owner. Presumably the decision of whether to mine would be based on balacing benefits from present use with anticipated benefits from future use. But ground water reservoirs are often hydrologically related to surface supplies and other aquifers, and are rarely in a single ownership. Thus, ground water reservoirs are managed (or mismanaged) as "common pool" resources, such that excessive use leads to premature exhaustion.

Common pool resources are those for which the right to use the resource without charge is shared with others. Usually there is no significant ceiling on the amount each user may take. Because the resource is not priced, there is no private incentive by any user to reduce current consumption for use in the future. Any user who does so runs the risk that another user

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will take the resource for present use. There is no incentive to save for tomorrow, even though there is general agreement that the value of the resource may be greater in the future. Two major social consequences of unregulated development of common pool resource are that (1) the resource may be consumed at a faster rate than is desirable, and (2) local and regional economies dependent on the resource may contract. This latter phenomenon is referred to as the boom and bust syndrome.

Most economists believe that restrictions on ground water use will often lead to greater economic benefits than ground water mining. Regulation of ground water mining, however, is not widespread in the western states. The major problem is political. Irrigators have traditionally been given a high degree of independence in determining how land and water resources are used in agricultural production. Government water use regulations are perceived as limiting this independence. Irrigators have incorrectly assumed that these regulations necessarily threaten their economic interests. This attitude is probably the single most important factor in preventing effective regulation of ground water mining.

States and the federal government have a common interest in addressing the ground water mining issue. States are interested in managing ground water mining to achieve the greatest economic benefit from ground water use. The economic impacts of depleting ground water reserves would be most significant at the state and local level. The federal interest in regulating ground water mining is somewhat different. If the economic depletion of a ground water reservoir is not planned for, the federal government is likely to be requested to furnish a supplementary water supply, sometimes referred to as a "rescue project," at taxpayer expense to sustain an established economy which developed on the improvident use of ground water.

In most western states ground water use is subject to some degree of state regulation. Significantly, however, in the western states in which sixty percent of the ground water withdrawn for irrigation in 1975--California, Texas, and Nebraska--meaningful state or local controls on ground water use historically have not existed. A more politically popular approach has been to import developed water supplies to augment diminishing ground water supplies. This has been accomplished principally at federal expense in southern California through the Boulder Canyon Project. Arizona and Texas are emulating the California experience in attempting to secure a federal rescue project to deal with their ground water mining problems through the Central Arizona Project and the High Plains-Ogallala Aquifer Study, respectively.

B. Ground Water Controls in Critical Areas.

The basic theories of western ground water law do not directly address the issues presented by ground water mining. The absolute ownership and reasonable use doctrines do not directly address the issue of ground water mining. Under the absolute ownership doctrine, a landowner may withdraw ground water without regard to whether ground water is being mined. Under the reasonable use doctrine, a landowner's right to withdraw ground water will be restricted only if it is wasteful, if the ground water is used on nonoverlying lands, or both. Otherwise, a landowner may withdraw ground water without regard to whether ground water is being mined.

The correlative rights doctrine addresses mining of ground water in theory by prorating the "safe yield" of an aquifer among ground water users.

However, in practice, correlative rights in California is part of the legal basis for integrating use of ground water and imported surface water supplies, not a policy for restricting ground water use.

Appropriation states vary in their approaches for dealing with ground water mining. In theory, one method of resolving disputes among appropriators is provided by the basic principle that a junior appropriator must stop using water when his withdrawals conflict with those of senior appropriators. Similarly, a policy of restricting new ground water appropriations may protect existing ground water users. However, neither approaches will not by itself necessarily prevent ground water mining.

Special regulation of ground water development and use in "critical areas" is the most common approach, being implemented in appropriation and overlying use jurisdictions through special ground water development and use regulations in designated areas. Twelve western states use this approach for designated areas. Ariz. Rev. Stat. Ann. §45-401 et seq., Colo. Rev. Stat. §37-90-102, Idaho Code §42-233a, Kan. Stat. Ann. §82a-1036, Mont. Rev. Codes Ann. §89-2914, Neb. Rev. Stat. §46-656, Nev. Rev. Stat. §434.020, N.M. Stat. Ann. §75-11-13, Or. Rev. Stat. §537.735, Tex. Water Code Ann. tit. 2, §52.02, Wash. Rev. Code Ann. §90.44.130, Wyo. Stat. §41-129. The general objective of such legislation is to slow or stop ground water mining and to protect existing irrigation-based economies. Specific policy objectives include protection and maintenance of current irrigation, Ariz. Rev. Stat. Ann. §45-401(A), Idaho Code §42-233a, maintaining aquifer yield, Ariz. Rev. Stat. Ann. §45-401(A), Wash. Rev. Code. Ann. §90.44.130, and preventing land subsidence, Tex. Water Code Ann. tit. 2, §52.117.

Designating special ground water control areas typically is a state responsibility. Ariz. Rev. Stat. Ann. §§45-412 to -414, Colo. Rev. Stat §37-90-106(1), Idaho Code §42-233a, Kan. Stat. Ann. §82a-1038, Mont. Rev. Codes Ann. §89-2914, Neb. Rev. Stat. §46-658(1), Nev. Rev. Stat. §534.030(2), N.M. Stat. Ann. §75-11-13, Or. Rev. Stat. §537-730, Wash. Rev. Code Ann. §90.44.130, Wyo. Stat. §41-129(b). Contra Tex. Water Code Ann. tit. 2, §52.021. The designation process can be initiated either by state officials, Ariz. Rev. Stat. Ann. §46-412, Colo. Rev. Stat. §37-90-106(1), Idaho Code §42-233a, Kan. Stat. Ann. §82a-1036, Mont. Rev. Codes Ann. §89-2914, Nev. Rev. Stat. §534.030(2), N.M. Stat. Ann. §75-11-13, Or. Rev. Stat. §537.730, Wash. Rev. Code Ann. §90.44.130, Wyo. Stat. §41-129(b), or upon the petition of local ground water users, Ariz. Rev. Stat. Ann. §45-415, Kan. Stat. Ann. §82a-1036, Mont. Rev. Codes Ann. §89-2914, Neb. Rev. Stat. §46-658(3), Nev. Rev. Stat. §534.030(1), Or. Rev. Stat. §537.730, Tex. Water Code Ann. tit. 2, §52.021, Wash. Rev. Code Ann. §90.44.130, Wyo. Stat. §41-132.

Criteria for establishing control areas vary considerably and include:

(1) withdrawals approaching or exceeding a ground water basin's "safe yield" or recharge, Ariz. Rev. Stat. Ann. §45-412(1), Kan. Stat. Ann. §82a-1036(b), Mont. Rev. Codes Ann. §89-2914(1), Or. Rev. Stat. §537.730(3), Wash. Rev. Code Ann. §90.44.130, Wyo. Stat. §41-219(a)(i),

(2) ground water level declines, Kan. Stat. Ann. §82a-1036(a), Or. Rev. Stat. §537.370(1), Wyo. Stat. §49-129(a)(ii),

(3) conflicts between ground water users, Neb. Rev. Stat. §46-658 (1)(a), Mont. Rev. Codes Ann. §89-2914(3), Or. Rev. Stat. §537.720(2), Wyo. Stat. §41-129(a)(iii),

(4) water quality degradation, Ariz. Rev. Stat. Ann. §45-412(3), Kan. Stat. Ann. §82a-1036(d), Or. Rev. Stat. §537.730, and
(5) land subsidence, Ariz. Rev. Stat. Ann. §45-412(2).

The ground water controls authorized in designated areas also vary. Authorized controls include:

(1) requiring permits for new wells, Colo. Rev. Stat. §37-90-107, Neb. Rev. Stat. §46-659(1), Nev. Rev. Stat. §534.050, Tex Water Code Ann. tit. 2, §52.114,
(2) restricting ground water development through permit denials, Colo. Rev. Stat. §37-90-107, Idaho Code §42-233a, Nev. Rev. Stat. §§533.370(4) -534.110(3), well spacing requirements, Neb. Rev. Stat. §46-666(1)(c), Tex. Water Code Ann. tit. 2, §52.117, Wyo. Stat. §41-132(a)(v), or well drilling moratoria, Kan. Stat. Ann. §82a-1038(b)(1), Neb. Rev. Stat. §46-666(4), Nev. Rev. Stat. §534.110(7), Or. Rev. Stat. §537.730(1), Wyo. Stat. §41-132(a)(i) [See also Ariz. Stat. Ann. §§45-432, 45-452 & 46-416], and
(3) reducing ground water use by enforcing priorities, Kan. Stat. Ann. §82a-1038(b)(2), Mont. Rev. Codes Ann. §89-2915(1), Nev. Rev. Stat. §534.110(6), Or. Rev. Stat. §537.730(a), Wash. Rev. Code Ann. §90.44.130, Wyo. Stat. §§41-132(a)(ii) & (iii); reducing presently authorized withdrawals, Ariz. Rev. Stat. Ann. §§ 45-541 to 45-545, & 45-563, Kan. Stat. Ann. §82a-1038(b)(3), Neb. Rev. Stat. §46-666(1)(a), Or. Rev. Stat. §537.730(4); rotating pumping, Kan. Stat. Ann. §82a-1036(b)(4), Neb. Rev. Stat. §46-666(1)(b), Or. Rev. Stat. §537-730(b), Wyo. Stat. §41-132(a)(iv); enforcing voluntary pumping agreements, Or. Rev. Stat. §573.735, Wyo. Stat. §41-132(c); or purchase and retirement of ground water rights, Ariz. Rev. Stat. Ann §§45-566(A)(6) & 45-567(A)(6).

Ground water controls are usually not embraced by irrigators. Development restrictions may be favored by existing irrigators because their pumping rights are protected from competition regarding new development. Development restrictions will be opposed by potential ground water users who correctly argue that they are being restricted for the benefit of the ground water miners. This argument may have more force in overlying rights jurisdictions where priority has no direct role in ground water allocation.

Use restrictions are also unpopular with irrigators who perceive them as threats to their economic livelihood. This ignores two facts. First, considerable room for improvement in irrigation water use efficiency is usually possible without substantial increases in irrigation costs. See Aiken, The National Water Policy Review and Western Water Rights Law Reform, 59 Neb. L. Rev. 327, 329-36 (1980). Second, if withdrawals are not reduced through regulation they ultimately will be reduced because of the reduced aquifer capacity. The issue is whether regulation to extend aquifer life is preferable to forced reductions in withdrawals because of increased costs, reduced aquifer capacity, or both.

C. Supply Augmentation.

Locally more popular than ground water regulations is supply augmentation, particularly if subsidized imported water can be obtained. Supply augmentation has been implemented on a large scale in California where the federal Boulder

Canyon project has made imported Colorado River water available for municipal and agricultural purposes. Because the Boulder Canyon project is the historical inspiration for the High Plains study, its political and legal history will be briefly considered.

The first source of supplemental water used by Los Angeles was the Owens Valley. Surface water was imported to Los Angeles from the Sierra Nevada mountains through the 250 mile LA Aqueduct, completed in 1913. Although LA financed most of the aqueduct and storage facilities the Owens Valley water was initially used for irrigation in the San Fernando Valley. LA subsequently had to buy up the irrigated land to obtain Owens Valley water.

The second source of supplemental water for LA is the Colorado River. As early as 1901 Colorado River water was imported to the Imperial Valley for irrigation through the Imperial Canal. Ultimately irrigation interests persuaded the federal Bureau of Reclamation to recommend in 1921 construction of a major reservoir in Boulder Canyon (Hoover Dam) for flood control, water supply, and hydropower generation as well as a canal to deliver water to Imperial Valley irrigators. In 1922 Secretary of State Herbert Hoover met with the seven basin states to negotiate an interstate compact apportioning Colorado River between Upper Basin states (Wyoming, Colorado and Utah) and Lower Basin states (New Mexico, Nevada, Arizona and California). Arizona refused to sign the initial compact proposal, correctly concluding that California would prevent Arizona's acquiring as much water as it would have preferred. A six state compact, excluding Arizona, was executed in 1925, allocating 7.5 million acre feet (maf) per year to the Upper and Lower Basin states, respectively. Up to 1 maf of any surplus above 15 maf could be appropriated by Lower Basin states. The compact did not apportion water among the Lower Basin states. For this reason Arizona did not ratify the compact until 1944, when it pursued construction of the Central Arizona Project.

The compact was ratified by Congress in the Boulder Canyon Project Act of 1928. 45 Stat. 1057, as amended, 43 U.S.C. §617. The Act required California to limit its annual consumption to 4.4 maf plus half of any surplus available to the Lower Basin states. The Act was passed in part because LA in 1923 proposed that a second dam (Imperial Dam) and canal (All-American Canal) be built to deliver Colorado River water to LA and Imperial Valley irrigators. LA initiated organization of municipal water districts from 13 southern California cities into the Metropolitan Water District (MWD). The combined urban and irrigation interests were able to secure passage of the Boulder Canyon Project Act, authorizing construction of Hoover Dam, Imperial Dam, and the All-American Canal. Parker Dam was subsequently authorized to complete the Colorado River Project. In 1931 MWD voters authorized construction of the Colorado River Aqueduct. Construction of Hoover Dam began in 1931 and was completed in 1935. Parker Dam and Imperial Dam were completed in 1938. The Colorado River Aqueduct was completed in 1939 and the All-American Canal in 1940. Total project costs exceeded $400 million.

As mentioned above Arizona ratified the Colorado River Basin compact in 1944 to pursue development of the Central Arizona Project (CAP). Congressional authorization of the CAP was delayed because of legal uncertainty regarding whether Arizona had title to sufficient water for the CAP. In 1952 Arizona sued California to clarify Arizona's compact water entitlements. In the 1963 decision of <u>Arizona v. California</u> 373 U.S. 546 (1963), the court ruled in favor of Arizona, clearing the way for pursuing the CAP. In 1985 part of California's share of Colorado River water will revert to Upper Basin states.

The availability of supplemental water has led to the integrated use of imported surface water and local ground water in southern California. This includes the use of the storage capacity of mined ground water reservoirs to store imported surface water underground. California Supreme Court decisions have facilitated the evolution of these integrated management policies by recognizing the exclusive right of recharge entities to control withdrawals of water stored underground. Los Angeles v. San Fernando, 537 P.2d 1250 (1957); Los Angeles v. Glendale, 142 P.2d 289 (1943). If rights to withdraw ground water are adjudicated and withdrawals limited to each user's proportionate share of the safe yield, recharge entities can charge ground water users for water withdrawn in excess of the safe yield allocation. The safe yield adjudication process essentially creates a presumption that ground water withdrawn in excess of the safe yield allocation is recharged ground water for which the recharge entity must be paid. These water management innovations should not obscure, however, that ground water users in southern California have thus far managed to avoid regulation of ground water development and use because of federally subsidized interstate surface water transfers.

II. The High Plains-Ogallala Aquifer Study

A. Background.

Texas is second only to California in the amount of ground water withdrawn and the number of acres irrigated. Irrigation from the Ogallala aquifer in Texas High Plains (panhandle) began in the 1930s. High Plains ground water levels started falling in the 1940s. State legislation authorized the organization of local ground water conservation districts, some of which have (1) restricted ground water development through well spacing requirements and (2) indirectly limited withdrawals through irrigation runoff control regulations. The first state water development plan concluded in 1966 that (1) water importation to west Texas from the rest of the state would not supply enough water to maintain High Plains irrigation, although limited amounts of east Texas water could be imported for municipal and industrial use, and (2) federally subsidized interstate surface water transfers from the Mississippi, Missouri, or Columbia Rivers could stabilize or expand High Plains irrigation. These conclusions were included in the final 1968 Texas Water Plan. Texas has opted to pursue implementation of the plan rather than impose ground water development restrictions.

B. The High Plains Study.

1. Study objectives. Texas, realizing that it needed to persuade Congress to finance water importation to the Texas High Plains, obtained authorization of the $6 million High Plains Study. P.L. 94-587 §193, 90 Stat. 2943 (October 22, 1976). The study authorization, however, reflects that some political compromises were necessary for study authorization. The study justifications are (1) "to assure an adequate supply of food to the Nation" and (2) "to promote the economic vitality of the High Plains Region" (emphasis added). The study objections are (1) "to study the depletion of the natural resources of [states using] declining water resources of the Ogallala

aquifer," and (2) "to develop plans to increase water supplies in the area and report thereon to Congress, together with any recommendations for further congressional action." The study must "examine the feasibility of various alternatives to provide adequate water supply in the area including, but not limited to, the transfer of water from adjacent areas. . .to assure the continued economic growth and vitality of the region." The study must include evaluating the costs and benefits of various actions and the costs of inaction. In evaluating water transfer options existing water rights and future water needs for all affected areas must be considered.

The apparent congressional intent suggests that (1) the economic vitality of the region as a whole is the primary concern rather than the economic vitality of individual states within the region, (2) depletion of oil and gas reserves in the region is a valid factor for consideration in addition to ground water depletion, (3) sources of supplemental water could include the Missouri and Mississippi rivers but probably would exclude the Columbia river, (4) future water needs of the exporting and importing basins are considered equally (no special basin of origin protection) and (5) environmental concerns (not mentioned in the authorization) probably are subordinate to economic development concerns.

2. Study administration. The Economic Development Administration (EDA), U.S. Department of Commerce, is responsible to Congress for the study. Because the six High Plains states are responsible for the actual conduct of the study and have a stake in the study outcome affected, study administration is governed by the High Plains Study Council. Council membership includes the Governors of the High Plains states, three other state representatives (usually water rights and/or planning administrators and state legislators) appointed by the Governor, and EDA representatives. Each state has equal representation on the Council, making study domination by any single state more difficult.

3. Study procedures. The study will examine six alternative development strategies: (1) basline (no change) (2) voluntary and mandatory water demand management, (3) intrabasin water supply augmention, (4) intrastate interbasin transfers, (5) interstate water transfers, and (6) nonagricultural development options. The baseline and interstate water transfers options are the only alternatives completed as of this writing.

4. Baseline results. The baseline scenario represent what would happen from 1977 to 2020 if current public policies are not changed; i.e. no new ground water regulations, supply sugmentation, or technological innovations. The baseline projects, however, that irrigation water use efficiency will increase significantly. Increasing irrigation costs are projected to give irrigators sufficient private economic incentives to adopt improved irrigation practices and technologies currently available. Crop prices are projected to increase in real terms (i.e. discounted for inflation) but not as rapidly as during the past decade. Increasing U.S. population and, more importantly, increases in agricultural exports are the primary reasons crop prices are expected to rise. The baseline also evaluates oil and gas production in the region.

The baseline results indicate that ground water withdrawals will decline from 22 million acre feet (1977) to 20 million acre feet (2020). However, the number of irrigated acres will increase from 12 million acres (1977) to 13.5 million acres (2020). The economic value of irrigated production will increase from \$4.5 billion (1977) to \$11 billion (2020), primarily because of increased crop prices. Natural gas production will decrease from 5.5 billion cubic feet (1977) to 0.5 billion cubic feet (2020). Oil production will decrease from 500 million barrels (1977) to 50 barrels (2020). The real value of oil and gas production will increase from \$3.5 billion (1977) to a peak of \$5 billion (2000), but then decline to \$1.5 billion (2020).

The regional irrigation aggregates indicating an net increase in the value of irrigated production masks a very substantial shift in the location of irrigation. The amount of ground water withdrawals decrease approximately 9% from 1977 to 2020 across the region. Most of the decrease will come in Kansas and Texas, whereas ground water withdrawals will increase in Nebraska. The amount of Texas ground water withdrawals will decrease 40%, from 8 million acre feet (maf) (1977) to 4.8 maf (2020). Kansas withdrawals will decline 90%, from 3 maf (1977) to 0.3 maf (2020). Withdrawals will increase in Nebraska 60%, from 8 maf (1977) to over 13 maf (2020). Withdrawals in Colorado, Oklahoma and New Mexico will be approximately 1 maf throughout the study period. The loss of irrigated acres in Texas and Kansas will be more than compensated by irrigation growth in Nebraska. Texas and Kansas also are likely to lose cattle feeding to Nebraska because of reduced irrigation. Approximately six million acres will be ceased being irrigated regionally while additional acres will be only partially irrigated.

The baseline results suggest that regional economic vitality will improve over the next 40 years. The regional value of irrigated production and oil and gas production will increase from \$8 billion to \$12.5 billion. If Nebraska were excluded, however, the rest of the region will decline economically regarding oil and gas production and irrigation.

5. Interstate transfers. The High Plains Study Council established by resolution that water needed for present and reasonably forseeable uses (including instream uses) will be considered unavailable to importation. Based on this and other resolutions the U.S. Army of Engineers has identified four interbasin surface water options. Routes A1 and A2 would transfer 2.1 maf and 6.4 maf of water respectively from the Missouri river at Ft. Randall reservoir in southeast South Dakota to soutwest Nebraska, northeast Colorado and western Kansas at an average annual cost cost of \$410 and \$360 per acre foot respectively. Routes B1 and B2 would transfer 1.0 maf and 6.0 maf from the Missouri river at St. Joseph, Missouri to west Kansas at an average annual cost of \$880 and \$352 per acre foot, respectively. Routes C1 and C2 would transfer 2.0 maf and 6.8 maf respectively principally from the Arkansas river at Van Buren and Cearendon, Arkansas to the northern Texas High Plains at an average annual cost of \$745 and \$482 per acre foot, respectively. Routes D1 and D2 would transfer 2.4 maf and 7.2 maf respectively from the Arkansas, Ouachita, Red, Sabine and Sulphur rivers in Arkansas and Texas to the northern and southern Texas High Plains at an average annual cost of \$785 and \$695 per acre foot, respectively. (Annual irrigation water use in the High Plains ranges from two to four acre feet annually.)

The costs of imported surface water averages \$600, and do not include the costs of delivering irrigation water to irrigators. In contrast irrigators are able to pay up to \$100 an acre foot for water only by 2020 if at all. Implementation of any of the transfer options would require a substantial subsidy.

Results from the other options are not available, although one option may simulate the impact of ground water regulations.

C. Congressional Options.

The High Plains Study resolution indicated two justifications for the study: (1) maintaining an adequate food supply to the Nation and (2) maintaining the economic vitality of the High Plains region. The baseline results indicate that food production will increase between 1977 and 2020, although food exports and prices both will increase. This suggests that food supplies will be adequate if somewhat more expensive. The economic vitality of the region will also improve, although most of the increase in irrigated production occurs in Nebraska. If Nebraska were excluded from the region, the regional economic picture would be negative due to oil, gas and irrigation production declines. Water importation to maintain irrigation in Texas and Kansas would require federal subsidies of up to $91.2 billion for construction plus up to $12.7 billion per year for operation and maintenance. Whether subsidies of this magnitude are politically feasible during what may be a period of federal budget austerity remains to be seen but appear unlikely, particularily if water supplies from the Upper Missouri basin are used for energy production. Perhaps ground water controls and/or improvements in irrigation water use efficiency in Texas and Kansas may yet be able to extend the life of ground water supplies. If not Texas and Kansas will suffer the consequences of not imposing the discipline of ground water regulations to extend the life of ground water supplies.

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